^{89}Y(p,nγ) 1972Gi06,1969Li17

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 114, 1 (2013)	20-Oct-2012

1972Gi06: E=5.26-6.42 MeV. Measured Eγ, Iγ, γγ.
1969Li17: E=5.4-7.8 MeV. Measured Eγ, Iγ, γ(θ), excitation functions and Hauser-Feshbach analysis. Resonances in neutron channels observed at E(p)=6.00, 6.16, 7.25 and 7.45 MeV. These resonances correspond to isobaric analog states in ^{90}Zr.

^{89}Zr Levels

E(level)†	Jπ#	$T_{1/2}$‡	Comments
0.0	$9/2^+$		
588 *1*	$1/2^-$	4.161 min	$T_{1/2}$: from Adopted Levels.
1094 *1*	$3/2^-$	>0.05 ps	
1453 *1*	$5/2^-$	>2.1 ps	E(level): 1450 (1969Li17).
1512?			E(level): from 1972Gi06.
1628 *1*	$5/2^+$	0.26 ps *4*	
1742 *1*	$1/2^-$	0.49 ps *13*	Jπ: $3/2^-$ is suggested from γ(θ) and excitation functions.
1834 *1*	$5/2^+$	0.32 ps *13*	
1865 *1*	$3/2^-$	>0.5 ps	
2086 *1*	$(5/2)^+$	>0.7 ps	E(level): 2081 (1969Li17).
2099 *1*	$5/2^-$	0.12 ps *4*	E(level): 2096 (1969Li17).
2130	$(7/2^+)$		E(level): a doublet with≈3 keV separation.
2220 *1*	$(9/2^-)$	<3 fs	Jπ: $11/2^+$ suggested from γ(θ) and excitation function.
2298 *1*	(7/2)	73 fs *21*	
2389 *1*	$(5/2^+,7/2^-)$	0.12 ps *4*	Jπ: from 1972Gi06. 1969Li17 propose 11/2 and exclude 7/2 from excitation function, but γ to $3/2^-$ excludes 11/2 from RUL.
2568 *1*	(≤7/2)	>0.9 ps	E(level): from 1972Gi06 only.
2572 *2*	$7/2^+,9/2^+$	90 fs *21*	Jπ: excitation function gives 7/2,9/2,11/2.
2610 *2*	$9/2^+$		E(level): from 1969Li17 only. Jπ: excitation function gives 7/2,9/2,11/2.

† From least-squares fit to Eγ data.
‡ From DSA (1972Gi06).
# From Adopted Levels, unless otherwise stated. The assignments are consistent with analysis of excitation functions and γ(θ) (1969Li17).

γ(^{89}Zr)

A_2 and A_4 are at E(p)=6.259 MeV (1969Li17), unless otherwise stated.

E_i(level)	J_i^π	E_γ†	I_γ‡	E_f	J_f^π	Mult.#	Comments
588	$1/2^-$	587.9	100	0.0	$9/2^+$	(M4)	Mult.: from Adopted Gammas.
1094	$3/2^-$	506@	100	588	$1/2^-$		Iγ(γ to 588 level)<1 (1972Gi06).
1453	$5/2^-$	360.5	40 *5*	1094	$3/2^-$		
		864&	60 *5*	588	$1/2^-$	(E2)	E_γ: 861.6 (1969Li17). From γ(θ): δ(M3/E2)=+0.15 *5* or +1.5 *2* (1969Li17). A_2=+0.151 *20*, A_4=−0.016 *20* (1969Li17). Additional information 1. Iγ(γ to g.s.)<3 (1972Gi06).
1512?		1512@	100	0.0	$9/2^+$		Contaminated by a line from ^{89}Y. Iγ(γ rays to states other than g.s.)<5 to<10 (1972Gi06).

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^{89}Y(p,nγ) 1972Gi06,1969Li17 (continued)

γ(^{89}Zr) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	δ[#]	Comments
1628	5/2$^+$	534[@]	12 *5*	1094	3/2$^-$			
		1628.0	88 *5*	0.0	9/2$^+$	(E2)		From γ(θ): δ(M3/E2)=+0.16 *+9−6* or −3.0 *+6−8* (1969Li17). A_2=0.00 *20* (1969Li17). Additional information 2. Iγ(γ rays to states other than g.s. and 1095)<3 to<20 (1972Gi06).
1742	1/2$^-$	1153.7	100	588	1/2$^-$	(M1)		Mult.,δ: δ(E2/M1)=+0.15 *+7−5* or −3.0 *+6−8*, but ΔJ$^\pi$ requires M1. A_2=−0.034 *20* (1969Li17). Additional information 3. Iγ(γ rays to states other than 588)<3 to<18 (1972Gi06).
1834	5/2$^+$	740[@]	7 *5*	1094	3/2$^-$			
		1833.8	93 *5*	0.0	9/2$^+$	(E2)		δ(M3/E2)=+0.16 *7*. A_2=+0.047 *20* (1969Li17). Additional information 4. Iγ(γ rays to states other than g.s. and 1095)<3 to<25 (1972Gi06).
1865	3/2$^-$	412[@]	8 *5*	1453	5/2$^-$			
		771.7	74 *5*	1094	3/2$^-$			
		1275.8	18 *5*	588	1/2$^-$			A_2=+0.05 *3* (at E(p)=5.973, 1969Li17). Iγ(γ rays to states other than 588, 1095 and 1452)<3 to<15 (1972Gi06).
2086	(5/2)$^+$	458[@]	13 *5*	1628	5/2$^+$			
		992[&]	87 *5*	1094	3/2$^-$	D+Q		E_γ: 988.0 (1969Li17). A_2=−0.07 *5*, A_4=+0.09 *6* (1969Li17). Additional information 5. Iγ(γ rays to states other than 1095 and 1628)<2 to<8 (1972Gi06).
2099	5/2$^-$	646[@]	30 *5*	1453	5/2$^-$			
		1005[&]	70 *5*	1094	3/2$^-$	(M1+E2)	−3.5 *4*	E_γ: 1002.1 (1969Li17). A_2=−0.19 *4*, A_4=+0.09 *4* (1969Li17). Additional information 6. Iγ(γ rays to states other than 1095 and 1452)<3 to<6 (1972Gi06).
2130	(7/2$^+$)	618[@a]	<10	1512?				
		2129.9	100	0.0	9/2$^+$	(M1+E2)	+2.1 *+8−3*	A_2=−0.64 *3*, A_4=+0.05 *4* (1969Li17). Iγ(γ rays to states other than g.s. and 1512)<10 to<30 (1972Gi06).
2220	(9/2$^-$)	2220.0	100	0.0	9/2$^+$			Mult.,δ: M1+E2 with δ=+5.8 *+35−15* from A_2=+0.26 *7*, A_4=+0.22 *9* (1969Li17), but γ(θ) in (α,nγ) and L(^{3}He,t) indicate ΔJ=0, dipole (E1) transition. Iγ(γ rays to states other than g.s.)<9 to<30 (1972Gi06).
2298	(7/2)	786[@a]	<8	1512?				
		2298.0	100	0.0	9/2$^+$	(D+Q)	<0.1	A_2=−0.10 *4*, A_4=−0.04 *5* (1969Li17). Iγ(γ rays to states other than g.s. and 1512)<6 to<12 (1972Gi06).
2389	(5/2$^+$,7/2$^-$)	936[@]	21 *5*	1453	5/2$^-$			
		1295[@]	21 *5*	1094	3/2$^-$			E_γ: 1292.0 (1969Li17). Iγ(γ rays to states other than g.s., 1095 and 1452)<3 to<6 (1972Gi06).

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^{89}Y(p,nγ) 1972Gi06,1969Li17 (continued)

γ(^{89}Zr) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Comments
2568	(≤7/2)	703[&]	100	1865	3/2$^-$	Iγ(γ rays to states other than 1865)<3 to<8 (1972Gi06).
2572	7/2$^+$,9/2$^+$	738[@a]	<40	1834	5/2$^+$	
		1060[@a]	<10	1512?		
		2572[&]	100	0.0	9/2$^+$	Iγ(γ rays to states other than g.s., 1512 and 1834)<10 to<25 (1972Gi06).
2610	9/2$^+$	2610 *2*	100	0.0	9/2$^+$	E_γ: only from 1969Li17.

[†] From 1969Li17, unless indicated otherwise. Some of the γ-ray energies from 1969Li17 have not been used due to poor fit in level scheme.
[‡] Branching ratios from 1972Gi06. Only the dominant decay mode is shown. Upper limits of branching ratios from 1972Gi06 for possible transitions to other states are given under comments.
[#] From Hauser-Feshbach analysis of γ excitation functions and γ(θ) (1969Li17).
[@] From level energy difference. In some cases energy available from 1969Li17, although quoted to a nearest 0.1 keV, is not used due to poor fit in level scheme.
[&] From table 3 of 1972Gi06.
[a] Placement of transition in the level scheme is uncertain.

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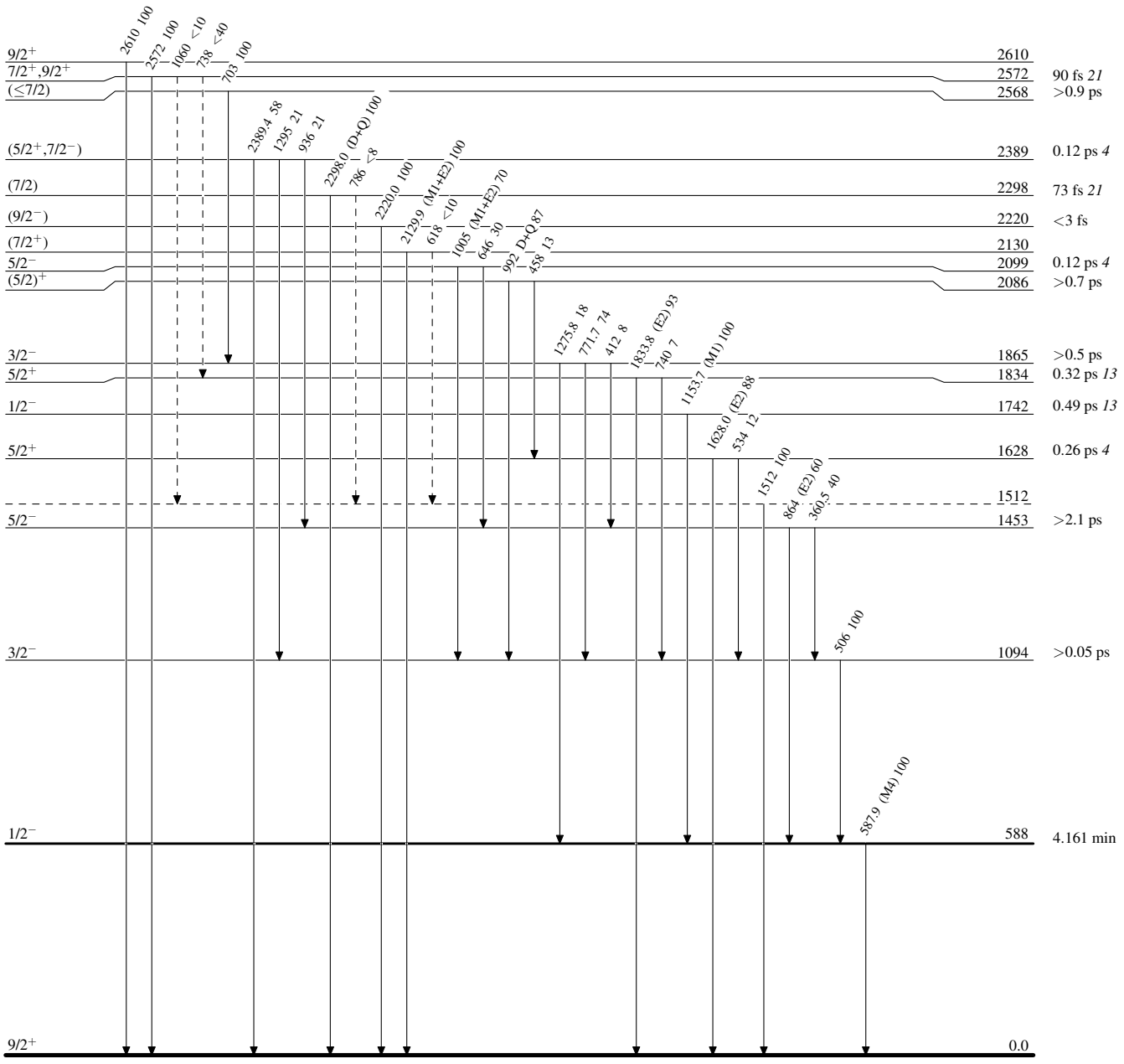
Legend

Level Scheme

Intensities: % photon branching from each level

γ Decay (Uncertain)



$^{89}_{40}Zr_{49}$