^{71}Ga(p,nγ) 1974Ma32,1975On01,1993Fe03

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 188,1 (2023)	17-Jan-2023

1974Ma32: E=1.72-2.96 MeV protons from the 3-MV Van de Graaff accelerator of the AEB at Pelindaba, South Africa. 99.6% enriched target. Measured Eγ, Iγ, γγ, nγ, γ(θ), excitation functions with Ge(Li) detectors. Deduced levels, J, π, branching ratios, mixing ratios. 1970Ma09 is an earlier study by the same group as 1974Ma32 at E=1.5-3.1 MeV.

1975On01: E=1.5-2.0, 5.0 MeV beams from the electrostatic generator at Kyushu University. 98.8% enriched target. Measured Eγ, Iγ, ce, excitation functions using a Ge(Li) detector and a double-focusing magnetic beta-ray spectrometer. Deduced levels.

1993Fe03: E=1.5-3.1 MeV. Measured excitation functions, enriched (99.6%) target. Comparisons with statistical model calculations, deduced spin assignments.

1999Iv08: E=3.0 and 3.5 MeV beams from the FN tandem Van de Graaff in Bucharest. 99.6% enriched target. Measured lifetimes using DSA technique. The gamma-ray energies and branching ratios listed in table IV are mainly from 1993 Nuclear Data Sheets for A=71.

2002Ka51: E=2.5-4.3 MeV. Measured Eγ, Iγ, γ(θ) at six angles from 0° to 90°, lifetimes by Doppler-shift attenuation method (DSAM) from singles spectra. Natural Ga target was used which has 40% abundance of ^{71}Ga. Gamma spectra contained a large contamination from γ lines in ^{69}Ge, and other competing reactions.

Others:

1976Br41: E=7 MeV. Measured γ(θ,H,t), deduced quadrupole relaxation rates.

1975Ri03, 1973RiZI, 1971RiZK: g-factor determined from perturbed angular distribution method with the excited state produced by (p,n) reaction.

1973Ca31: E=3 MeV. Measured Eγ.

1970Be29: E=5.2 MeV. Measured γγ(θ,H,t), deduced g factor.

1970RoZX: E(p)=2.95 MeV; in-beam measurement of ce.

1970Be29: E(p)=5.2 MeV.

1968Mo12: differential perturbed angular distribution of γ used to determine the g-factor and $T_{1/2}$ of 175 level.

1962Re09: E(p)≈20 MeV; $T_{1/2}$ of 198 level and α(exp) of 175γ.

1961Sc11: E(p)=1.315-2.17 MeV; $T_{1/2}$ of 198 level.

^{71}Ge Levels

E(level)[†]	Jπ[‡]	$T_{1/2}$[#]	Relative population[a]	Comments
0.0	1/2⁻			
174.99 *5*	5/2⁻	79 ns *2*		g=+0.406 *4* (1968Mo12) $T_{1/2}$: from γγ(t) (1968Mo12). Other: 84 ns *2* (thesis by W. Withuhn, Freien University, Berlin (1968); quoted by 1978Ta08).
198.43 *10*	9/2⁺	20.1 ms *4*		g=−0.2307 *1*; Q=0.34 *5* (1975Ri03) $T_{1/2}$: 20.2 ms (1970Be29). g: other: −0.2304 *5* (1970Be29). $T_{1/2}$: weighted average of 20.3 ms *3* (1961Sc11) and 19.5 ms *5* (1962Re09). Value is 20.22 ms *12* in the Adopted Levels.
499.81 *6*	3/2⁻		96 *4*	Relative population: at E(p)=2.03 MeV. Jπ: γ(θ) of 500γ limits it to 1/2 or 3/2; γ(θ) of 247γ to this level excludes 1/2; π from multipolarity of 500γ (1975On01). Excitation function (1993Fe03) gives 3/2⁻,5/2⁻, excludes 1/2⁻.
525.09 *8*	5/2⁺		100 *3*	Jπ: 5/2 from excitation function and γ(θ). Excitation function (1993Fe03) gives 3/2⁺,5/2⁺, excludes 7/2⁺.
589.67 *9*	7/2⁺		55.4 *20*	Jπ: 7/2⁺ to 11/2⁺ from γ(θ) and M1 transition to the 198 9/2⁺ level, the excitation function favors J=7/2. Excitation function (1993Fe03) gives 5/2⁻,7/2⁺, excludes 5/2⁺,7/2⁻,9/2⁺.
708.16 *7*	3/2⁻	>10.7 ps	82.1 *23*	$T_{1/2}$: from 1999Iv08. Other: 0.46 ps +6−5 (2002Ka51). Jπ: 3/2⁻,1/2⁻ from excitation function and γ(θ); π from multipolarity of 708γ. Excitation function (1993Fe03) gives 3/2⁻,5/2, excludes 1/2⁻.

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^{71}Ga(p,nγ) 1974Ma32,1975On01,1993Fe03 (continued)

^{71}Ge Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$[#]	Relative population[a]	Comments
747.21 *6*	5/2⁻	0.28[@] ps *+6−4*	57.6 *12*	Jπ: γ(θ) gives a unique assignment of 5/2; π from M1+E2 γ to 500 level. Excitation function (1993Fe03) gives 3/2⁻,5/2⁻, excludes 7/2⁻.
808.10 *7*	1/2⁻	0.21[@] ps *+5−4*	29.3 *8*	Jπ: 1/2 from γ(θ) and excitation function (1993Fe03). Excitation function (1993Fe03) excludes 3/2⁻,5/2.
831.17 *7*	3/2⁻	0.44[@] ps *4*	67.8 *14*	Jπ: 3/2⁻ from γ(θ) and excitation function; π from M1 transition to 500 level Excitation function (1993Fe03) gives 3/2⁻, excludes 1/2⁻,3/2⁺,5/2.
1026.51 *9*	5/2⁻	>1.2 ps	36.1 *10*	$T_{1/2}$: from 1999Iv08. Other: 0.47 ps *+15−9* (2002Ka51). Jπ: 5/2 uniquely determined from γ(θ) of 527γ; negative parity preferred from excitation function. Excitation function (1993Fe03) gives 3/2⁻,5/2⁻,7/2⁺ with a better agreement with 5/2⁻; excludes 3/2⁺,5/2⁺,7/2⁻.
1037.65 *17*	9/2⁺		6.25 *16*	E(level): level from 1974Ma32 only. Jπ: (7/2 to 11/2) from γ(θ) of 839γ; excitation function prefers J=9/2. Excitation function (1993Fe03) gives 9/2⁻,9/2⁺, excludes 7/2,11/2⁺.
1095.51 *20*	3/2⁻	0.62 ps *14*	34.8 *9*	Jπ: 1/2,3/2 from γ(θ) of 1096γ; excitation function prefers J=3/2. Excitation function (1993Fe03) gives 3/2⁻, marginally excludes 5/2⁻; excludes 1/2⁻,3/2⁺,5/2⁺,7/2⁺.
1096.07 *20*	7/2⁻	0.49[@] ps *+8−6*	12.2 *11*	$T_{1/2}$: from Doppler shift for 921γ (2002Ka51); the authors incorrectly assigned 921γ to 3/2⁻ level. Jπ: 7/2 uniquely determined from γ(θ) of 921γ. Excitation function (1993Fe03) gives 7/2⁻, excludes 5/2,7/2⁺,9/2.
1139.29 *12*	3/2⁻	4.0 ps *14*	37.5 *12*	Jπ: 3/2,1/2 from γ(θ) of g.s. transition; excitation function favors J=3/2. Excitation function (1993Fe03) gives 3/2,5/2⁺, excludes 1/2,5/2⁻.
1192.3 *10*	11/2⁺			E(level): level from 1999Iv08 and 1993Fe03. Jπ: excitation function (1993Fe03) gives 11/2, excludes 9/2.
1205.04 *15*	5/2⁺	1.11 ps *28*	10.9 *4*	Jπ: 3/2 to 7/2 from γ(θ); excitation function favors 5/2. Excitation function (1993Fe03) gives 3/2⁻,5/2⁺, excludes 3/2⁺,5/2⁻,7/2.
1212.45 *10*	5/2⁻	>1.2 ps	20.8 *6*	$T_{1/2}$: from 1999Iv08. Other: 0.31 ps *+5−4* (2002Ka51). Jπ: unique assignment of 5/2 from γ(θ) of both 713γ and 1212γ; excitation function favors negative parity. Excitation function (1993Fe03) gives 3/2⁻,5/2⁻, excludes 3/2⁺,5/2⁺,7/2⁺.
1288.59 *15*	1/2⁻		6.26 *25*	Jπ: excitation function (1993Fe03) gives 1/2⁻, excludes 1/2⁺,3/2,5/2.
1298.71 *17*	3/2⁻	0.42 ps *9*	8.1 *4*	$T_{1/2}$: other: 0.31 ps +5−4 (2002Ka51). Jπ: 1/2,3/2 from γ(θ) of 1299γ; excitation function favors negative parity. Excitation function (1993Fe03) gives 1/2⁺,3/2⁻, excludes 1/2⁻,3/2⁺, 5/2,7/2.
1349.1 *6*	1/2⁺	0.46 ps *11*		$T_{1/2}$: 0.33 ps +8−6 (2002Ka51). Jπ: excitation function (1993Fe03) gives 1/2⁻, but does not seem to rule out 1/2⁺ and 7/2 from figure 3 in 1993Fe03, excludes 3/2,5/2.
1378.01? *12*	5/2⁻			E(level): doublet proposed by the evaluators.
1379.0 *7*	(1/2⁻)	0.21[@] ps *+8−5*		Jπ: excitation function (1993Fe03) gives 1/2⁻,7/2⁻, excludes 1/2⁺,3/2, 5/2,7/2⁺; γ to 1/2⁻.
1406.5 *9*	7/2⁻	0.86[@] ps *+21−15*		Jπ: excitation function (1993Fe03) gives 7/2⁻, excludes 3/2,5/2,7/2⁺,9/2.

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^{71}Ga(p,nγ) 1974Ma32,1975On01,1993Fe03 (continued)

^{71}Ge Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$[#]	Comments
1414.6 *7*	(1/2⁻,3/2,5/2⁻)	0.33[@] ps *4*	Jπ: excitation function (1993Fe03) gives 1/2⁺,7/2⁺, excludes 1/2⁻,3/2, 5/2,7/2⁻.
1422.12 *11*	9/2⁻	437[@] fs *+14−11*	E(level): level from 2002Ka51 and 1993Fe03. Jπ: excitation function (1993Fe03) gives 9/2, excludes 7/2,11/2,
1454.2? *10*	(1/2⁺)		Jπ: excitation function (1993Fe03) gives 1/2⁺,3/2⁻,5/2⁻ excludes 1/2⁻, 3/2⁺,5/2⁺.
1477.4 *8*	(5/2⁻)		Jπ: excitation function (1993Fe03) gives 5/2⁻,7/2⁺, excludes 5/2⁺, 7/2⁻,9/2⁺.
1507.0 *3*	7/2⁻	0.51 ps *16*	Jπ: excitation function (1993Fe03) gives 7/2⁻,9/2 excludes 5/2,7/2⁺.
1542.5 *9*	(1/2⁺,3/2⁻)		Jπ: excitation function (1993Fe03) gives 1/2⁺,3/2⁻ excludes 1/2⁻, 3/2⁺,5/2.
1558.8 *9*	5/2⁺	0.24[@] ps *+4−3*	Jπ: excitation function (1993Fe03) gives 3/2,5/2,7/2⁺, excludes 7/2⁻.
1566.2 *10*	(5/2⁻,7/2⁺)	61[@] fs *+15−4*	Jπ: excitation function (1993Fe03) gives 3/2⁻,5/2⁻,7/2⁺ excludes 3/2⁺,5/2⁺,7/2⁻,9/2.
1599.1 *15*	3/2⁻	0.55 ps *15*	Jπ: excitation function (1993Fe03) gives 1/2⁺,3/2⁻,5/2⁻,7/2⁺ excludes 1/2⁻,3/2⁺,5/2⁺,7/2⁻.
1629.6 *9*			Jπ: excitation function (1993Fe03) gives 1/2⁺,3/2⁺,5/2⁺,7/2⁺.
1698.6? *20*	(9/2)⁺		Jπ: excitation function (1993Fe03) gives 9/2⁺ but 11/2⁺ is not ruled out; excludes 7/2⁺.
1743.5 *7*	3/2⁻	0.42 ps *15*	$T_{1/2}$: other: 65 fs +11−9 (2002Ka51).
1792.4 *20*	(3/2⁺,5/2⁻)		
1937.8[&] *20*	(3/2⁺,5/2⁻)	0.69 ps *28*	
1965.4[&] *20*	3/2⁻		

[†] From a least-squares fit to Eγ data.
[‡] From the Adopted Levels. Supporting arguments from this reaction are indicated.
[#] From DSAM (1999Iv08) unless otherwise stated. The values from 1999Iv08 are treated as more reliable by the evaluators since these authors used an enriched ^{71}Ga target, whereas 2002Ka51 used a natural Ga target where ^{71}Ga abundance is ≈40%.
[@] From DSAM (2002Ka51), value not measured in 1999Iv08. This values is treated as uncertain by the evaluators and has not been included in Adopted Levels due to likely contribution from impurity lines in singles γ spectrum used in the DSA analysis. Also side feeding corrections were not stated in the paper.
[&] γ rays associated with these levels are seen weakly at the highest E(p)=3.1 MeV only (1970Ma09).
[a] At E(p)=2.34 MeV unless otherwise stated.

γ(^{71}Ge)

Experimental conversion coefficients are from 1975On01, except where noted otherwise.

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[@]	δ[&]	α[e]	Comments
174.99	5/2⁻	174.9 *1*	100	0.0	1/2⁻	E2		0.0916	α(exp)=8.8×10^{-2} *10*; α(K)exp=7.8×10^{-2} *9*; α(L)exp+α(M)exp=1.12×10^{-2} α(K)=0.0809 *12*; α(L)=0.00925 *14*; α(M)=0.001371 *20*; α(N)=7.92×10^{-5} *12* Eγ=174.7 *1*, relative Iγ=673 *14* (1975On01, at E(p)=5.0 MeV). α(exp),α(K)exp: from 1970RoZX; other: α(exp)=1.2×10^{-1} *3* (1962Re09). There seems a misprint in α(L)exp+α(M)exp=1.12×10^{-1} in 1975On01.
198.43	9/2⁺	(23.4)		174.99	5/2⁻				E_γ: rounded value from the Adopted Levels, Gammas.
499.81	3/2⁻	324.4[#] *1*	3.0[#] *15*	174.99	5/2⁻				E_γ: poor fit; level-energy difference=324.8.
		499.9[a] *1*	100 *5*	0.0	1/2⁻	M1+E2	−2.8 *+11−36*	0.00224 *15*	α(K)exp=1.7×10^{-3} *2*; α(L)exp+α(M)exp=1.8×10^{-4} *11* α(K)=0.00200 *13*; α(L)=0.000210 *14*; α(M)=3.13×10^{-5} *21*; α(N)=2.00×10^{-6} *13* A_2=−0.007 *7*; A_4=+0.002 *8* (1974Ma32) Eγ=499.8 *2*, relative Iγ=321.1 *73* (1975On01, at E(p)=5.0 MeV). δ: −2.8 *+11−36* or +0.18 *20* (1974Ma32); α(K)exp agrees with higher δ. γ(θ) at E(p)=2.03 MeV.
525.09	5/2⁺	326.7[a] *1*	100.0 *7*	198.43	9/2⁺	E2		0.00956 *14*	α(K)exp=1.00×10^{-2} *4*; α(L)exp+α(M)exp=1.7×10^{-3} *3* α(K)=0.00850 *12*; α(L)=0.000914 *13*; α(M)=0.0001359 *19* α(N)=8.42×10^{-6} *12* A_2=+0.002 *9*; A_4=+0.011 *11* (1974Ma32) A_2=−0.009 *5*; A_4=+0.010 *5* (2002Ka51) Eγ=326.3 *1*, relative Iγ=227.3 *51* (1975On01, at E(p)=5.0 MeV). δ: −2.05 *+25−31* or +0.05 *+6−5* (1974Ma32), +0.10 *+5−2* (2002Ka51).
		350.2[a] *1*	11.8 *7*	174.99	5/2⁻	E1+M2	−0.09 *+11−10*	0.0019 *3*	α(K)exp=1.8×10^{-3} *8* α(K)=0.0017 *3*; α(L)=0.00017 *3*; α(M)=2.5×10^{-5} *5*; α(N)=1.6×10^{-6} *3* A_2=+0.058 *14*; A_4=+0.010 *16* (1974Ma32) Eγ=350.3 *1*, relative Iγ=28.0 *17* (1975On01, at E(p)=5.0 MeV). Iγ(350)/Iγ(326)=0.107 *2* (2002Ka51), 0.123 *8* (1975On01). δ: −0.09 *+11−10* or +2.1 *+7−5* (1974Ma32), α(K)exp agrees with

$^{71}_{32}Ge_{39}$-4

^{71}Ga(p,nγ) 1974Ma32,1975On01,1993Fe03 (continued)

γ(^{71}Ge) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[@]	δ[&]	α[e]	Comments
									lower δ. α(K)exp marginally agrees with pure M1 also. γ(θ) at E(p)=2.03 MeV.
589.67	7/2$^+$	64.7[#] *1*	4.7[#] *3*	525.09	5/2$^+$				
		391.2[a] *1*	100.0 *8*	198.43	9/2$^+$	M1+E2	−0.18 *+4−3*	0.00255 *5*	α(K)exp=2.9×10^{-3} *2*; α(L)exp+α(M)exp=4.4×10^{-4} *16* α(K)=0.00227 *5*; α(L)=0.000236 *5*; α(M)=3.52×10^{-5} *7*; α(N)=2.30×10^{-6} *5* A_2=+0.004 *6*; A_4=−0.017 *6* (2002Ka51) A_2=+0.027 *10*; A_4=+0.006 *12* (1974Ma32) Eγ=391.4 *1*, relative Iγ=223.8 *53* (1975On01, at E(p)=5.0 MeV). δ: −3.7 *+5−6* or −0.18 *+4−3* (1974Ma32); −0.11 +3−2 (2002Ka51) α(K)exp agrees with lower δ value.
		414.7[#] *1*	4.9[#] *5*	174.99	5/2$^-$				I_γ: uncertainty of 0.02 assigned by 2002Ka51 is unrealistic, the evaluators have assigned 10%.
708.16	3/2$^-$	533.2[a] *1*	2.9 *2*	174.99	5/2$^-$				A_2=−0.06 *4*; A_4=+0.02 *4* (1974Ma32) Eγ=533.6 *4*, relative Iγ=3.6 (1975On01, at E(p)=5.0 MeV). Iγ(533)/Iγ(708)=0.054 *2* (2002Ka51), 0.029 (1975On01).
		708.1[a] *1*	100.0 *2*	0.0	1/2$^-$	M1+E2			α(K)exp=6.6×10^{-4} *17* A_2=−0.008 *8*; A_4=+0.001 *9* (1974Ma32) A_2=−0.115 *12*; A_4=+0.060 *12* (2002Ka51) Eγ=708.4 *1*, relative Iγ=111.9 *39* (1975On01, at E(p)=5.0 MeV). δ: −2.9 *+8−14* or +0.19 *+10−8* (1974Ma32), −0.6 *+8−22* (2002Ka51); α(K)exp gives M1 or E2.
747.21	5/2$^-$	247.3 *1*	85 *5*	499.81	3/2$^-$	M1+E2	−0.18 *7*	0.0081 *6*	α(K)exp=6.0×10^{-3} *11*; α(L)exp+α(M)exp=7×10^{-4} *7* α(K)=0.0072 *5*; α(L)=0.00075 *5*; α(M)=0.000113 *8*; α(N)=7.3×10^{-6} *5* A_2=−0.101 *13*; A_4=+0.008 *15* (1974Ma32) Eγ=247.3 *1*, relative Iγ=50.4 *20* (1975On01, at E(p)=5.0 MeV). Iγ(247)/Iγ(572)=0.66 *2* (2002Ka51), 0.91 *6* (1975On01). δ: −2.1 *+3−5* or −0.18 *7* (1974Ma32); α(K)exp consistent with lower δ.
		572.3[a] *1*	100 *4*	174.99	5/2$^-$	M1+E2		0.0013 *3*	α(K)exp=1.0×10^{-3} *4* α(K)=0.00116 *24*; α(L)=0.00012 *3*; α(M)=1.8×10^{-5} *4*; α(N)=1.16×10^{-6} *24* A_2=+0.037 *8*; A_4=−0.002 *10* (1974Ma32) A_2=+0.026 *22*; A_4=−0.027 *22* (2002Ka51) Eγ=572.3 *1*, relative Iγ=55.2 *29* (1975On01, at E(p)=5.0 MeV). δ: −0.07 *7* or +2.1 *+4−3* (1974Ma32), −0.30 *+5−8* (2002Ka51).
		747.2[a] *1*	53 *2*	0.0	1/2$^-$	(Q)			A_2=+0.047 *8*; A_4=+0.018 *9* (1974Ma32)

From ENSDF

^{71}Ga(p,nγ) **1974Ma32,1975On01,1993Fe03 (continued)**

$\gamma(^{71}$Ge) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[@]	δ[&]	α[e]	Comments
									Eγ=747.5 *1*, relative Iγ=23.2 *23* (1975On01, at E(p)=5.0 MeV). Iγ(747)/Iγ(572)=0.48 *2* (2002Ka51), 0.42 *5* (1975On01). δ: −1.9 +*7*−*9* or −0.14 +*14*−*22* (1974Ma32). α(K)exp=7.1×10^{-4} *77* (1975On01); M2 assignment in table II of 1975On01 is inconsistent with E2 from Δ(J^π).
808.10	1/2$^-$	308.2[a] *1*	82 *4*	499.81	3/2$^-$				A_2=+0.011 *19*; A_4=−0.003 *23* (1974Ma32) Eγ=308.6 *3*, relative Iγ=15.7 (1975On01, at E(p)=5.0 MeV). Iγ(308)/Iγ(808)=0.73 *2* (2002Ka51), 0.55 (1975On01). γ(θ) at E(p)=2.03 MeV.
		633.2[a] *1*	48 *2*	174.99	5/2$^-$				A_2=−0.023 *13*; A_4=+0.008 *17* (1974Ma32) Eγ=632.9 *2*, relative Iγ=15.3 *25* (1975On01, at E(p)=5.0 MeV). Iγ(633)/Iγ(808)=0.57 *3* (2002Ka51), 0.53 *10* (1975On01).
		808.1[a] *1*	100 *3*	0.0	1/2$^-$				A_2=−0.009 *9*; A_4=0.000 *11* (1974Ma32) Eγ=808.5 *1*, relative Iγ=28.6 *28* (1975On01, at E(p)=5.0 MeV).
831.17	3/2$^-$	241.8 *2*	2.5 *3*	589.67	7/2$^+$				Iγ(242)/Iγ(831)=3.0 *2* (2002Ka51).
		306.1[a] *1*	28.5 *19*	525.09	5/2$^+$	D+Q			A_2=−0.003 *20*; A_4=−0.016 *20* (2002Ka51) A_2=+0.030 *28*; A_4=+0.04 *3* (1974Ma32) Eγ=306.4 *1*, relative Iγ=35.7 *18* (1975On01, at E(p)=5.0 MeV). Iγ(306)/Iγ(831)=0.290 *6* (2002Ka51), 0.357 *18* (1975On01). δ: +0.10 +*5*−*2* or −12 +*4*−*3* (2002Ka51); higher δ implies M2 which is unlikely.
		331.2 *1*	25.0 *22*	499.81	3/2$^-$	E2(+M1)	>1.4	0.0082 *10*	A_2=−0.007 *32*; A_4=+0.01 *4* (1974Ma32) Eγ=331.3 *1*, relative Iγ=10.3 *12* (1975On01, at E(p)=5.0 MeV). Iγ(331)/Iγ(831)=0.240 *5* (2002Ka51), 0.103 *12* (1975On01). δ: from α(K)exp=6.8×10^{-3} *19*.
		831.2[a] *1*	100.0 *22*	0.0	1/2$^-$	M1+E2	−0.6 +*4*−*7*	0.00048 *4*	A_2=−0.027 *7*; A_4=0.000 *9* (1974Ma32) A_2=−0.114 *13*; A_4=+0.032 *13* (2002Ka51) Eγ=831.5 *2*, relative Iγ=100.0 (1975On01, at E(p)=5.0 MeV). δ: from 1974Ma32. Other: −0.5 *1* (2002Ka51).
1026.51	5/2$^-$	279.2[d] *2*	22.5 *14*	747.21	5/2$^-$	D+Q			A_2=+0.031 *21*; A_4=+0.02 *3* (1974Ma32) Eγ=279.1 *3*, relative Iγ=5.0 *12* (1975On01, at E(p)=5.0 MeV). Iγ(279)/Iγ(527)=0.191 *13* (2002Ka51), 0.13 *3* (1975On01). δ: −0.12 +*17*−*19* or +2.5 +*22*−*8* (1974Ma32).
		526.7[a] *1*	100.0 *22*	499.81	3/2$^-$	D+Q			A_2=−0.173 *13*; A_4=−0.006 *13* (2002Ka51) A_2=−0.141 *8*; A_4=−0.009 *10* (1974Ma32) Eγ=526.8 *1*, relative Iγ=39.8 *22* (1975On01, at E(p)=5.0 MeV). δ: −1.07 +*47*−*21* or −0.53 +*11*−*44* (1974Ma32); −0.75 +*14*−*12* (2002Ka51).
		851.6[a] *2*	23.4 *11*	174.99	5/2$^-$	D+Q			A_2=+0.081 *13*; A_4=+0.012 *17* (1974Ma32) Eγ=852.6 *4*, relative Iγ=8.5 *24* (1975On01, at E(p)=5.0 MeV). Iγ(852)/Iγ(527)=0.18 *2* (2002Ka51), 0.21 *6* (1975On01). δ: +0.3 +*12*−*2* or +1.0 +*4*−*9* (1974Ma32).
		1026.5[a] *2*	35.3 *14*	0.0	1/2$^-$	Q			A_2=+0.36 *8*; A_4=−0.24 *8* (2002Ka51) A_2=+0.037 *11*; A_4=+0.042 *14* (1974Ma32)

$^{71}_{32}Ge_{39}$-6

γ(^{71}Ge) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[@]	δ[&]	Comments
								Iγ(1027)/Iγ(527)=0.35 *2* (2002Ka51). δ: δ(O/Q)=−0.7 *+4−7* (1974Ma32); δ=+12.5 *3* (2002Ka51) is not possible for 5/2⁻ to 1/2⁻ transition.
1037.65	9/2⁺	448.0[d] *2*	34.8 *19*	589.67	7/2⁺	D+Q	+0.42 *8*	A_2=+0.14 *3*; A_4=+0.03 *4* (1974Ma32) A_2=+0.23 *7*; A_4=+0.011 *6* (1999Iv08) Eγ=448.2 *3*, relative Iγ=9.2 *12* (1975On01, at E(p)=5.0 MeV, placed from 1543 level only). δ: from 1999Iv08. Other: +0.29 *4* or +11 *+8−3* (1974Ma32).
		839.2[a] *2*	100.0 *19*	198.43	9/2⁺	D+Q		A_2=+0.275 *15*; A_4=−0.005 *18* (1974Ma32) A_2=+0.26 *7*; A_4=0.0 (1999Iv08) Eγ=839.6 *2*, relative Iγ=27.2 *25* (1975On01, at E(p)=5.0 MeV, unplaced). δ: +0.10 *18* (1999Iv08), −0.05 *+5−6* or +0.9 *+14−12* (1974Ma32).
1095.51	3/2⁻	1095.5[a] *2*	100	0.0	1/2⁻	D+Q		A_2=−0.017 *7*; A_4=+0.009 *9* (1974Ma32) δ: −2.1 *+5−8* or +0.11 *+12−13* (1974Ma32). E_γ: weak γ rays are present whose intensities could not be estimated because of background or proximity to other strong gammas.
1096.07	7/2⁻	596.1 *5*	20 *6*	499.81	3/2⁻	Q		A_2=+0.22 *7*; A_4=−0.01 *10* (1974Ma32) Eγ=596.5 *1* assigned to ^{74}Ge(n,n′γ) in 1975On01. I_γ: 1974Ma32 have used the branching ratios of 1971Mu14 to analyze the 596-keV γ line which probably contains a component from the decay of the 1095.46-keV level. γ(θ) at E(p)=2.03 MeV. Mult.,δ: δ(O/Q)=+0.05 *+26−24* or −4.7 to +3.5 (1974Ma32). Other: δ(O/Q)=0.14 *+48−32* or 2.05 to 4.01 (1974Ma32), if 7/2⁺ for 1096.
		921.1 *2*	100 *6*	174.99	5/2⁻	D+Q		A_2=−0.326 *25*; A_4=+0.093 *25* (2002Ka51) A_2=−0.21 *5*; A_4=+0.065 *25* (1999Iv08) A_2=−0.29 *3*; A_4=+0.03 *4* (1974Ma32) I_γ: 1974Ma32 have used the branching ratios of 1971Mu14 to analyze the 921-keV γ line which probably contains a component from the decay of the 1095.46-keV line. γ(θ) at E(p)=2.03 MeV (1974Ma32). δ: −2.0 *+3−4* or −0.23 *+7−8* (1974Ma32); −3.0 *4* or −0.10 *7* (1999Iv08); −1.0 *+6−8* (2002Ka51).
1139.29	3/2⁻	431.0 *3*	2.4 *2*	708.16	3/2⁻			A_2=+0.10 *8*; A_4=−0.05 *9* (1974Ma32)
		639.5[d] *2*	6.3 *7*	499.81	3/2⁻			A_2=+0.03 *4*; A_4=+0.01 *5* (1974Ma32)
		964.3[a] *2*	12.5 *7*	174.99	5/2⁻	D+Q	−0.8 *+9−49*	A_2=+0.027 *15*; A_4=−0.029 *19* (1974Ma32) δ: from 1974Ma32.
		1139.3 *2*	100.0 *10*	0.0	1/2⁻	D+Q		A_2=+0.002 *7*; A_4=−0.005 *9* (1974Ma32) Mult.,δ: δ=−3.7 *+13−34* or +0.27 +13 (1974Ma32).

$^{71}_{32}$Ge$_{39}$-7

$\gamma(^{71}Ge)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[@]	δ[&]	Comments
1192.3	11/2$^+$	993.9		198.43	9/2$^+$	M1+E2	+1.3 *5*	A_2=+0.59 *10*; A_4=+0.12 *6* (1999Iv08) E_γ: from 1999Iv08 only.
1205.04	5/2$^+$	373.7 *3*	24 *8*	831.17	3/2$^-$	D+Q		A_2=−0.06 *4*; A_4=−0.01 *5* (1974Ma32) Eγ=374.4 *2*, relative Iγ=6.9 *13* (1975On01, at E(p)=5.0 MeV). Iγ(374)/Iγ(615)=0.20 *4* (1975On01). δ: −3.1 *+8−16* or 0.00 *11* (1974Ma32).
		615.4 *2*	100 *6*	589.67	7/2$^+$	D+Q		A_2=+0.002 *14*; A_4=+0.012 *17* (1974Ma32) Eγ=615.6 *1*, relative Iγ=33.8 *23* (1975On01, at E(p)=5.0 MeV). δ: −3.5 *+6−8* or −0.14 *5* (1974Ma32).
		680.0 *2*	14.4 *17*	525.09	5/2$^+$	D+Q		A_2=+0.10 *5*; A_4=−0.04 *6* (1974Ma32) Eγ=679.7 *4*, relative Iγ=3.1 *17* (1975On01, at E(p)=5.0 MeV). Iγ(680)/Iγ(615)=0.09 *5* (1975On01). δ: +0.07 *+33−25* or +1.2 *+13−6* (1974Ma32).
1212.45	5/2$^-$	465.2 *2*	26.3 *19*	747.21	5/2$^-$	D+Q		A_2=+0.16 *6*; A_4=−0.10 *8* (1974Ma32) Eγ=465.4 *4*, relative Iγ=3.4 *12* (1975On01, at E(p)=5.0 MeV). Iγ(465)/Iγ(713)=0.25 *2* (2002Ka51), 0.21 *7* (1975On01). δ: −0.36 to +5.7 (1974Ma32). γ(θ) at E(p)=2.03 MeV.
		504.1[a] *2*	47 *14*	708.16	3/2$^-$	D+Q		B(M1)(W.u.)≤0.0512 (1999Iv08) A_2=+0.04 *4*; A_4=−0.03 *6* (1974Ma32) Iγ(504)/Iγ(713)=0.46 *3* (2002Ka51). δ: +0.31 *+27−24* or −4.3 to +3.7 (1974Ma32). B(E2)(W.u.)<2865 (1999Iv08), in contrast to RUL=300 for B(E2)(W.u.). γ(θ) at E(p)=2.71 MeV.
		712.7[a] *2*	100 *8*	499.81	3/2$^-$	D+Q		A_2=+0.04 *6*; A_4=−0.06 *6* (2002Ka51) A_2=−0.126 *14*; A_4=−0.003 *18* (1974Ma32) Eγ=712.8 *2*, relative Iγ=16.5 *20* (1975On01, at E(p)=5.0 MeV, doublet placed from 1212 and 1543 levels). δ: −2.4 *+8−23* or −0.21 *+14−15* (1974Ma32); −0.49 *+9−26* or −1.5 *2* (2002Ka51).
		1037.7 *3*	70 *7*	174.99	5/2$^-$	D+Q		A_2=−0.046 *23*; A_4=+0.01 *3* (1974Ma32) Iγ(1038)/Iγ(713)=0.68 *10* (2002Ka51). δ: −0.5 to +19 (1974Ma32).
		1212.5[a] *2*	82 *3*	0.0	1/2$^-$	Q		A_2=+0.063 *12*; A_4=+0.032 *15* (1974Ma32) Iγ(1212)/Iγ(713)=0.79 *6* (2002Ka51). δ: δ(O/Q)=−1.9 *+7−12* or −0.12 *+19−24* (1974Ma32).
1288.59	1/2$^-$	580.5 *2*	11 *3*	708.16	3/2$^-$			A_2=−0.07 *6*; A_4=+0.15 *9* (1974Ma32) Iγ(581)/Iγ(789)=0.15 *2* (2002Ka51). γ(θ) at E(p)=2.71 MeV.
		788.7[a] *2*	100 *3*	499.81	3/2$^-$			A_2=−0.001 *13*; A_4=0.000 *15* (1974Ma32) Eγ=788.9 *1*, relative Iγ=10.6 (1975On01, at E(p)=5.0 MeV).
1298.71	3/2$^-$	798.9[fd] *3*	9.4[f] *9*	499.81	3/2$^-$			A_2=−0.025 *33*; A_4=−0.02 *5* (1974Ma32) Eγ=798.8 *2*, relative Iγ=9.2 *23* (1975On01, at E(p)=5.0 MeV).

γ(^{71}Ge) (continued)

E$_i$(level)	J_i^π	E$_\gamma$[†]	I$_\gamma$[‡]	E$_f$	J_f^π	Mult.[@]	Comments
							Iγ(799)/Iγ(1299)=0.091 *13* (2002Ka51). γ(θ) at E(p)=2.71 MeV.
1298.71	3/2$^-$	1298.7[a] *2*	100.0 *9*	0.0	1/2$^-$	D+Q	A_2=−0.154 *20*; A_4=+0.09 *3* (2002Ka51) A_2=−0.010 *15*; A_4=−0.019 *17* (1974Ma32) δ: −1.8 +*7*−*15* or +0.02 +*19*−*25* (1974Ma32); −0.6 +*7*−*18* (2002Ka51).
1349.1	1/2$^+$	517.6 *10*	100	831.17	3/2$^-$		Eγ=517.9 *1*, relative Iγ=17.3 (1975On01, at E(p)=5.0 MeV).
		824.2 *10*	32	525.09	5/2$^+$		Eγ=824.5 *3*, relative Iγ=4.6 *22* (1975On01, at E(p)=5.0 MeV). Iγ(824)/Iγ(518)=0.325 *11* (2002Ka51), 0.27 (1975On01).
		1349.2 *10*	20	0.0	1/2$^-$		Iγ(1349)/Iγ(517)=0.291 *10* (2002Ka51).
1378.01?	5/2$^-$	281.8[#g] *1*	100[#] *6*	1096.07	7/2$^-$		A_2=+0.1 *10*; A_4=0.0 *10* (2002Ka51) δ: δ(Q/D)=+2.9 *1* for J(1378)=5/2 (2002Ka51) cannot be obtained from quoted A_2 and A_4 values. E$_\gamma$: this γ not seen in ε decay and other reactions.
		630.8[#g] *1*	84[#] *8*	747.21	5/2$^-$		
		788.5[#g]	[#]	589.67	7/2$^+$		I$_\gamma$: branching ratio given by 2002Ka51 is much higher than in Adopted Levels, Gammas. Note that the main placement of this γ ray is from 1288 level. It seems 2002Ka51 have not properly accounted for the two placements.
1379.0	(1/2$^-$)	855.0[g] *20*	60	525.09	5/2$^+$		Eγ=855.7 *4*, relative Iγ=7.2 *23* (1975On01, at E(p)=5.0 MeV). E$_\gamma$: 855.7 *4* (1975On01). E$_\gamma$: questionable γ not included in Adopted Levels, Gammas.
		1204.2 *10*	100	174.99	5/2$^-$		
		1378.7 *10*	100	0.0	1/2$^-$		E$_\gamma$: 1376.80 *15* (2002Ka51).
1406.5	7/2$^-$	659.1 *10*	100	747.21	5/2$^-$		Eγ=659.5 *2*, relative Iγ=6.7 *16* (1975On01, at E(p)=5.0 MeV). E$_\gamma$: 659.1 *1* (2002Ka51).
		906.9 *20*	<20	499.81	3/2$^-$		A_2=−0.10 *13*; A_4=0.00 *14* (2002Ka51) Iγ(907)/Iγ(659)=0.18 *5* (2002Ka51). δ: δ(Q/D)=−0.2 *1* (2002Ka51) for J=5/2.
		1231.8 *20*	80	174.99	5/2$^-$	M1+E2	A_2=+0.08 *10*; A_4=+0.01 *10* (2002Ka51) A_2=+0.23 *6*; A_4=+0.010 *5* (1999Iv08) Iγ(1232)/Iγ(659)=0.76 *6* (2002Ka51). δ: +0.58 *15* or +3.2 *4* (1999Iv08); +0.49 +*15*−*11* (2002Ka51).
1414.6	(1/2$^-$,3/2,5/2$^-$)	914.7 *20*	20	499.81	3/2$^-$		Iγ(915)/Iγ(1414)=0.30 *5* (2002Ka51).
		1239.7 *10*	40	174.99	5/2$^-$		Iγ(1240)/Iγ(1414)=0.57 *9* (2002Ka51).
		1414.5 *10*	100	0.0	1/2$^-$		
1422.12	9/2$^-$	675.0[#] *2*	26[#] *5*	747.21	5/2$^-$		
		1247.1[#] *1*	100[#] *4*	174.99	5/2$^-$	Q(+O)	A_2=+0.31 *12*; A_4=+0.01 *3* (1999Iv08) A_2=+0.23 *6*; A_4=−0.01 *6* (2002Ka51) E$_\gamma$: unassigned 1247.5γ with Iγ=4 in 1970Ma09. δ: +0.15 *10* or +7.0 *7* (1999Iv08); +0.10 *7* (2002Ka51).

$^{71}_{32}$Ge$_{39}$-9

γ(^{71}Ge) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.[@]	Comments
1454.2?	(1/2$^+$)	646.1[g] *10*	100	808.10	1/2$^-$		Eγ=646.7 *2*, relative Iγ=6.1 *5* (1975On01, at E(p)=5.0 MeV).
1477.4	(5/2$^-$)	887.6 *10*	100	589.67	7/2$^+$		
		952.4 *10*	36	525.09	5/2$^+$		
1507.0	7/2$^-$	798.9[f] *3*	<86[f]	708.16	3/2$^-$		
		1006.8 *20*	<40	499.81	3/2$^-$		
		1331.7 *10*	100	174.99	5/2$^-$		
1542.5	(1/2$^+$,3/2$^-$)	447.6[g] *10*	29	1095.51	3/2$^-$		Eγ=448.2 *3*, relative Iγ=9.2 *12* (1975On01, at E(p)=5.0 MeV, placed from 1543 level only).
		1017.3 *10*	100	525.09	5/2$^+$		
		1542.9 *20*	24	0.0	1/2$^-$		Iγ(1542)/Iγ(1017)=0.078 *9* (2002Ka51).
1558.8	5/2$^+$	1033.7 *10*	100	525.09	5/2$^+$	D+Q	A_2=+0.07 *4*; A_4=+0.01 *4* (2002Ka51) δ: +0.48 *+26−18* (2002Ka51).
		1058.8 *20*	10	499.81	3/2$^-$		Iγ(1059)/Iγ(1034)=0.148 *25* (2002Ka51).
1566.2	(5/2$^-$,7/2$^+$)	976.5 *10*	100	589.67	7/2$^+$	D+Q	A_2=−0.18 *10*; A_4=−0.01 *11* (2002Ka51) δ: −1.54 *+22−16* (2002Ka51).
1599.1	3/2$^-$	1424.1 *20*	100	174.99	5/2$^-$		
		1599.0 *20*	100	0.0	1/2$^-$		
1629.6		882.1 *20*	≈40	747.21	5/2$^-$		
		1629.6 *10*	≈100	0.0	1/2$^-$		
1698.6?	(9/2)$^+$	867.4[g] *20*	100	831.17	3/2$^-$	[E3]	
1743.5	3/2$^-$	935.2 *10*	100	808.10	1/2$^-$		A_2=−0.06 *13*; A_4=+0.01 *14* (2002Ka51) Iγ(935)/Iγ(1743)=0.85 *9* (2002Ka51). δ=−0.5 *+4−8* (2002Ka51).
		996.2[#g]	36[#] *7*	747.21	5/2$^-$		
		1743.7 *10*	100	0.0	1/2$^-$		A_2=+0.02 *3*; A_4=0.00 *3* (2002Ka51) δ=−12 *4* (2002Ka51).
1792.4	(3/2$^+$,5/2$^-$)	983.7[g] *20*	<50	808.10	1/2$^-$		
		1044.5[g] *20*	100	747.21	5/2$^-$		
		1084.4[g] *20*		708.16	3/2$^-$		
		1617.4 *20*	100	174.99	5/2$^-$		
1937.8	(3/2$^+$,5/2$^-$)	1191.5[g] *20*		747.21	5/2$^-$		A 1191.18γ is placed from a level at 1780.76 in Adopted Gammas.
		1762.7[g] *20*		174.99	5/2$^-$		
		1937.8 *20*		0.0	1/2$^-$		
1965.4	3/2$^-$	1965.4[g] *20*		0.0	1/2$^-$		

[†] From 1974Ma32 for γ rays from levels up to 1299 keV. Values for γ rays from higher levels are from 1970Ma09. Uncertainties for γ rays from 1970Ma09 are assigned as 1 keV for prominent transitions and 2 keV for weak transitions based on a general comment by the authors. Values are also available from 2002Ka51 for γ rays up to 1743 level and from 1975On01 for levels up to 855. The values from 2002Ka51 are quoted with unrealistic uncertainties for many γ-ray energies, and those from 1975On01 are less complete, thus generally not used in this evaluation.

γ(^{71}Ge) (continued)

‡ Relative photon branching from each level. Values are mainly from 1974Ma32, and their earlier paper 1970Ma09. Some others are from 1975On01. Values from 2002Ka51 are also available, but are considered as less reliable by evaluators due to natural target used with many strong impurity lines in spectra, and several values quoted with unrealistic uncertainties. These are given here only when a gamma ray is reported only in this work, but not included in the Adopted dataset.

From 2002Ka51 only. Energy uncertainty has been increased by the evaluators to 0.1 keV, when the authors quote less than this value. The assignment of this γ to ^{71}Ge should be treated with caution since a natural target was used in this study, consequently many lines were contributed by ^{69}Ga in the target material. This γ has not been in Adopted Levels, Gammas dataset.

@ From ce data of 1975On01, unless otherwise noted.

& From 1999Iv08, 1974Ma32 and some from 2002Ka51.

[a] Seen in nγ coin (1974Ma32).

[b] Weak unplaced γ from 1970Ma09.

[c] Weak unplaced γ from 1975On01.

[d] Seen very weakly in nγ coin (1974Ma32).

[e] 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.

[f] Multiply placed with undivided intensity.

[g] Placement of transition in the level scheme is uncertain.

[x] γ ray not placed in level scheme.

$^{71}_{32}$Ge$_{39}$-11

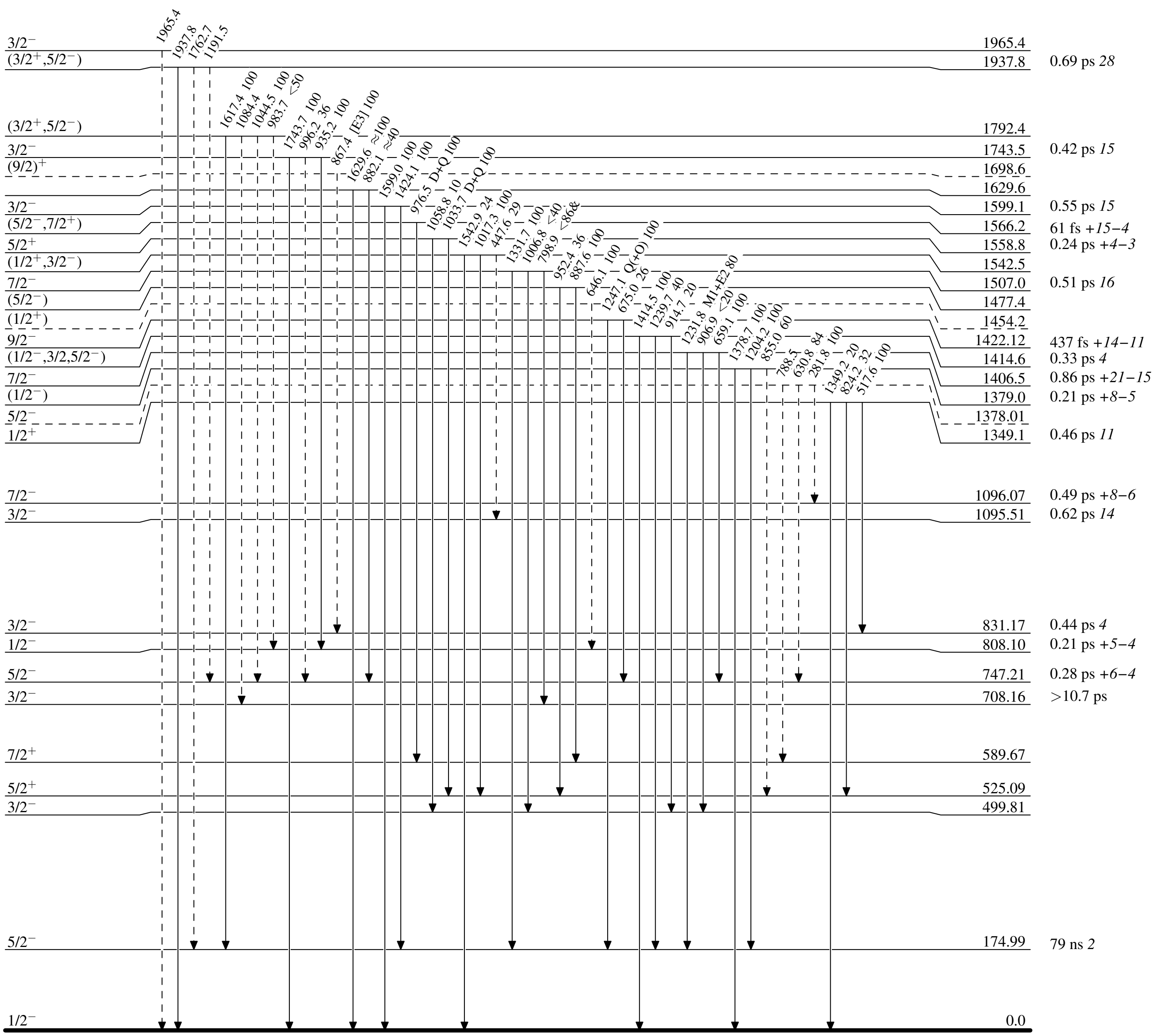
^{71}Ga(p,nγ) 1974Ma32,1975On01,1993Fe03

Legend

Level Scheme

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

- - - - - -► γ Decay (Uncertain)



$^{71}_{32}Ge_{39}$

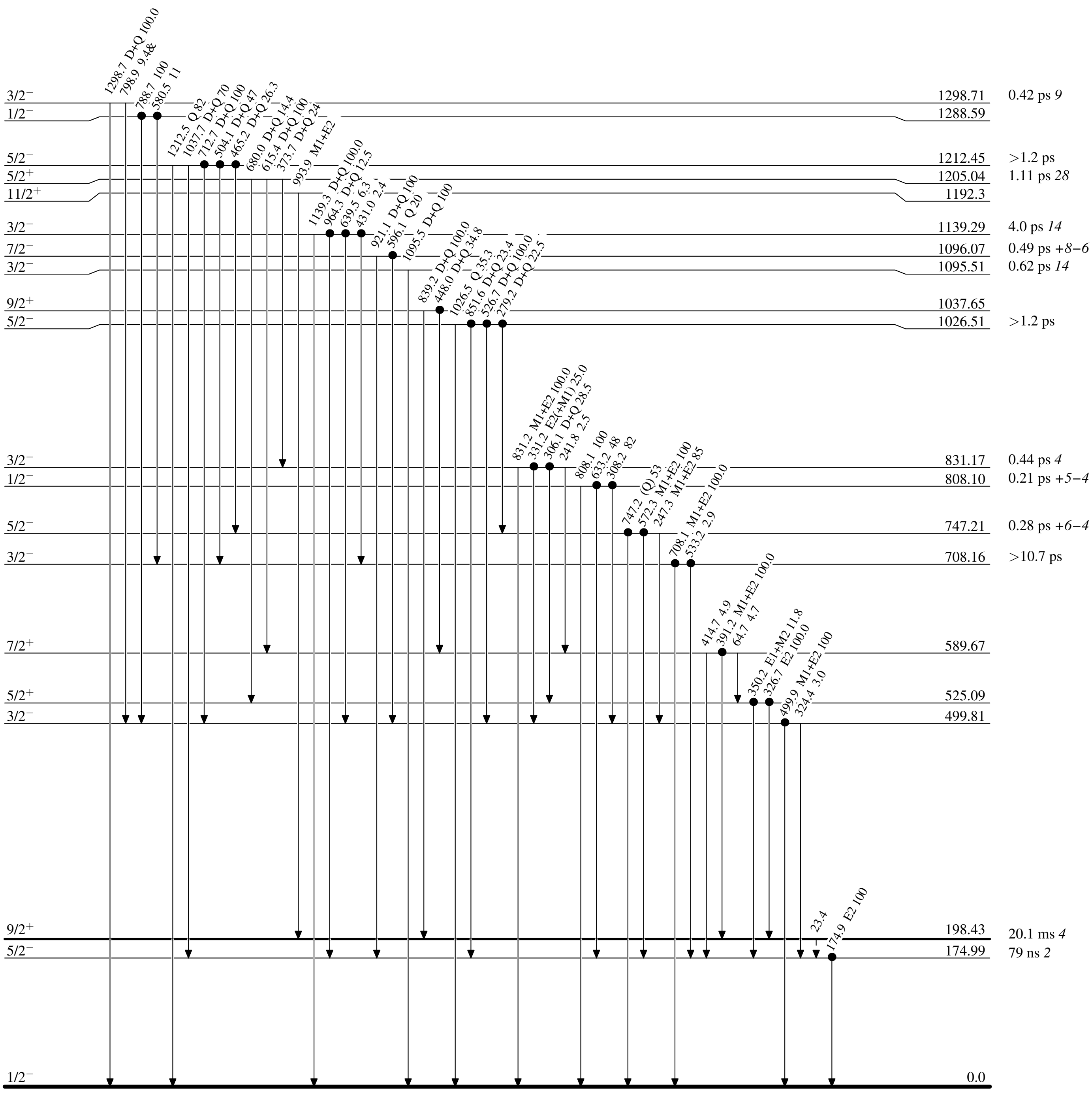
$^{71}Ga(p,n\gamma)$ 1974Ma32,1975On01,1993Fe03

Legend

Level Scheme (continued)

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

γ Decay (Uncertain)
Coincidence



$^{71}_{32}Ge_{39}$