^{72}Ge(d,p),(pol d,p) 1973Ka03,1976Yo04,1972Ha74

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 158, 1 (2019)	16-May-2019

$J^\pi(^{72}Ge\ g.s.)=0^+$.

1973Ka03: (d,p) E=6.02 MeV deuteron beam was produced from the Kyushu University electrostatic generator. Target was ~80 $\mu g/cm^2$ GeO_2 (90.88% enriched in ^{72}Ge) on a 5 $\mu g/cm^2$ carbon foil. Reaction products were detected with two silicon surface-barrier detectors (FWHM=16-18 keV). Measured $\sigma(\theta)$, θ=0°−160°. Deduced levels, J, π, L-transfers, spectroscopic factors from DWBA analysis. Comparisons with available data.

1976Yo04 (also 1975YoZR): (pol d,p) E=12 MeV polarized deuteron beam was produced from the Notre Dame tandem accelerator. Target was GeO_2 (96% enriched in ^{72}Ge) with a thickness of about 600 $\mu g/cm^2$ evaporated onto 10 $\mu g/cm^2$ carbon foils. Reaction products were detected with Si(Li) detectors (FWHM≈45 keV). Measured analyzing powers $A_y(\theta)$, $\sigma(\theta)$ with θ=15°−120°. Deduced levels, J, π, L-transfers, spectroscopic factors from DWBA analysis. Comparisons with available data.

1972Ha74: (d,p) E=12 MeV deuteron beam was produced from the Niels Bohr Institute tandem accelerator. Targets were about 30 $\mu g/cm^2$ natural Ge samples (≈99% enrichment) deposited on carbon foils. Reaction products were momentum-analyzed with a single-gap broad-range magnetic spectrograph (FWHM=8 keV) and detected in nuclear emulsions. Measured $\sigma(\theta)$, θ=11°−86°. Deduced levels, J, π, L-transfers, spectroscopic factors from DWBA analysis.

1969He05: E=8.0 MeV deuteron beam was produced from the Aldermaston accelerator. Target was 100 $\mu g/cm^2$ isotopically enriched ^{72}Ge (82.0%) on a carbon backing. Reaction products were momentum-analyzed with the Aldermaston multi-gap magnetic spectrograph and detected in nuclear emulsion plates. Measure $\sigma(\theta)$, θ=5°−175°. Deduced levels, J, π, L-transfers, spectroscopic factors from DWBA analysis.

Other: 1966Bo05, 1967Li15.

Cross-section data

Level	(dσ/dΩ) (max) (mb/sr)		
	1969He05	1972Ha74	1973Ka03
0	0.66	2.02	0.27
13	0.22	0.80	0.16
66	0.91	2.88	0.38
356			0.36
361	0.75	3.10	
392		1.56	0.13
503	0.64	1.83	0.43
560	0.37	0.97	0.16 a
658	0.16	0.47	0.08
888	0.20	1.44	
899	0.40	0.82	0.18
939			0.08
1046	0.24	0.97	0.11
1139		1.37	0.08
1260	0.21		0.04
1329			0.04
1599	0.53	0.17	0.21 a
1623	1.26	4.39	1.11
1733	2.22	0.72	1.24 a
1754		0.29	
1804	0.55		
1911	0.67	1.96	0.42
1962	0.42	1.05	0.25
1995		0.24	
2030	0.28	0.46	
2067	0.98		0.54 a
2088		0.57	0.20 a
2225	0.42	2.13	0.27
2312	0.16		
2319	0.24	1.08	0.14

2374	0.31		0.15 a
2459	1.25	1.32	0.73 a
2576	0.51	1.52	0.30
2618			0.11
2683	0.12		0.07
2732	0.46	1.63	0.29 a
2846	0.20		0.10
2915	0.82	0.64	0.65 a
2973			0.08
3037			0.12
3178			0.04
3223			0.04
3277			0.08
3305			0.07
3356			0.04
3418			0.17
3514			0.13 a
3551			0.20 a
3727			0.33
3766			0.11
3809			0.59
3849			0.33
3918			0.45
4009			0.41

a: second maximum

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^{73}Ge Levels

Spectroscopic factor S is extracted using the relation: $(d\sigma/d\Omega)_{exp}=(2J+1)S\times(d\sigma/d\Omega)_{DWBA}$, where J is the spin of the final level.

E(level)[†]	J^{π}[@]	L[&]	(2J+1)S[&]	Comments
0	$9/2^+$	4	5.04	(2J+1)S: others: 4.39 (1969He05), 7.35 (1972Ha74), 6.1 (1976Yo04).
13 *5*	$5/2^+$	2	0.30	(2J+1)S: others: 0.13 (1969He05), 0.28 (1972Ha74).
66 *5*	$1/2^-$	1	0.52	E(level): others: 67 *5* (1972Ha74), 67 *10* (1969He05). (2J+1)S: others: 0.32 (1969He05), 0.78 (1972Ha74), 0.72 (1976Yo04).
352[‡] *10*				
361[‡] *10*	$3/2^-$	1	0.48	E(level): others: 356 *5* from 1973Ka03 and 368 *10* from 1969He05 could correspond to 352+361 resolved in 1972Ha74. (2J+1)S: other: 0.25 (1969He05), 0.59 (1972Ha74).
392 *5*	$3/2^-$	1	0.14	E(level): others: 396 *10* (1969He05), 390 *5* (1972Ha74). (2J+1)S: others: 0.40 (1972Ha74), 0.52 (1976Yo04).
503 *5*	$5/2^+$	2	0.65	E(level): other: 512 *10* (1969He05), 497 *5* (1972Ha74). L: other: 1 from 1969He05 is inconsistent. (2J+1)S: others: 0.20 for L=1 (1969He05), 0.58 (1972Ha74), 0.72 (1976Yo04).
560 *5*	$1/2^+$	0	0.11	E(level): others: 562 *10* (1969He05), 551 *5* (1972Ha74). L: other: 0+2 (1969He05). (2J+1)S: others: 0.20 for L=2 (1969He05), 0.054 (1972Ha74).
593[‡] *5*				
658 *5*	$9/2^+$	4	1.06	E(level): others: 666 *10* (1969He05), 655 *5* (1972Ha74). (2J+1)S: others: 0.65 (1969He05), 1.62 (1972Ha74), 1.05 (1976Yo04).
727[#] *10*				
769[‡] *5*				
820[‡] *5*				
888[‡] *5*		1[‡]	0.25[‡]	E(level): other: 864 *10* (1969He05). (2J+1)S: other: 0.06 (1969He05).
904[‡] *5*		1[‡]	0.19[‡]	E(level),J^{π}: 899, $1/2^-$, (2J+1)S=0.38 from 1976Yo04 for an unresolved doublet; 899 5,

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^{72}Ge(d,p),(pol d,p) 1973Ka03,1976Yo04,1972Ha74 (continued)

^{73}Ge Levels (continued)

E(level)[†]	Jπ[@]	L[&]	(2J+1)S[&]	Comments
				(2J+1)S=0.24 from 1973Ka03 could also be a doublet corresponding to 888+904 resolved in 1972Ha74. Other: 904 *10*, (2J+1)S=0.12 (1969He05).
939 *5*				E(level): others: 926 *10* (1969He05), 925 10 (1972Ha74).
1046 *10*	3/2$^-$	1	0.08	E(level): others: 1051 *10* (1969He05), 1036 10 (1972Ha74). (2J+1)S: others: 0.07 (1969He05), 0.16 (1972Ha74), 0.16 (1976Yo04).
1139 *10*	1/2$^-$	1	0.14	E(level): others: 1141 *10* (1969He05), 1123 *10* (1972Ha74). (2J+1)S: from 1976Yo04. Other: 0.23 (1972Ha74).
1176[#] *10*				
1260 *10*		0	0.01	E(level): other: 1274 *10* (1969He05). L,(2J+1)S: from 1969He05.
1322[#] *10*				
1329 *10*				E(level): other: 1344 *10* (1969He05), 1308 *10* (1972Ha74).
1376[‡] *10*				
1599 *10*		(0)	0.10	E(level): others: 1617 *10* (1969He05), 1595 *10* (1972Ha74). L: other: 0+2 (1969He05). (2J+1)S: others: 0.24 for L=2 (1969He05), <0.01 (1972Ha74).
1623 *10*	5/2$^+$	2	1.13	E(level): others: 1646 *10* (1969He05), 1623 *10* (1972Ha74). (2J+1)S: others: 0.58 (1969He05), 1.13 (1972Ha74), 1.32 (1976Yo04).
1733 *10*		0	0.67	E(level): others: 1756 *10* (1969He05), 1733 *10* (1972Ha74). L: other: 0+2 (1969He05). (2J+1)S: others: 0.97 for L=2 (1969He05), 0.037 (1972Ha74), 0.45 (1976Yo04).
1754[‡] *10*		4[‡]	0.86[‡]	
1804[#] *10*		2	0.25	L,(2J+1)S: from 1969He05; L=0+2 is also possible.
1911 *10*	5/2$^+$	2	0.45	E(level): other: 1936 *10* (1969He05), 1911 *10* (1972Ha74). L: other: 1 from 1969He05 is inconsistent. (2J+1)S: others: 0.48 (1972Ha74), 0.46 (1976Yo04), 0.16 for L=1 (1969He05).
1962 *10*	5/2$^+$	2	0.26	E(level): others: 1983 *10* (1969He05), 1958 *10* (1972Ha74). L: other: 1 from 1969He05 is inconsistent. (2J+1)S: others: 0.25 (1972Ha74), 0.25 (1976Yo04), 0.10 for L=1 (1969He05).
1995[‡] *10*		2[‡]	0.058[‡]	E(level): other: 2010 *10* (1969He05).
2030 *10*		(2)	0.11	E(level): other: 2024 *10* (1972Ha74), 2053 *10* (1969He05). L,(2J+1)S: from 1972Ha74. Other: L=1 with (2J+1)=0.06 from 1969He05 is inconsistent.
2067 *10*		0	0.24	E(level): others: 2066 *10* (1972Ha74).
2088 *10*		2	0.27	E(level): others: 2093 *10* (1969He05), 2088 *10* (1972Ha74). L,(2J+1)S: from 1972Ha74. Others: (2J+1)S=0.41 (1969He05); L=(0), (2J+1)S=0.098 from 1973Ka03; L=0+2 is also possible (1969He05).
2164[#] *10*				
2225 *10*	5/2$^+$	2	0.24	E(level): others: 2251 *10* (1969He05), 2225 *10* (1972Ha74). (2J+1)S: others: 0.17 (1969He05), 0.49 (1972Ha74), 0.35 (1976Yo04).
2312[#] *10*		2	0.07	L,(2J+1)S: from 1969He05.
2319 *10*	3/2$^+$	2	0.12	E(level): other: 2353 *10* (1969He05), 2321 *10* (1972Ha74). (2J+1)S: others: 0.10 (1969He05), 0.24 (1972Ha74), 0.24 (1976Yo04).
2337[‡] *10*				
2374 *10*		0	0.08	E(level): other: 2411 *10* (1969He05). L,(2J+1)S: 0.07 for L=1 is inconsistent (1969He05).
2459 *10*		0	0.32	E(level): other: 2495 *10* (1969He05), 2463 *10* (1972Ha74). L: other: 0+2 (1969He05). (2J+1)S: others: 0.49 for L=2 (1969He05), 0.065 (1972Ha74), 0.36 (1976Yo04).
2470[‡] *10*				
2576 *10*	5/2$^+$	2	0.32	E(level): others: 2614 *10* (1969He05), 2583 *10* (1972Ha74). (2J+1)S: others: 0.20 (1969He05), 0.32 (1972Ha74), 0.48 (1976Yo04).
2618 *10*		(2)	0.10	E(level): other: 2618 *10* (1972Ha74).
2683 *10*		2	0.08	E(level): other: 2726 *10* (1969He05). L: from 1969He05. Other: L=(2) from 1973Ka03.

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^{72}Ge(d,p),(pol d,p) 1973Ka03,1976Yo04,1972Ha74 (continued)

^{73}Ge Levels (continued)

E(level)[†]	L[&]	(2J+1)S[&]	Comments
			(2J+1)S: other: 0.05 (1969He05). L=2 is inconsistent with J^{π}(2678)=1/2$^-$,3/2$^-$ in Adopted Levels.
2732 *10*	0	0.08	
2743[‡] *10*	2	0.34	E(level): other: 2773 *10* (1969He05). (2J+1)S: other: 0.18 (1969He05).
2846 *10*	(2)	0.11	E(level): others: 2885 *10* (1969He05), 2860 *10* (1972Ha74). L: from 1969He05. Other: L=(2) from 1973Ka03. (2J+1)S: other: 0.08 (1969He05).
2915 *10*	0	0.30	E(level): other: 2963 *10* (1969He05), 2931 *10* (1972Ha74). L: other: 0+2 (1969He05). (2J+1)S: other: 0.28 for L=2 (1969He05), 0.032 (1972Ha74).
2973 *10*			
3037 *15*			
3178 *15*			
3223 *15*			
3277 *15*			
3305 *15*			
3356 *15*			
3418 *15*	2	0.11	
3514 *15*	(0)	0.03	
3551 *15*	(0)	0.07	
3727 *15*	(2)	0.04	
3766 *15*	(2)	0.02	
3809 *15*			
3849 *15*			
3918 *15*			
4009 *15*			

[†] From 1973Ka03, unless otherwise noted. Values from 1969He05 are systematically higher than values in 1973Ka03 and 1972Ha74 by a few keV to about 40 keV as level energy increases.
[‡] From 1972Ha74.
[#] From 1969He05 only.
[@] From L-transfers and vector-analyzing powers in 1976Yo04.
[&] Extracted from DWBA fit to measured $\sigma(\theta)$. Quoted values are from 1973Ka03, unless otherwise noted. Values of (2J+1)S from 1976Yo04 and 1972Ha74 are given under comments; Values of L-transfers from others are consistent with those from 1973Ka03 and are given under comments if different.