^{70}Ge(d,p),(pol d,p) 1977Bi08,1976Yo04,1968Go02

History

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

1977Bi08 (1977BiZS thesis): (pol d,p) E=12 MeV beam at the University of Notre Dame. 84.6% enriched Ge target. Measured proton energies, $\sigma(\theta)$ from 15° to 90°, analyzing powers at 16° and 20° using a magnetic spectrograph (FWHM=12-20 keV) and nuclear emulsion plates. Deduced levels, J, π, L-transfers, spectroscopic factors from DWBA analysis.

1976Yo04 (also 1975YoZR thesis): (pol d,p) E=12.0 MeV at the University of Notre Dame. Enriched ^{70}Ge target. Protons detected by Si(Li) detectors (FWHM=50 keV). Measured $\sigma(\theta)$ and vector analyzing powers for θ(lab)=15°−120°. Deduced levels, J, L-transfers, spectroscopic factors from DWBA analysis. A total of 13 groups up to 2640 were studied.

1968Go02: (d,p) E=7.5 MeV beam from the MIT-ONR electrostatic generator. Protons were detected with a multigap magnetic spectrograph (FWHM=25 keV) and nuclear emulsion plates. Measured $\sigma(\theta)$ for θ(lab)=7°−172.5°. Deduced levels, J, π, L-transfers, spectroscopic factors from DWBA analysis. Total of 86 groups reported up to 4520 excitation energy.

Additional information 1.

1967Li15: E=6.5 MeV. Measured proton energies, cross sections, angular distributions. A total of 34 groups (eight of these uncertain) were reported. The L-transfers were determined for 11 groups. Due to poor resolution (energy uncertainty of 30 keV) it is difficult to compare results in this study with later works.

^{71}Ge Levels

E(level)†	J$^\pi$&	L†	(2J+1)S†	Comments
0.0	1/2$^-$[a]	1[c]	0.62	(2J+1)S: 0.59 (1976Yo04), 0.55 (1968Go02). dσ/dΩ(max)=940 μb/sr (1968Go02).
60? *10*				E(level): possible level reported only in 1968Go02, not in any other reaction or decay. Level not listed in the Adopted Levels. dσ/dΩ(max)<7 μb/sr (1968Go02).
176 *3*	(5/2)$^-$	3[c]	1.49	(2J+1)S: 0.4 (1968Go02). dσ/dΩ(max)=70 μb/sr for 160 level (1968Go02).
199 *3*	9/2$^+$[a]	4[c]	4.15	(2J+1)S: 8.7 (1976Yo04), 7.3 (1968Go02). dσ/dΩ(max)=610 μb/sr for 190 level (1968Go02).
501 *3*	3/2$^-$	1[c]	0.36	E(level): 510 in 1976Yo04 is composite of 501 and 526 levels; 480 listed in table 2 of 1976Yo04 and in table I of 1968Go02. (2J+1)S: 0.27 (1968Go02). dσ/dΩ(max)=600 μb/sr for 480 level (1968Go02).
526 *3*	5/2$^+$	2[c]	0.52	(2J+1)S: 0.62 (1968Go02). dσ/dΩ(max)=750 μb/sr for 510 level (1968Go02).
587 *3*				dσ/dΩ(max)=14 μb/sr for 570 level (1968Go02).
620 *10*				E(level): level reported only in 1968Go02, not in any other reaction or decay. dσ/dΩ(max)=35 mb/sr (1968Go02).
630? *10*				E(level): possible level reported only in 1968Go02, not in any other reaction or decay. Level not listed in the Adopted Levels. dσ/dΩ(max)<7 mb/sr (1968Go02).
707 *3*	3/2$^-$[a]	1[c]	≤0.07	(2J+1)S: 0.12 (1976Yo04), 0.054 (1968Go02). dσ/dΩ(max)=130 μb/sr for 700 level (1968Go02).
747		3	0.12	E(level): 1977Bi08 state that energy is from 1976Yo04 but the latter do not report this level. L: (2) in 1968Go02. (2J+1)S: 0.021 (1968Go02). dσ/dΩ(max)=25 μb/sr for 730 level (1968Go02).
801 *3*				dσ/dΩ(max)=10 μb/sr for 790 level (1968Go02).
817 *3*				dσ/dΩ(max)=22 μb/sr for 810 level (1968Go02).
890 *10*		(1)	0.014	E(level),L,(2J+1)S: level reported in 1968Go02. dσ/dΩ(max)=35 mb/sr (1968Go02).
950? *10*				E(level): level reported only in 1968Go02, not in any other reaction or decay. Level not listed in the Adopted Levels. dσ/dΩ(max)<7 mb/sr (1968Go02).

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^{70}Ge(d,p),(pol d,p) 1977Bi08,1976Yo04,1968Go02 (continued)

^{71}Ge Levels (continued)

E(level)†	Jπ&	L†	(2J+1)S†	Comments
970 *10*				E(level): level reported only in 1968Go02, not in any other reaction or decay. dσ/dΩ(max)=40 mb/sr (1968Go02).
1032 *3*				dσ/dΩ(max)=59 μb/sr for 1030 level (1968Go02).
1095 *3*	3/2−	1[c]	0.14	(2J+1)S: 0.10 (1968Go02). dσ/dΩ(max)=280 μb/sr for 1090 level (1968Go02).
1133‡ *5*				dσ/dΩ(max)=28 μb/sr for 1120 level (1968Go02).
1154# *3*				
1171 *3*	5/2+[a]	2	0.78	Jπ,L,(2J+1)S: from 1976Yo04; no angular distribution data in 1977Bi08. (2J+1)S: 0.029 (1968Go02). dσ/dΩ(max)=37 μb/sr for 1160 level (1968Go02).
1203 *3*	(5/2)+[b]	2	0.32	(2J+1)S: 0.036 (1968Go02). dσ/dΩ(max)=46 μb/sr for 1200 level (1968Go02).
1237‡ *5*				
1286 *3*	1/2−	1	0.05	dσ/dΩ(max)=59 μb/sr for 1280 level (1968Go02).
1346 *3*	1/2+[a]	0	0.11	(2J+1)S: 0.185 (1976Yo04), 0.093 (1968Go02). dσ/dΩ(max)=630 μb/sr for 1340 level (1968Go02).
1375 *3*	(7/2−,5/2+)	(3,2)	0.07	E(level): possibly a doublet from L=(3,2). (2J+1)S,L: 0.019 for L=(2) for 1380 group (1968Go02). dσ/dΩ(max)=26 μb/sr for 1380 level (1968Go02).
1401 *3*				
1415 *3*				dσ/dΩ(max)<7 μb/sr for 1410 level (1968Go02).
1453 *3*		(0)	0.02	dσ/dΩ(max)=28 μb/sr for 1450 level (1968Go02).
1474 *3*		2	0.11	(2J+1)S,L: 0.55 for L=(3) for 1470 group (1968Go02). dσ/dΩ(max)=140 μb/sr for 1470 level (1968Go02).
1485 *3*		(2)	0.057	L,(2J+1)S: from 1968Go02 for 1500 level. dσ/dΩ(max)=77 μb/sr for 1500 level (1968Go02).
1539 *3*		(2)	0.057	
1556 *3*	5/2+	2	0.24	Jπ: from VAP data of 1976Yo04 for 1542 group which is identified in 1977Bi08 with their 1556 group. (2J+1)S: 0.493 (1976Yo04), 0.21 (1968Go02). dσ/dΩ(max)=280 μb/sr for 1550 level (1968Go02).
1595# *3*				dσ/dΩ(max)=40 μb/sr for 1590 level (1968Go02).
1695 *3*	(9/2)+	4	0.93	(2J+1)S: 1.53 (1976Yo04), 0.63 for L=(3) (1968Go02). Jπ: 7/2 was proposed by 1976Yo04 from their VAP data but this assignment has been questioned by 1977Bi08. dσ/dΩ(max)=160 μb/sr for 1690 level (1968Go02).
1751‡ *5*				
1789 *3*		(1)	0.013	L,(2J+1)S: from 1968Go02 for 1780 level. dσ/dΩ(max)=41 μb/sr for 1780 level (1968Go02).
1814 *3*				
1841 *3*				
1868‡ *5*				dσ/dΩ(max)=10 μb/sr for 1870 level (1968Go02).
1891 *3*				
1909‡ *5*				
1941 *3*	(9/2)+	4	0.26	dσ/dΩ(max)≈20 μb/sr for 1940 level (1968Go02).
1961‡ *5*	1/2+[a]	0[c]	0.04	(2J+1)S: 0.108 (1976Yo04), 0.039 (1968Go02). dσ/dΩ(max)=300 μb/sr for 1960 level (1968Go02).
1979‡ *5*				
2028 *3*		2	0.03	
2041 *3*		1[c]	0.06	(2J+1)S: 0.097 (1968Go02). dσ/dΩ(max)=320 μb/sr for 2040 level (1968Go02).
2071‡ *5*				
2082‡ *5*				

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^{70}Ge(d,p),(pol d,p) 1977Bi08,1976Yo04,1968Go02 (continued)

^{71}Ge Levels (continued)

E(level)[†]	J$^{\pi}$[&]	L[†]	(2J+1)S[†]	Comments
2094 *3*				
2139[‡] *5*		(3)	0.12	L,(2J+1)S: from 1968Go02 for 2120 *10* group. dσ/dΩ(max)=32 μb/sr for 2120 level (1968Go02).
2180[‡] *5*				dσ/dΩ(max)=20 μb/sr for 2170 level (1968Go02).
2210[‡] *5*		(0,3)		
2220 *3*	1/2^{+}[a]	0[c]	0.30	(2J+1)S: 0.431 (1976Yo04), 0.25 (1968Go02). dσ/dΩ(max)=2000 μb/sr for 2220 level (1968Go02).
2236[‡] *5*				
2277[‡] *5*	5/2^{+}[a]	2[c]	0.26	(2J+1)S: 0.462 (1976Yo04), 0.27 (1968Go02). dσ/dΩ(max)=440 μb/sr for 2270 level (1968Go02).
2297[‡] *5*				
2330[‡] *5*				dσ/dΩ(max)≈50 μb/sr for 2330 level (1968Go02).
2345 *3*	5/2^{+}	2	≤0.02	E(level): a small peak from the 1006 level in ^{77}Ge is also present. S′ upper limit with about one-third of observed strength due to 1006 level.
2363 *3*		(0)	≤0.03	E(level): a doublet partly due to 1733 level in ^{73}Ge. dσ/dΩ(max)=170 μb/sr for 2350 level (1968Go02).
2388[‡] *5*				
2432 *3*		0	0.020	L,(2J+1)S: from 1968Go02. dσ/dΩ(max)=160 μb/sr for 2410 level (1968Go02).
2455 *3*				
2486 *3*		0[c]	0.03	(2J+1)S: 0.044 (1968Go02). dσ/dΩ(max)=360 μb/sr for 2480 level (1968Go02).
2523 *3*	5/2^{+}	2[c]	0.17	(2J+1)S: 0.21 (1968Go02). dσ/dΩ(max)=370 μb/sr for 2510 level (1968Go02).
2543 *3*				
2572[‡] *5*				dσ/dΩ(max)=48 μb/sr for 2560 level (1968Go02).
2590 *3*				
2616 *3*				dσ/dΩ(max)=41 μb/sr for 2600 level (1968Go02).
2644 *3*	5/2^{+}[a]	2[c]	0.11	(2J+1)S: 0.310 (1976Yo04), 0.18 (1968Go02). dσ/dΩ(max)=320 μb/sr for 2640 level (1968Go02).
2669[‡] *5*				
2694[‡] *5*				
2725[‡] *5*				dσ/dΩ(max)=90 μb/sr for 2700 level (1968Go02).
2742[‡] *5*		(1)[c]	0.01	(2J+1)S: 0.0024 (1968Go02). dσ/dΩ(max)=90 μb/sr for 2730 level (1968Go02).
2756 *3*		2	0.06	dσ/dΩ(max)=320 μb/sr for 2750 level (1968Go02).
2773 *3*		0	0.02	
2789 *3*				
2802[‡] *5*				
2830 *3*				dσ/dΩ(max)=210 μb/sr for 2820 level (1968Go02).
2857 *3*		2	0.01	
2881 *3*	3/2^{+}	2	0.08	dσ/dΩ(max)=170 μb/sr for 2870 level (1968Go02).
2896 *3*		(1)	0.17	
2911 *3*				dσ/dΩ(max)=70 μb/sr for 2900 level (1968Go02).
2922[‡] *5*				
2940 *3*				
2960 *3*		0[c]	0.03	(2J+1)S: 0.028 (1968Go02). dσ/dΩ(max)=250 μb/sr for 2950 level (1968Go02).
3003 *3*	5/2^{+}	2	0.05	dσ/dΩ(max)=160 μb/sr for 2990 level (1968Go02).
3035 *3*	5/2^{+}	2	0.16	dσ/dΩ(max)=410 μb/sr for 3020 level (1968Go02).
3065 *3*		2	0.03	
3087 *3*		0	≤0.03	E(level): a doublet partly due to the 2459 level in ^{73}Ge.

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^{70}Ge(d,p),(pol d,p) 1977Bi08,1976Yo04,1968Go02 (continued)

^{71}Ge Levels (continued)

E(level)†	Jπ&	L†	(2J+1)S†	Comments
				dσ/dΩ(max)=380 μb/sr for 3080 level (1968Go02).
3102 *3*				
3114 *3*				
3129 *3*				
3154 *3*				
3161‡ *5*				
3183‡ *5*		0[c]	0.06	(2J+1)S: 0.068 (1968Go02). dσ/dΩ(max)=620 μb/sr for 3170 level (1968Go02).
3205‡ *5*		2	0.07	
3232 *3*		(0)	0.01	L: 0 in 1977Bi08, but σ(θ) distribution not shown by authors. dσ/dΩ(max)=260 μb/sr for 3230 level (1968Go02).
3273‡ *5*				
3286 *3*	(5/2+,1/2−)	(2,1)	≤0.03	E(level): a doublet partly due to 2382 level in ^{75}Ge. (2J+1)S,L: 0.086 for L=2 (1968Go02). dσ/dΩ(max)=180 μb/sr for 3280 level (1968Go02).
3293‡# *5*				
3311‡ *5*	(1/2−)[b]	(1)	0.01	
3334 *3*		(2)	0.067	L,(2J+1)S: from 1968Go02. dσ/dΩ(max)=140 μb/sr for 3330 level (1968Go02).
3361‡ *5*				
3375 *3*				dσ/dΩ(max)=360 μb/sr for 3360 level (1968Go02).
3380‡ *5*		(3,0)	0.20	
3404‡ *5*				
3422‡ *5*		2	0.04	
3444‡ *5*				dσ/dΩ(max)=190 μb/sr for 3430 level (1968Go02).
3459‡ *5*				
3473‡ *5*		2		L: from Fig. 9 in 1977Bi08.
3483 *3*	(3/2)+	2	0.05	dσ/dΩ(max)=240 μb/sr for 3470 level (1968Go02).
3496‡ *5*				
3509‡ *5*				dσ/dΩ(max)=540 μb/sr for 3520 level (1968Go02).
3558 *3*		2[c]	0.02	(2J+1)S: 0.16 (1968Go02). dσ/dΩ(max)=350 μb/sr for 3550 level (1968Go02).
3571 *3*		1	0.08	
3597 *3*	3/2−	1	0.05	dσ/dΩ(max)=410 μb/sr for 3590 level (1968Go02).
3615‡ *5*				
3633# *3*		(0)	0.043	L,(2J+1)S: from 1968Go02 for 3620 *10* group. dσ/dΩ(max)=420 μb/sr for 3620 level (1968Go02).
3647‡ *5*				
3659 *3*				
3682 *3*		2,(1)		dσ/dΩ(max)=140 μb/sr for 3670 level (1968Go02).
3721 *3*		0[c]	0.06	(2J+1)S: 0.07 (1968Go02). dσ/dΩ(max)=690 μb/sr for 3710 level (1968Go02).
3744 *3*				
3767 *3*	(5/2+)[b]	(2)	0.05	(2J+1)S: 0.05 for L=0 for 3760 *10* (1968Go02). dσ/dΩ(max)=500 μb/sr for 3760 level (1968Go02).
3778‡ *5*				
3793‡ *5*				
3824‡ *5*				
3843 *3*				
3855 *3*				dσ/dΩ(max)=350 μb/sr for 3850 level (1968Go02).

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^{70}Ge(d,p),(pol d,p) 1977Bi08,1976Yo04,1968Go02 (continued)

^{71}Ge Levels (continued)

E(level)†	Jπ&	L†	(2J+1)S†	Comments
3866‡ *5*				
3884‡ *5*				
3899 *3*	$(3/2)^{+}$*b*	2	0.07	
3910 *3*	$(5/2^{+})$	(2)	0.07	dσ/dΩ(max)=220 μb/sr for 3900 level (1968Go02).
3924 *3*				
3944 *3*		(1,2)		
3960 *3*		0	0.02	L,(2J+1)S: from 1968Go02. dσ/dΩ(max)=210 μb/sr for 3960 level (1968Go02).
3976‡ *5*				
3996‡ *5*				dσ/dΩ(max)=220 μb/sr for 4000 level (1968Go02).
4050@ *10*				dσ/dΩ(max)=410 mb/sr (1968Go02).
4080@ *10*				dσ/dΩ(max)=440 mb/sr (1968Go02).
4090@ *10*				dσ/dΩ(max)=410 mb/sr (1968Go02).
4140@ *10*				dσ/dΩ(max)=320 mb/sr (1968Go02).
4220@ *10*				dσ/dΩ(max)=460 mb/sr (1968Go02).
4310@ *10*				dσ/dΩ(max)=390 mb/sr (1968Go02).
4410@ *10*		(0)	0.13	L,(2J+1)S: from 1968Go02. dσ/dΩ(max)≈1400 mb/sr (1968Go02).
4520@ *10*				dσ/dΩ(max)=510 mb/sr (1968Go02).

† From 1977Bi08, unless indicated otherwise. The L-values for 34 levels were also determined by 1968Go02 and for 13 levels by 1976Yo04. The groups at 890, 970, 1500, 1780 and 2410 reported in 1968Go02 seem to be from impurities.

‡ Seen only in one of the two high-resolution spectra obtained by 1977Bi08.

Angular distribution data obtained by 1977Bi08 but no L assignment was possible.

@ From 1968Go02.

& From DWBA analysis of $\sigma(\theta)$ and vector analyzing power by 1977Bi08, unless indicated otherwise.

[a] From vector analyzing power (VAP) measurement in 1976Yo04. The VAP measurements by 1977Bi08 at two angles are consistent.

[b] In the opinion of the evaluators, the VAP data of 1977Bi08 are not conclusive about spin choice for this level due to the isotropic pattern of the VAP data for L+1/2 and L−1/2.

[c] Same L value in 1968Go02.