

⁹⁰Zr(³He, α) [1977Ga18](#),[1981Du13](#),[1995So05](#)

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

[1977Ga18](#): E=39 MeV. Measured $\sigma(\theta)$, FWHM=30-35 keV, split-pole spectrometer, DWBA analysis.

[1981Du13](#): E=97.3 MeV. Measured $\sigma(\theta)$, DWBA analysis.

[1995So05](#): E=102 MeV. Measured α spectra, neutron decay of excited states, (α)n coin, deduced neutron decay of hole states, statistical-model calculations.

[1978Va05](#) (also [1975Ge09](#)): E=217 MeV. Measured $\sigma(\theta)$, DWBA analysis. Data for g.s., 1090, 1450+1520, and structures at 2100, 2760 *4100*, 9000, 9900, 13200.

[1969Ba21](#) (also [1968Ba57](#),[1969PiZX](#)): E=18 MeV. Measured $\sigma(\theta)$, FWHM=60-70 keV.

[Additional information 1](#).

[1968Ru02](#): E=25 MeV. Measured $\sigma(\theta)$. Data for g.s., 580, 1080, 1450, 1820 states.

[1967Fo04](#): E=18 MeV. Measured $\sigma(\theta)$. Data for g.s., 590, 1070, 1440, 1520, 1720, 1840, 2060, 8100, 9600 states.

Others:

[1989Su17](#): E=35-60 MeV. Measured $\sigma(\theta)$.

[1984ChZT](#): E=132 MeV. Measured $\sigma(\theta)$, DWBA.

[1982La17](#): E=205 MeV. Analyzed data for g.s., DWBA.

[1971BrZQ](#): E=16 MeV. Measured α spectra, deduced IAS.

⁸⁹Zr Levels

Cross section data ([1995So05](#))

Level (MeV)	σ (mb/sr)
0.0	41.82
0.6	3.12
1.1	4.47
1.46	8.99
1.52	1.54
1.75	0.62
1.87	1.28
2.1	2.17
2.7	1.10
3.0	1.47
3.1	1.58
3.6	4.75
4.1	2.50
5.2	1.01
5.5	4.81
8.1	0.51
9.0	0.21
9.3	14.29
9.62	1.19
9.86	1.27
15.0	9.11
17.0	4.08
20.0	4.33
25.0	1.13
26.0	2.03
31.0	0.66

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$^{90}\text{Zr}(^3\text{He},\alpha)$ **1977Ga18,1981Du13,1995So05 (continued)** ^{89}Zr Levels (continued)

E(level) [†]	J ^{π&}	L [‡]	S [@]	Comments
0 ^f	9/2 ⁺	4	8.00	S: 9.1 (1981Du13), 9.7 (1969Ba21), 3.41 (1968Ru02), 10.0 (1967Fo04). Other: 6.1, 6.4 (1982La17).
590 ^g 5	1/2 ⁻	1	1.70	E(level): from 1969Ba21. 595 8 (1977Ga18). S: 1.6 (1981Du13), 2.7 (1969Ba21), 2.02 (1968Ru02), 1.7 (1967Fo04).
1100 ^h 8	3/2 ⁻	1	2.48	S: 2.4 (1981Du13), 3.0 (1969Ba21), 2.41 (1968Ru02), 2.6 (1967Fo04).
1460 ⁱ 8	5/2 ⁻	3	2.50	S: 2.7 (1981Du13), 4.1 (1969Ba21), 2.59 (1968Ru02), 2.7 (1967Fo04).
1520 ^f 8	(9/2) ⁺	4	0.37	
1631 8		2	0.10	
1750 ^h 8	1/2 ⁻	1	0.26	S: 0.4 (1967Fo04).
1871 ^h 8	3/2 ⁻	1	0.53	S: 1.08 (1968Ru02), 0.9 (1967Fo04).
2107 ⁱ 8	5/2 ⁻	3	1.00	S: 1.4 (1969Ba21), 0.9 (1967Fo04). E(level): 1978Va05 report wide structure centered at 2100 with L=3.
2230 8		#		L: >5 (1977Ga18).
2296 8		#		
2402 8		#		
2624 12	9/2 ⁺	4	0.11	
2732 ^{ef} 12		4	<0.14	L: probable doublet with a level of unknown L value.
2782 12		3	0.39,0.28	E(level): 1978Va05 report wide structure centered at 2760 with L=4 (g9/2).
2934 12	7/2 ⁺ , 9/2 ⁺	4	0.13	
3022 ⁱ 12	7/2 ⁻	3	0.28	
3.1×10 ³ dg				
3142 12	9/2 ⁺	4	0.13	
3273 12	9/2 ⁺	4	0.08	
3330 12	1/2 ⁻ , 3/2 ⁻	1	0.09	
3383 12	9/2 ⁺	4	0.06	
3530 12	(5/2, 7/2) ⁻	3	0.26,0.16	
3572 12	(5/2) ⁻	3	0.16	
3.6×10 ³ dh				
3765 12	5/2 ⁻	3	0.46,0.29	
3837 12	7/2 ⁺ , 9/2 ⁺	4	0.04	
3930 ^e 12	(7/2) ⁻	3	0.10	
3980 ^e 12	(7/2) ⁻	3	0.08,0.05	
4100 ^j 12	7/2 ⁻	3	0.48,0.30	E(level): 1978Va05 report wide structure (3600-6000) centered at 4100 with L=3 (f7/2).
4200 12	5/2 ⁻ , 7/2 ⁻	3	0.21,0.13	
4280 12	7/2 ⁻	3	0.15,0.09	
4360 12	(1/2 ⁻ , 3/2 ⁻)	1,(2)	0.09	
4590 12	7/2 ⁻	3	0.20,0.12	
4680 12	7/2 ⁻	3	0.33,0.19	
4730 12	3/2 ⁺ , 5/2 ⁺	2	0.03,0.04	
4900 ^e 12	7/2 ⁻	3	0.20,0.12	L,S: for 3500-5700 structure and centroid at ≈4900 (1981Du13), L=3, S=3.6.
5000 20	(1/2 ⁻ , 3/2 ⁻)	1,(2)	0.08	
5100 20	7/2 ⁻	3	0.24,0.15	
5170 20	(3/2 ⁺ , 5/2 ⁺)	2,(1)	0.03,0.04	
5.2×10 ³ dj				
5300 ^e 20	7/2 ⁻	3	0.33,0.20	
5500 ^{ei} 20	7/2 ⁻	3	0.23,0.14	
5730 ^e 20	7/2 ⁻	3	0.19,0.11	
5950 ^e 20	7/2 ⁻	3	0.25,0.15	
6100 ^e 20	7/2 ⁻	3	0.23,0.14	
6280 ^e 20	7/2 ⁻	3	0.48,0.31	
6700 ^e 20	7/2 ⁻	3	0.40,0.25	

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$^{90}\text{Zr}(^3\text{He},\alpha)$ **1977Ga18,1981Du13,1995So05 (continued)** ^{89}Zr Levels (continued)

E(level) [†]	J ^{π&}	L [‡]	S [@]	Comments
6900 ^e 20	5/2 ⁻ , 7/2 ⁻	3	0.15, 0.09	
7060 ^e 20	(5/2 ⁻ , 7/2 ⁻)	(3)	0.17, 0.10	
7200 ^e 20	(5/2 ⁻ , 7/2 ⁻)	(3)	0.18, 0.11	
8100 ^g 20	1/2 ⁻	1	^a	S: 3.0, 0.66, 1.88 (1977Ga18); 2.4 (1981Du13); 0.7 (1967Fo04). E(level): isobaric analog state of ^{89}Y g.s..
9030 ^f 20	9/2 ⁺	4	^a	S: 2.4, 0.60, 1.6 (1977Ga18).
$\approx 9.2 \times 10^3$ ^c	(7/2 ⁻)	3 ^c	1.3 ^c	E(level): centroid of 7000-12300 structure (1981Du13). 1978Va05 report a wide structure centered at 9 MeV with L=4 (g9/2).
9.3×10^3 ^{dj}				
9620 ^h 20	3/2 ⁻	1	^a	S: 5.7, 1.4, 3.6 (1977Ga18); 1.3 (1967Fo04).
9860 ⁱ 20	5/2 ⁻	3	^a	S: 13.4, 3.1, 7.8 (1977Ga18). E(level): a wide L=3 structure reported by 1978Va05.
11.6×10^3 ^b				
12.2×10^3 ^b				
13100 20	(7/2) ⁻	3	0.06 ^a	E(level): 13200 (1978Va05). S: 1.76, 0.58, 1.6 (1977Ga18).
14×10^3 ^c	(3/2, 5/2) ⁺	2, (3) ^c	0.5 ^c	E(level): centroid of 10000-19000 structure (1981Du13).
15.0×10^3 ^d				2s _{1/2} state (1995So05).
17.0×10^3 ^d				1d _{3/2} state (1995So05).
20.0×10^3 ^d				1d _{5/2} state (1995So05).
25.0×10^3 ^d				1p _{1/2} state (1995So05).
26.0×10^3 ^d				1p _{3/2} state (1995So05).
31.0×10^3 ^d				1s _{1/2} state (1995So05).

[†] From 1977Ga18, unless otherwise stated.[‡] From DWBA analysis of $\sigma(\theta)$ (1977Ga18), unless stated otherwise.# $\sigma(\theta)$ (1977Ga18) does not fit pattern for any L value.[@] From DWBA analysis of $\sigma(\theta)$, from 1977Ga18, unless otherwise stated.

& From Adopted Levels.

^a 1977Ga18 give spectroscopic factors obtained by three different approaches for the neutron form factors (separation energy, centroid energy, and coupled channels).^b Sharp but weakly-excited peaks at a few angles (1977Ga18).^c From 1981Du13.^d From 1995So05.^e Possible doublets or multiplets (1977Ga18).^f 1g_{9/2} orbital.^g 2p_{1/2} orbital.^h 2p_{3/2} orbital.ⁱ 1f_{5/2} orbital.^j 1f_{7/2} orbital.