^{29}Si(α,n),(α,α),(α,γ):res 1975Sa05,1975Ba01,1978Ok02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 199,1 (2025)	30-Sep-2024

1975Sa05: (α,n) E=3.5-5.5 MeV alpha beams were produced from the Lowell Technological Institute 5.5 MeV Van de Graaff accelerator. Target was a thin silicon dioxide (92% ^{29}Si). Neutrons were detected with a liquid scintillator. Measured $\sigma(E_\alpha,\theta)$, $\theta_{c.m.}$=0° to 169°. Deduced resonance levels, J, π, from a single-level or coherent two-level analysis of the on-resonance angular distribution data.

1975Ba01: (α,n) E=2.15-5.25 MeV alpha beams in steps of 2.5 keV were produced from the 5.5 MeV Van de Graaff accelerator at Trombay. Target was SiO_2 deposited on a 250 μm tantalum backing (84% ^{29}Si). Neutrons were detected with a 4π-geometry neutron counter for neutron detection. Measured $\sigma(E_\alpha)$. Deduced resonance levels, J, π, widths, from the comparison of the Breit-Wigner expression of resonance with the data.

1978Ok02: (α,γ),(α,n) E=1.962-4.287 MeV alpha beams were produced from the SUNY/Albany 4 MV Dynamitron accelerator. Target was thin SiO_2 deposited on carbon foils (99.7% ^{29}Si). γ rays were detected with a 40 c.c. Ge(Li) detector and neutrons were detected with a BF_3 neutron counter. Measured $\sigma(E_\alpha)$, Eγ, $\gamma(\theta)$. Deduced levels, J, π, mixing ratios.

1971Mc23: (α,n) E=3.0-4.8 MeV of about 1 μA alpha beams were produced from the 5.5 MeV Van de Graaff accelerator of the Southern Universities Nuclear Institute. Target was 30 μg/cm^2 SiO_2 (95.3% ^{29}Si) evaporated onto tantalum and copper backings. Neutrons were detected with a Ne-213 liquid scintillators. Measured $\sigma(E_\alpha,\theta)$, $\theta_{c.m.}$=≈0° to 130°. Deduced resonance levels, J, π, from the comparison of the data with the theoretical angular distribution.

1978Fl07: (α,n) E=2.8-6.8 MeV alpha beams were produced from a 6-MV Van de Graaff accelerator of the University of Kentucky. Target was 95.28% enriched ^{29}Si, about 113 μg/cm^2 thick on 10 μg/cm^2 carbon backings. Measured $\sigma(E_\alpha)$.

Other: 1959Gi47.

^{33}S Levels

Γ_α and Γ_n under comments are from 1975Ba01.

E(level)[†]	J$^\pi$[‡]	Comments
0	3/2$^+$[b]	
840	1/2$^+$[b]	
1966	5/2$^+$[b]	
2316	3/2$^+$[b]	
2870	5/2$^+$[b]	J$^\pi$: 3/2$^+$ quoted in 1978Ok02.
2937	7/2$^-$[b]	
2974	7/2$^+$[b]	
3225	3/2$^-$[b]	
3837	5/2$^+$[b]	J$^\pi$: (3/2$^+$,5/2$^+$) quoted in 1978Ok02.
3935	3/2$^+$[b]	J$^\pi$: (3/2,5/2)$^+$ quoted in 1978Ok02.
4049	1/2$^+$[b]	J$^\pi$: (1/2,3/2)$^+$ quoted in 1978Ok02.
4211	3/2$^-$[b]	
4425		J$^\pi$: 1/2$^+$,3/2 from the Adopted Levels, but 7/2$^+$ quoted in the level scheme and (7/2$^+$,9/2$^+$) quoted in the text in 1978Ok02. It is unclear how this J^π is assigned and where it is taken from in 1978Ok02.
4920	1/2$^-$[b]	
5479	1/2$^+$[b]	
5720	1/2$^-$[b]	
8334		
9010		J$^\pi$: 1/2$^+$ in 1978Ok02.
9200		J$^\pi$: 5/2$^+$ in Adopted Levels, but 3/2$^-$ quoted in 1978Ok02. It is unclear how J^π=3/2$^-$ is assigned and where it is taken from in 1978Ok02.
9345		

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^{29}Si(α,n),(α,α),(α,γ):res 1975Sa05,1975Ba01,1978Ok02 (continued)

^{33}S Levels (continued)

E(level)[†]	Jπ[‡]	Eα(lab)[#]	Comments
9352			
9701 *5*	3/2[@&]	2942[d] *5*	Eα(lab): other: 2942 (1971Mc23). Γα=0.05 keV *1*, Γn=2.15 keV *43*.
9774		3025[c]	
9810 *5*	3/2[@&]	3066[d] *6*	Eα(lab): other: 3069 (1971Mc23). Γα=0.020 keV *4*, Γn=0.98 keV *20*.
9852		3114[c]	
9878		3144[c]	
9930 *6*	5/2[@&]	3203[d] *7*	Eα(lab): other: 3202 (1971Mc23). Γα=0.010 keV *2*, Γn=0.99 keV *20*.
9947		3222[c]	
9963		3240[c]	
10001 *7*	1/2[@&]	3284[d] *8*	Eα(lab): other: 3283 (1971Mc23). Γα=0.080 keV *16*, Γn=4.6 keV *9*.
10025 *7*	3/2[@&]	3311[d] *8*	Eα(lab): other: 3314 (1971Mc23). Γα=0.120 keV *24*, Γn=6.5 keV *13*.
10053	1/2[a]	3343[e]	Jπ: 1978Ok02 propose π=+ by considering 8085γ to 5/2+ can only be E2, but there is no supporting evidence in 1978Ok02. Eα(lab): other: 3344 (1971Mc23).
10058		3348[c]	
10081 *7*	(5/2)[@&]	3375[d] *8*	Eα(lab): other: 3373 (1971Mc23). Γα=0.020 keV *4*, Γn=0.98 keV *20*.
10134 *8*	5/2[@&]	3435[d] *9*	Eα(lab): other: 3432 (1971Mc23). Γα=0.080 keV *10*, Γn=4.9 keV *10*.
10145		3447[c]	
10167		3472[c]	
10184 *9*	3/2[@&]	3492[d] *10*	Eα(lab): other: 3489 (1971Mc23). Γα=0.15 keV *3*, Γn=6.2 keV *12*.
10223	3/2	3536[c]	
10255		3573[c]	
10312 *10*	7/2[@&]	3637[d] *11*	Eα(lab): other: 3635 (1971Mc23). Γα=0.010 keV *2*, Γn=0.99 keV *20*.
10331		3659[c]	
10336		3665[c]	
10345	3/2	3675	Eα(lab): other: 3674 (1971Mc23).
10357		3689[c]	
10381		3716[c]	
10391		3728[c]	
10407		3746[c]	
10419 *10*	3/2(−)	3759[d] *11*	Jπ: (3/2−,7/2−) from 1975Sa05, 3/2 from 1975Ba01 and 1971Mc23. Eα(lab): others: 3755 (1975Sa05), 3759 (1971Mc23). Γα=2.18 keV *44*, Γn=4.1 keV *8*.
10424	(1/2−,5/2−)	3765	Eα(lab): other: 3777 (1971Mc23).
10444	3/2[a]	3788[e]	Jπ: 1978Ok02 propose π=+ by assuming 8475γ to 5/2+ is M1+E2. Eα(lab): other: 3791 (1971Mc23).
10460 *11*	3/2[@&]	3806[d] *12*	Eα(lab): other: 3803 (1971Mc23). Γα=0.040 keV *8*, Γn=3.3 keV *7*.
10475		3823[c]	
10494 *12*	(3/2,5/2)[@&]	3845[d] *13*	Jπ: 3/2 from fit to resonance data in 1971Mc23 and 1975Ba01, but 5/2 from γ(θ) in 1978Ok02. π=− is proposed in 1978Ok02 assuming 6281γ and 7266γ to 3/2− are

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^{29}Si(α,n),(α,α),(α,γ):res 1975Sa05,1975Ba01,1978Ok02 (continued)

^{33}S Levels (continued)

E(level)[†]	Jπ[‡]	Eα(lab)[#]	Comments
			M1+E2.
			Eα(lab): others: 3844 (1971Mc23), 3845 (1978Ok02).
			Γα=0.030 keV *6*, Γn=4.0 keV *8*.
10507	3/2	3860	Eα(lab): other: 3865 (1971Mc23).
10521	(1/2+,5/2+)	3875	Eα(lab): other: 3872 (1971Mc23).
10539		3896[c]	
10582	(1/2−,5/2+)	3945	Eα(lab): other: 3937 (1971Mc23).
10593		3957[c]	
10603		3969[c]	
10617	7/2−	3985	Eα(lab): other: 3980 (1971Mc23).
10637 *12*	3/2(+)	4007[d] *13*	Jπ: (1/2−,3/2+) from 1975Sa05, 3/2 from 1975Ba01 and 1971Mc23.
			Eα(lab): others: 4020 (1975Sa05), 4011 (1971Mc23).
			Γα=0.55 keV *11*, Γn=14.4 keV *29*.
10656		4029[c]	
10668		4043[c]	
10676		4052[c]	
10682 *13*	(3/2)[@&]	4059[d] *15*	Eα(lab): other: 4064 (1971Mc23).
			Γα=0.28 keV *6*, Γn=7.3 keV *15*.
10692	(1/2+,5/2−)	4070	
10702		4081[c]	
10710	5/2(+)	4090	Jπ: 5/2 from γ(θ) in 1978Ok02; (1/2−,5/2+) from 1975Sa05. But 1978Ok02 propose π=− considering 4986γ to 1/2− is E2.
			Eα(lab): other: 4091 (1971Mc23, 1978Ok02).
10726		4109[c]	
10749	1/2	4135	Eα(lab): other: 4127 (1971Mc23).
10765	5/2[a]	4153[e]	Jπ: 1978Ok02 propose π=− by assuming 6551γ to 3/2− is M1+E2 and 7909γ to 5/2+ is E1.
			Eα(lab): doublet with 4171 in 1978Ok02. Other: 4149 (1971Mc23).
10781	3/2[a]	4171[e]	Jπ: 1978Ok02 propose π=+ by assuming 7909γ to 5/2+ and 9938γ to 1/2+ are M1+E2.
			Eα(lab): doublet with 4153 in 1978Ok02. Other: 4169 (1971Mc23).
10804		4197[c]	
10825		4222[c]	
10835		4233[c]	
10846	(1/2−,5/2+)	4245	Eα(lab): other: 4244 (1971Mc23).
10867		4269[c]	
10882		4286[c]	
10894	3/2	4300	Eα(lab): other: 4301 (1971Mc23).
10916	(1/2−,5/2+)	4325	Eα(lab): other: 4316 (1971Mc23).
10941 *13*	3/2[@&]	4354[d] *15*	Eα(lab): other: 4351 (1971Mc23).
			Γα=0.30 keV *6*, Γn=9.0 keV *18*.
10956	(3/2+,5/2−)	4370	Eα(lab): other: 4366 (1971Mc23).
10963		4379[c]	
10982	7/2−	4400	Eα(lab): other: 4392 (1971Mc23).
10989 *16*	(3/2)[&]	4408[d] *18*	Jπ: other: (3/2,5/2) from 1971Mc23.
			Eα(lab): other: 4407 (1971Mc23).
			Γα=0.170 keV *34*, Γn=3.8 keV *8*.
11008 *14*	3/2(+)	4430[d] *16*	Jπ: (3/2+,7/2−) from 1975Sa05, 3/2 from 1975Ba01, (3/2,5/2) from 1971Mc23.
			Eα(lab): others: 4425 (1975Sa05), 4424 (1971Mc23).
			Γα=0.34 keV *7*, Γn=4.8 keV *10*.
11017	(1/2−,5/2+)	4440	Eα(lab): other: 4434(1971Mc23).
11029		4454[c]	
11049		4476[c]	

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^{29}Si(α,n),(α,α),(α,γ):res 1975Sa05,1975Ba01,1978Ok02 (continued)

^{33}S Levels (continued)

E(level)[†]	Jπ[‡]	Eα(lab)[#]	Comments
11076 *15*	(5/2+)	4507[d] *17*	Jπ: (5/2+,9/2+) from 1975Sa05, (5/2) from 1975Ba01 and 1971Mc23. Eα(lab): others: 4495 (1975Sa05), 4502 (1971Mc23). Γα=0.22 keV *5*, Γn=2.8 keV *6*.
11087	(3/2+,9/2+)	4520	Eα(lab): other: 4529 (1971Mc23).
11103		4538[c]	
11118	(1/2+,3/2−)	4555	Eα(lab): other: 4556 (1971Mc23).
11147		4588[c]	
11153	(7/2−,9/2+)	4595	Eα(lab): also from 1971Mc23.
11162	(1/2−,9/2+)	4605	
11176 *18*	3/2[@&]	4621[d] *20*	Eα(lab): other: 4614 (1971Mc23). Γα=0.54 keV *11*, Γn=7.5 keV *15*.
11188	3/2−	4635	Eα(lab): other: 4634 (1971Mc23).
11216		4666[c]	
11228	(1/2−,3/2+)	4680	Eα(lab): other: 4678 (1971Mc23).
11253		4709[c]	
11267	1/2	4725	Eα(lab): other: 4732 (1971Mc23).
11285	(1/2+,7/2−)	4745	Eα(lab): also from 1971Mc23.
11298		4760[c]	
11311	(5/2+,9/2+)	4775	
11373	(3/2−,5/2+)	4845	
11382	(1/2+,7/2−)	4855	
11404	(1/2−,5/2+)	4880	
11439	5/2	4920	
11483	(3/2−,5/2+)	4970	
11597	(1/2−,7/2+)	5100	
11623	(1/2+,5/2+)	5130	
11667	(5/2+,7/2−)	5180	
11716	5/2+	5235	
11759	(1/2−,3/2+)	5285	
11803	(3/2−,5/2+)	5335	
11830	(3/2+,5/2+)	5365	
11869	(1/2+,9/2+)	5410	
11944	(1/2−,5/2+)	5495	

[†] From 1978Ok02 based on Eγ data up to 9352 level and from Ec.m.+Sα(^{33}S) for levels above that, where Sα(^{33}S)=7115.6926 *14* from 2021Wa16 and Ec.m. deduced from Eα(lab). Uncertainties of Eα(lab) in 1975Ba01 deduced by evaluators based on the statement of 5 keV uncertainty at low α beam energies and 20 keV at beam energies close to 5 MeV. No uncertainties are given for Eα values in 1975Sa05 and 1971Mc23.

[‡] From a single-level or coherent two-level analysis of the on-resonance angular distribution data in 1975Sa05 for resonance levels above 9352, unless otherwise noted.

[#] From 1975Sa05, unless otherwise noted.

[@] From the comparison of the data with the theoretical angular distribution in 1971Mc23.

[&] From the comparison of the Breit-Wigner expression of resonance with the data in 1975Ba01.

[a] From 1978Ok02 based on measured γ(θ) and known assignments of low-lying states.

[b] From the Adopted Levels, as quoted in 1978Ok02, unless otherwise noted.

[c] From 1971Mc23.

[d] From 1975Ba01.

[e] From 1978Ok02.

^{29}Si(α,n),(α,α),(α,γ):res 1975Sa05,1975Ba01,1978Ok02 (continued)

$\gamma(^{33}S)$

E_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ[‡]	Comments
554	2870	$5/2^+$	2316	$3/2^+$			
676	9010		8334				
701	10053	1/2	9352				
708	10053	1/2	9345				
840	840	$1/2^+$	0	$3/2^+$			
967	3837	$5/2^+$	2870	$5/2^+$			
986	4211	$3/2^-$	3225	$3/2^-$			
1018	9352		8334				
1043	10053	1/2	9010				
1126	1966	$5/2^+$	840	$1/2^+$			
1268	5479	$1/2^+$	4211	$3/2^-$			
1294	10494	(3/2,5/2)	9200				
1434	10444	3/2	9010				
1476	2316	$3/2^+$	840	$1/2^+$			
1619	3935	$3/2^+$	2316	$3/2^+$			
1719	10053	1/2	8334				
1966	1966	$5/2^+$	0	$3/2^+$			
2245	4211	$3/2^-$	1966	$5/2^+$			
2316	2316	$3/2^+$	0	$3/2^+$			
2459	4425		1966	$5/2^+$			
2870	2870	$5/2^+$	0	$3/2^+$			
2937	2937	$7/2^-$	0	$3/2^+$			
2974	2974	$7/2^+$	0	$3/2^+$			
3225	3225	$3/2^-$	0	$3/2^+$			
3513	5479	$1/2^+$	1966	$5/2^+$			
3837	3837	$5/2^+$	0	$3/2^+$			
3935	3935	$3/2^+$	0	$3/2^+$			
4049	4049	$1/2^+$	0	$3/2^+$			
4211	4211	$3/2^-$	0	$3/2^+$			
4425	4425		0	$3/2^+$			
4574	10053	1/2	5479	$1/2^+$			
4724	10444	3/2	5720	$1/2^-$			
4880	5720	$1/2^-$	840	$1/2^+$			
4920	4920	$1/2^-$	0	$3/2^+$			
4990	10710	$5/2^{(+)}$	5720	$1/2^-$			
5045	10765	5/2	5720	$1/2^-$			
5479	5479	$1/2^+$	0	$3/2^+$			
5720	5720	$1/2^-$	0	$3/2^+$			
5844	10765	5/2	4920	$1/2^-$			
5974	9200		3225	$3/2^-$			
6003	10053	1/2	4049	$1/2^+$			
6018	10444	3/2	4425				Mult.: 1978Ok02 propose a pure E2 for this γ and $7/2^+$ for the final level at E=4425, which is inconsistent with adopted J^π(4425)=($1/2^+$,3/2). Note that $\gamma(\theta)$ for E2 could be also consistent with $\Delta J=0$.
6282	10494	(3/2,5/2)	4211	$3/2^-$	D+Q	0.211	
6284	10710	$5/2^{(+)}$	4425				
6498	10710	$5/2^{(+)}$	4211	$3/2^-$			
6553	10765	5/2	4211	$3/2^-$	D+Q	0.206	
6829	10765	5/2	3935	$3/2^+$			
6943	10781	3/2	3837	$5/2^+$			
7268	10494	(3/2,5/2)	3225	$3/2^-$	D+Q	0.126	
7469	10444	3/2	2974	$7/2^+$			
7623	10494	(3/2,5/2)	2870	$5/2^+$			
7772	10710	$5/2^{(+)}$	2937	$7/2^-$			

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^{29}Si(α,n),(α,α),(α,γ):res 1975Sa05,1975Ba01,1978Ok02 (continued)

γ(^{33}S) (continued)

E_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ[‡]	Comments
7827	10765	5/2	2937	$7/2^-$			
7910	10781	3/2	2870	$5/2^+$	D+Q	0.114	
8086	10053	1/2	1966	$5/2^+$			
8177	10494	(3/2,5/2)	2316	$3/2^+$			
8333	8334		0	$3/2^+$			
8393	10710	$5/2^{(+)}$	2316	$3/2^+$			
8448	10765	5/2	2316	$3/2^+$	D		
8477	10444	3/2	1966	$5/2^+$	D+Q	0.255	δ: from Table 2 of 1978Ok02, but 0.05 quoted in the text of 1978Ok02.
8527	10494	(3/2,5/2)	1966	$5/2^+$			
8743	10710	$5/2^{(+)}$	1966	$5/2^+$			
8814	10781	3/2	1966	$5/2^+$			
9344	9345		0	$3/2^+$			
9351	9352		0	$3/2^+$			
9939	10781	3/2	840	$1/2^+$	D+Q	0.195	
10051	10053	1/2	0	$3/2^+$			
10442	10444	3/2	0	$3/2^+$			
10492	10494	(3/2,5/2)	0	$3/2^+$	D		
10708	10710	$5/2^{(+)}$	0	$3/2^+$			

[†] Transitions reported in 1978Ok02; Eγ values are not listed by the authors and quoted values are deduced from level-difference by the evaluators.

[‡] From 1978Ok02, unless otherwise noted. The evaluators have replaced M1 and E2 with D and Q, respectively, since there is no experimental evidence for assignments of electric and magnetic natures in 1978Ok02.

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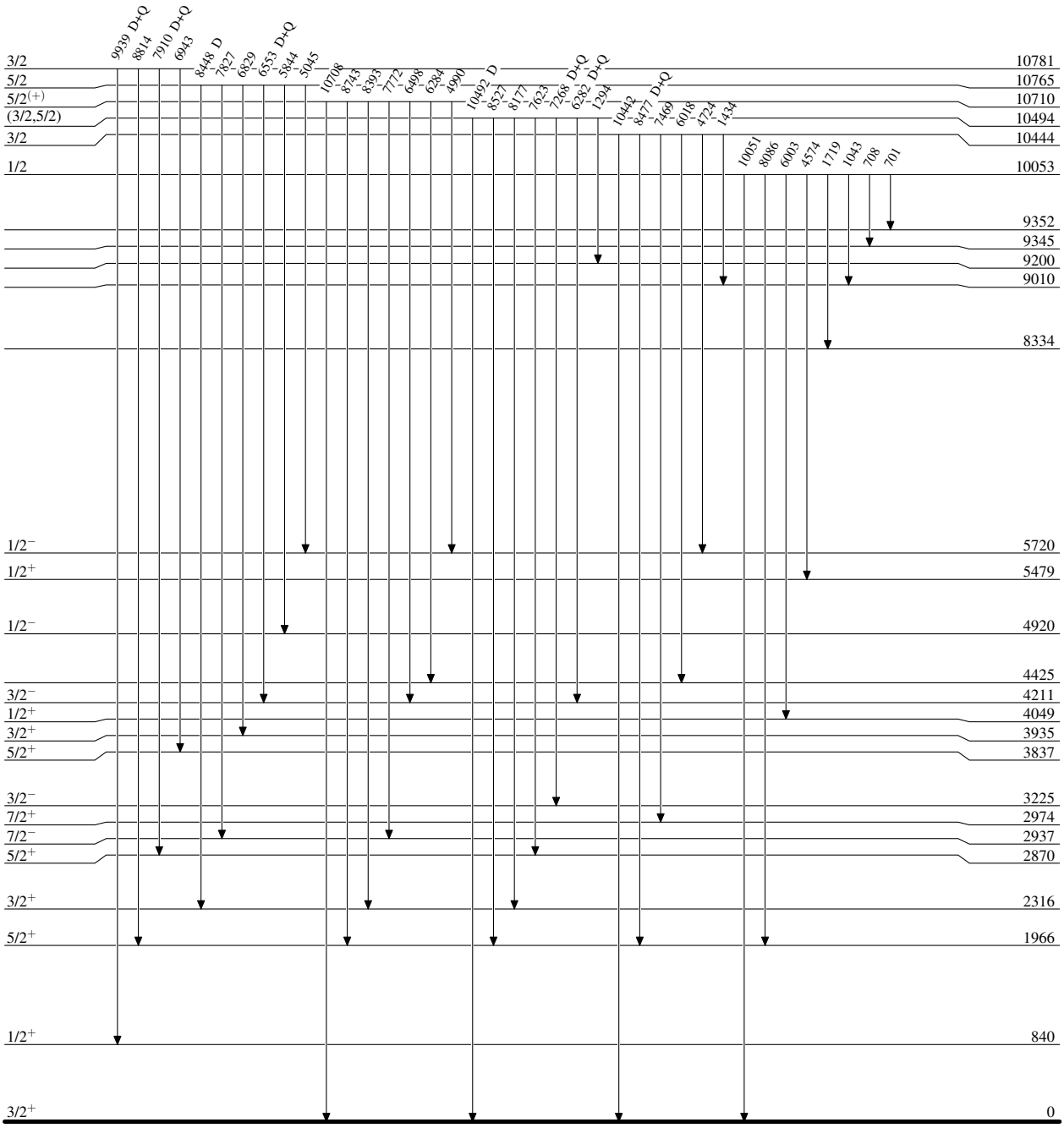
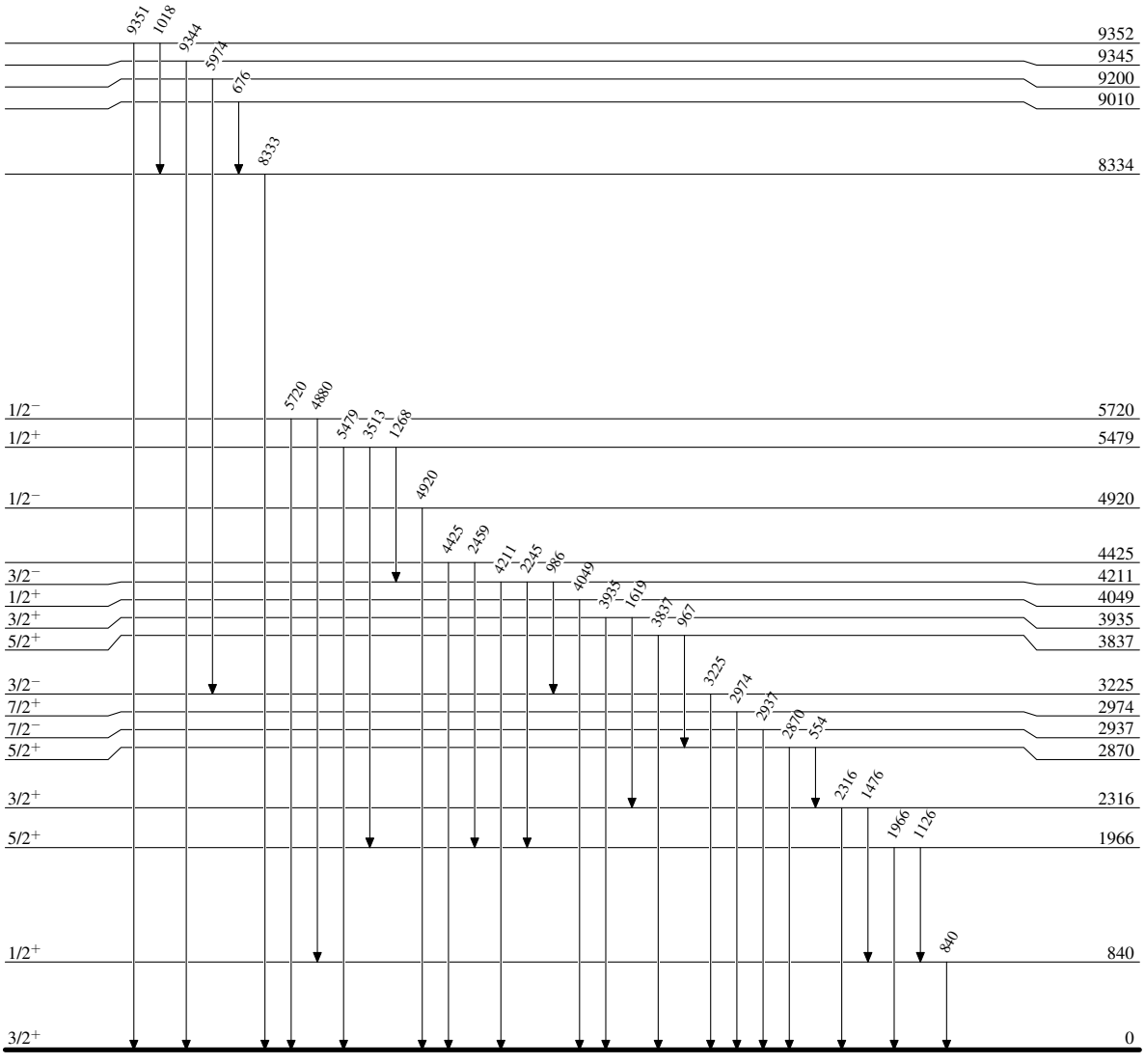
Level Scheme



$^{33}_{16}S_{17}$

^{29}Si(α,n),(α,α),(α,γ):res 1975Sa05,1975Ba01,1978Ok02

Level Scheme (continued)



$^{33}_{16}S_{17}$