^{30}Si(^{3}He,d),(pol ^{3}He,d) 1990Ve04,2022Ha03,1984Mc12

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 184, 29 (2022)	24-Jun-2022

1990Ve04: (^{3}He,d) E=25 MeV from Orsay MP Tandem Van de Graaff accelerator. Enriched metallic silicon targets (95% ^{30}Si). Measured deuteron energies, angular distributions using an Enge split pole magnetic spectrograph (FWHM=23 keV). A combination of plastic scintillator and proportional counters used as detectors. DWBA analysis includes shell model calculations.

2022Ha03: (^{3}He,d) E=25 MeV ^{3}He beam was produced from the Tandem Van de Graaff accelerator at the Maier-Leibnitz-Laboratorium (MLL) in Garching, Germany. Target was 16 μg/cm^2 *3* 95% enriched $^{30}SiO_2$ on a 40 μg/cm^2 *1* carbon backing. Reaction products were momentum-analyzed with a Q3D magnetic spectrometer and detected by proportional counters. Measured $\sigma(\theta)$,at θ=6° to 32°. Deduced levels, L-transfers, spectroscopic factors from DWBA analysis. Calculated proton widths, resonance strengths, astrophysical ^{30}Si(p,γ) reaction rates. Comparisons with available data.

1984Mc12: (pol ^{3}He,d) E=33.4 MeV from University of Birmingham Radial Ridge Cyclotron. Enriched Si target (95% ^{30}Si). Measured $\sigma(\theta)$ ($\theta_{c.m}$=14°−100°), analyzing powers with ΔE-E telescopes. Deduced levels, J, π, L-transfers, spectroscopic factors from DWBA analysis.

1970Wo01: (^{3}He,d) E=12 MeV from tandem Van de Graaff accelerator at Utrecht. Enge split pole magnetic spectrograph with scattering chamber equipped with 8 position sensitive Si detectors used to measure angular distributions (θ_{lab}=5°−70°, 5° steps) of deuterons. Targets of enriched Si (95% ^{30}Si). DWBA analysis. Also 1970WoZW thesis.

1970Mo01: (^{3}He,d) E=15 MeV from Argonne tandem Van de Graaff accelerator. Enriched targets (96% ^{30}Si). Silicon ΔE-E telescopes or magnetic spectrograph; FWHM=20 keV for θ<20°. Angular distribution measurements from θ_{lab}=7°−90°. DWBA analysis.

Others:

1969Mo03: (^{3}He,d) E=10.001 MeV from the ONR-CIT tandem accelerator. Enriched Silicon foil targets (89% ^{30}Si). Double focusing magnetic spectrometer. Deuterons detected using Au-Si surface barrier detectors. Total instrumental resolution of 30 keV.

1970Lu07: (^{3}He,d) E=17.85 MeV from Lawrence Livermore Laboratory. Enriched metallic target (95.2% ^{30}Si). Scattering chamber for particle identification and silicon ΔE-E detectors used to measure angular distributions. 70 keV FWHM resolution.

1970Me19: (^{3}He,d) E=20 MeV from the Tandem Van de Graaff in Heidelberg. Measured $\sigma(\theta)$ at θ=5°−165° with four ΔE-E counter telescopes.

1966Be26: (^{3}He,d) E=15 MeV. Measured $\sigma(\theta)$.

1985Br05: (pol ^{3}He,d) E=33 MeV. Measured σ.

^{31}P Levels

Proton resonance energies (E_r), calculated proton widths (Γ_p) and resonance strengths ($\omega\gamma$) by 2022Ha03 are given under comments. S(p)(^{31}P)=7296.553 *23* (2021Wa16) is used to deduced E_r.

E(level)†	Jπ#	L@	C^{2}S&	Comments
0	1/2$^+$	0	0.64	L: 0 (1990Ve04,1970Lu07,1970Wo01,1970Mo01,1970Me19,1966Be26). C^{2}S: others: 0.34 (1984Mc12), 0.49 (1970Lu07), 0.44 (1970Mo01), 0.47 (1970Wo01), 0.45 *5* (1966Be26).
1269 *4*	3/2$^+$	2	0.69	E(level): weighted average of 1268 *4* (1990Ve04), 1270 *7* (1970Mo01), 1267 *12* (1969Mo03), and 1270 *15* (1966Be26). Additional information 1. C^{2}S: others: 0.36 (1984Mc12), 0.65 (1970Lu07), 0.8 (1970Mo01), 0.48 (1970Wo01), 0.45 *5* (1966Be26).
2229 *4*	5/2$^+$	2	0.06	E(level): weighted average of 2227 *4* (1990Ve04), 2230 *7* (1970Mo01), 2234 *10* (1969Mo03), and 2230 *15* (1966Be26). Additional information 2. C^{2}S: others: 0.05 (1984Mc12), 0.08 (1970Lu07), 0.08 (1970Mo01), 0.046 (1970Wo01), 0.043 *4* (1966Be26).
3136 *4*		0	0.03	E(level): weighted average of 3134 *4* (1990Ve04), 3140 *7* (1970Mo01), 3135 *12* (1969Mo03), and 3140 *15* (1966Be26). Additional information 3.

Continued on next page (footnotes at end of table)

^{30}Si(^{3}He,d),(pol ^{3}He,d) 1990Ve04,2022Ha03,1984Mc12 (continued)

^{31}P Levels (continued)

E(level)†	Jπ#	L@	C^{2}S&	Comments
				C^{2}S: others: 0.03 (1970Lu07), 0.029 (1970Mo01), 0.022 (1970Wo01), 0.0130 *13* (1966Be26).
3296 *4*		2	<0.001	E(level): weighted average of 3297 *4* (1990Ve04), 3290 *7* (1970Mo01), 3301 *10* (1969Mo03), and 3300 *15* (1966Be26). L: from 1970Lu07. (2) from 1990Ve04. Additional information 4. C^{2}S: for J=5/2. Others: ≈0.0013 (1970Mo01), ≈0.0025 (1966Be26).
3414 *4*				E(level): other: 3406 *18* (1969Mo03).
3504 *4*		(2)	0.006	E(level): weighted average of 3501 *4* (1990Ve04), 3510 *7* (1970Mo01), 3509 *13* (1969Mo03), and 3520 *15* (1966Be26). Additional information 5. C^{2}S: others: ≈0.005 (1970Mo01), 0.0025 (1966Be26).
4189 *4*		2	0.03	E(level): others: 4190 *7* (1970Mo01), 4191 *10* (1969Mo03); 4100 *15* (1966Be26) is discrepant. Additional information 6. C^{2}S: for J=5/2. Others: 0.022 (1970Mo01), 0.021 (1970Wo01).
4257 *5*		2	0.005	E(level): weighted average of 4258 *4* (1990Ve04), 4265 *10* (1969Mo03), and 4230 *15* (1966Be26). Additional information 7. C^{2}S: others: 0.06 (1970Lu07), 0.005 (1970Wo01), 0.025 *3* (1966Be26).
4431 *4*	7/2$^-$	3	0.30	E(level): weighted average of 4429 *4* (1990Ve04), 4430 *7* (1970Mo01), 4432 *10* (1969Mo03), and 4450 *15* (1966Be26). Additional information 8. C^{2}S: others: 0.24 (1984Mc12), 0.36 (1970Lu07), 0.29 (1970Mo01), 0.26 (1970Wo01), 0.34 *4* (1966Be26).
4591 *4*		2	0.03	E(level): weighted average of 4590 *4* (1990Ve04), 4590 *7* (1970Mo01), and 4600 *15* (1966Be26). L: 2 (1990Ve04,1970Lu07,1970Wo01,1970Mo01,1966Be26). C^{2}S: others: 0.06 (1970Lu07), 0.034 (1970Mo01), 0.018 (1970Wo01), 0.007 for J=5/2 (1966Be26).
4789 *6*		(2)	<0.001	E(level): other: 4784 *17* (1969Mo03). Additional information 9. C^{2}S: for J=5/2.
5013 *4*	3/2$^-$	1	0.17	E(level): others: 5010 *7* (1970Mo01), 5015 *10* (1969Mo03), 5030 *15* (1966Be26). Additional information 10. C^{2}S: others: 0.16 (1984Mc12), 0.24 (1970Lu07), 0.21 (1970Mo01), 0.17 (1970Wo01), 0.16 *2* (1966Be26).
5112 *4*		(2)	<0.001	E(level): other: 5111 *12* (1969Mo03). C^{2}S: for J=5/2.
5256 *4*		0	0.05	E(level): weighted average of 5255 *4* (1990Ve04), 5250 *7* (1970Mo01), 5257 *10* (1969Mo03), and 5290 *15* (1966Be26). Additional information 11. C^{2}S: others: 0.05 (1970Lu07), 0.07 (1970Mo01), 0.03 (1970Wo01), 0.032 *3* (1966Be26).
5345 *4*		4	0.016	E(level): other: 5346 *12* (1969Mo03). L: from 1970Wo01. C^{2}S: from 1970Wo01 for J=7/2; 0.006 for J=9/2.
5525 *4*				E(level): other: 5530 *17* (1969Mo03).
5562 *5*		2	0.02	E(level): weighted average of 5560 *4* (1990Ve04), 5561 *17* (1969Mo03), and 5590 *15* (1966Be26). Additional information 12. C^{2}S: other: 0.017 (1970Wo01).
5674 *4*				E(level): other: 5677 *12* (1969Mo03).
5775 *4*				
5893 *4*		4	0.023	E(level): weighted average of 5892 *4* (1990Ve04) and 5907 *18* (1969Mo03). L: from 1970Wo01. C^{2}S: from 1970Wo01 for J=7/2; 0.010 for J=9/2.
5988 *4*		2	0.007	L: 2 (1990Ve04).

Continued on next page (footnotes at end of table)

^{30}Si(^{3}He,d),(pol ^{3}He,d) 1990Ve04,2022Ha03,1984Mc12 (continued)

^{31}P Levels (continued)

E(level)[†]	L[@]	C^2S[&]	Comments
6051 *4*			
6080 *4*			
6234 *4*			
6336 *4*	0	0.004	
6386 *5*	2	0.22	E(level): weighted average of 6381 *4* (1990Ve04), 6400 *7* (1970Mo01), 6382 *10* (1969Mo03), and 6410 *15* (1966Be26). Additional information 13. C^2S: others: 0.25 (1970Lu07), 0.25 (1970Mo01), 0.18 (1970Wo01), 0.079 *8* (1966Be26).
6462 *4*	2	0.04	L: 2 (1990Ve04,1970Wo01). C^2S: others: 0.027 (1970Wo01); 0.33 for J=3/2, 0.17 for J=5/2 for a level at 6500 (1984Mc12), which could correspond to the 6381 level.
6500 *4*	1	0.05	E(level): weighted average of 6496 *4* (1990Ve04), 6494 *12* (1969Mo03), 6520 *35* (1970Lu07), 6510 *7* (1970Mo01), and 6520 *15* (1966Be26). J^π: the Ay(θ) for the E=6520 *35* in 1984Mc12 cannot be reproduced with either a $3/2^+$ or a $5/2^+$, likely due to many nearby states. L: 1 (1990Ve04,1970Wo01),1966Be26, (1) (1970Lu07), C^2S: others: 0.14 (1970Mo01), 0.07 for J=3/2 (1970Lu07), 0.10 (1970Wo01), 0.088 *9* (1966Be26).
6594 *4*	3	0.03	L: 3 (1990Ve04,1970Wo01). C^2S: for J=5/2. Other: 0.024 for J=5/2 (1970Wo01).
6615 *6*	1	0.02	E(level): weighted average of 6610 *4* (1990Ve04), 6630 *7* (1970Mo01), 6607 *10* (1969Mo03), and 6640 *15* (1966Be26). Additional information 14. C^2S: others: 0.038 for J=3/2 (1970Lu07), 0.013 (1970Mo01), 0.015 for J=3/2 (1970Wo01), 0.037 *4* (1966Be26).
6797 *4*			
6826.5[‡] *9*	5[‡]	0.005[‡]	E(level): other: 6826 *4* (1990Ve04). C^2S: from (2J+1)C^2S=0.061 (2022Ha03) and adopted $J^\pi=11/2^-$.
6844.0[‡] *8*	3	0.005	E(level): other: 6843 *4* (1990Ve04). L: 3 (1990Ve04,2022Ha03,1970Wo01). C^2S: for J=7/2 (1990Ve04). Others: 0.0057 (2022Ha03) and 0.011 (1970Wo01) for J=5/2.
6911.3[‡] *10*	1	0.02	E(level): others: 6910 *4* (1990Ve04), 6910 *20* (1970Mo01). Additional information 15. C^2S: others: 0.013 (2022Ha03), 0.07 (1970Mo01), 0.022 for J=3/2 (1970Wo01).
6933.2[‡] *9*	2	0.02	E(level): other: 6932 *4* (1990Ve04). L: 2 (1990Ve04,1970Wo01), 2 or 3 (2022Ha03). C^2S: for J=5/2. Other: 0.010 (1970Wo01) and 0.014 (2022Ha03).
7068.5[‡] *9*	3	0.005	E(level): other: 7068 *4* (1990Ve04). C^2S: other: 0.005 (2022Ha03).
7082.4[‡] *14*	1[‡]	0.001[‡]	E(level): other: 7082 *4* (1990Ve04). C^2S: for J=3/2.
7140.7[‡] *8*	0	0.11	E(level): others: 7139 *4* from 1990Ve0, 7150 *7* (1970Mo01), and 7150 *15* (1966Be26). L: 0 (1990Ve04,1970Lu07,1970Wo01),1966Be26, (0) (1970Mo01). C^2S: others: 0.34 (1970Lu07), ≈0.08 (1970Mo01), 0.08 (1970Wo01), 0.150 *15* (1966Be26), 0.05 (2022Ha03).
7159.7[‡] *16*	(1,3)[‡]	[‡]	(2J+1)C^2S=0.002 for L=1, or 0.003 for L=3 (2022Ha03).
7214.4[‡] *8*	1	0.008	E(level): others: 7214 *4* (1990Ve04), 7206 *6* (1970Wo01), and 7220 *15* (1966Be26). L: 1 (1990Ve04,2022Ha03,1970Wo01,1966Be26). C^2S: other: 0.020 (1970Wo01), 0.010 *1* (1966Be26), 0.005 (2022Ha03).
7316.1[‡] *9*	3[‡]	0.00094[‡]	E_r=19.6 *9*, calculated $\Gamma_p=2.94\times10^{-39}$ eV and $\omega\gamma=1.18\times10^{-38}$ eV (2022Ha03). E(level): other: 7314 *4* (1990Ve04). L: poor fit with L=3 in 1990Ve04, with C^2S=0.002 for J=7/2.
7347.1[‡] *12*	1,2[‡]	[‡]	E_r=50.5 *12*, calculated $\Gamma_p=5.20\times10^{-21}$ eV and $\omega\gamma=1.04\times10^{-20}$ eV (2022Ha03).

Continued on next page (footnotes at end of table)

^{30}Si(^{3}He,d),(pol ^{3}He,d) 1990Ve04,2022Ha03,1984Mc12 (continued)

^{31}P Levels (continued)

E(level)†	L@	C^2S&	Comments
			(2J+1)C^2S=0.007 for L=1 or 0.0012 for L=2 (2022Ha03).
7446‡ *3*	(2,3)‡	0.0007‡	E_r=149.2 *29*, calculated $\Gamma_p=1.16\times10^{-11}$ eV and $\omega\gamma=2.33\times10^{-11}$ eV (2022Ha03). (2J+1)C^2S=0.0007 for L=2 or 0.0006 for L=3 (2022Ha03).
7470.4‡ *22*	(3)‡	0.0001‡	E_r=174.0 *23*, calculated $\Gamma_p=1.59\times10^{-12}$ eV and $\omega\gamma=6.38\times10^{-12}$ eV (2022Ha03).
7690.9‡ *10*	3‡	0.0075‡	E_r=394.6 *10*, calculated $\Gamma_p=1.47\times10^{-6}$ eV and $\omega\gamma=4.40\times10^{-6}$ eV (2022Ha03).
7719.4‡ *8*	3‡	0.0056‡	E_r=423.0 *8*, calculated $\Gamma_p=2.48\times10^{-5}$ eV and $\omega\gamma=7.42\times10^{-5}$ eV (2022Ha03). E(level): other: 7718 *4* (1990Ve04). L: other: 2 from 1966Be26 for a group at 7720 *15* is inconsistent.
7737.3‡ *8*	3	0.02	E_r=440.8 *7*, calculated $\Gamma_p=9.79\times10^{-5}$ eV and $\omega\gamma=3.92\times10^{-04}$ eV (2022Ha03). E(level): other: 7736 *4* (1990Ve04). C^2S: other: 0.014 (2022Ha03).
7781.1‡ *8*	1	0.005	E_r=484.6 *8*, calculated Γ_p=0.061 eV and $\omega\gamma$=0.123 eV (2022Ha03). E(level): other: 7780 *4* (1990Ve04). C^2S: other: 0.0038 (2022Ha03).
7851.2‡ *8*	1,2‡	‡	E_r=554.9 *8*, calculated Γ_p=0.244 eV and $\omega\gamma$=0.181 eV (2022Ha03). E(level): other: 7855 *4* (1990Ve04). (2J+1)C^2S=0.009 for L=1 or 0.0114 for L=2 (2022Ha03).
7863.8‡ *14*	(3)‡	0.0005‡	E_r=566.9 *16*, calculated $\Gamma_p=5.55\times10^{-5}$ eV and $\omega\gamma=1.67\times10^{-4}$ eV (2022Ha03).
7898.0‡ *8*	1	0.08	E_r=601.3 *7*, calculated Γ_p=6.49 eV (2022Ha03). E(level): others: 7900 *4* (1990Ve04), 7900 *15* (1966Be26). L: 1 (1990Ve04,2020Ha03,1966Be26). C^2S: for J=1/2. Other: 0.058 (2022Ha03).
7911.5‡ *8*	3	0.03	E(level): other: 7913 *4* (1990Ve04). C^2S: other: 0.024 (2022Ha03).
7946.2‡ *8*	2	0.01	E(level): other: 7949 *4* (1990Ve04). C^2S: other: 0.008 (2022Ha03).
7976.4‡ *8*	2‡	0.0058‡	E(level): other: 7980 *4* (1990Ve04). L,C^2S: others: 0.004 for L=2 and 0.008 for L=3 (1990Ve04).
8048.4‡ *11*	1	0.01	E(level): other: 8051 *4* (1990Ve04). C^2S: other: 0.0085 (2022Ha03).
8078.0‡ *17*	(1)‡	0.001‡	E(level): other: 8080 *4* (1990Ve04).
8104.9‡ *15*	2	0.003	E(level): other: 8107 *4* (1990Ve04). C^2S: for J=5/2. Other: 0.0038 (2022Ha03).
8209 *4*			E(level),L: 8190, L=2 in 1970Lu07 probably corresponds to 8209+8227+8242. No L value is adopted here due to the complex nature of this group.
8227 *4*			
8246 *4*	1+3	0.02,0.01	E(level): Doublet. Other: 8250 *30* weakly populated in 1970Mo01.
8355 *4*	3	0.006	C^2S: for J=5/2.
8433 *4*	3	0.005	
8462 *4*	2	0.004	C^2S: for J=5/2.
8553 *4*		(0.02)	C^2S: Doublet of 8552+8556. 1990Ve04 derives 2 values of C^2S=(0.02,0.01). L: (0) (1990Ve04) perhaps in error; L=0+1 for the doublet from the best fit to $\sigma(\theta)$ in FIG.3 of 1990Ve04.
8574 *4*			
8600 *4*			
8642 *4*	2	0.004	
8735 *4*	2	0.02	
8758 *4*			
8840 *4*	2	0.004	
9015 *4*	2	0.008	
9052 *4*	1	0.07	
9130 *4*			

Continued on next page (footnotes at end of table)

^{30}Si(^{3}He,d),(pol ^{3}He,d) 1990Ve04,2022Ha03,1984Mc12 (continued)

^{31}P Levels (continued)

E(level)†	L@	C^2S&	Comments
9247 *4*			
9294 *4*	1	0.04	
9360 *4*	1	0.05	
9410 *4*	3	0.21	L: 3 (1990Ve04,1970Lu07).
9447 *4*	2	0.02	C^2S: if $d_{5/2}$ orbital.
9577 *4*	1	0.07	J^π: $7/2^-$ from 1984Mc12 is inconsistent with L=1 from 1990Ve04. C^2S: for J=1/2. Other: 0.2 for J=7/2 (1984Mc12).
9720 *4*	1+3	0.03,0.02	
9800 *4*	1	0.07	
9830 *4*	1+3	0.03,0.007	
9950 *4*	3	0.01	C^2S: for J=5/2.

† From 1990Ve04, unless otherwise stated. Average is taken where values from other studies are also available, as given under comments.

‡ From 2022Ha03. Uncertainty in $(2J+1)C^2S$ is estimated as ≈30%, mostly from optical potentials used in DWBA analysis (2022Ha03). Parentheses are added by the evaluators for L-transfers from poor fits as shown in Fig.3 and Fig.4 of 2022Ha03.

From L-transfers and Ay(θ) (1984Mc12).

@ From 1990Ve04, unless otherwise stated. Values from other studies are in general agreement but are less complete.

& From 1990Ve04, unless otherwise noted. Values from other studies are not as complete and precise, and are given under comments where available. $C^2S=d\sigma/d\Omega(exp)/[N(d\sigma/d\Omega(DWBA))]$, where N=4.43, C^2=2/3 and 1/2 for T=1/2 and T=3/2 levels, respectively. Authors assume $2p_{3/2}$, $1d_{3/2}$, $1f_{7/2}$ transfer for L=1,2,3 respectively if J^π not given or specified. The same assumption applies to values given under comments where available.