$^{32}S(\alpha,p\gamma)$ 1970Ho09,1972Br33,1973Al22

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen, John Cameron and Balraj Singh	NDS 112,2715 (2011)	20-Oct-2011

1970Ho09: $^{32}S(\alpha,p\gamma)$ E=10.975, 11.960, 12.120 MeV alpha beams produced from the Chalk River MP tandem accelerator. Target of a 100 $\mu g/cm^2$ Sb_2S_3 on a 10 $\mu g/cm^2$ carbon backing. Six 15.2-cm-long by 12.7-cm-diam NaI(Tl) detectors for detecting γ-rays and an annular silicon surface detector for detecting protons, FWHM=30 keV. Measured $\sigma(E_p)$, Eγ, Iγ, p$\gamma(\theta)$. Deduced levels, J, branchings, mixing ratios.

1972Br33: $^{32}S(\alpha,p\gamma)$, E=10 MeV alpha beam from the Chalk River MP tandem accelerator. Targets of 340 $\mu g/cm^2$ Sb_2S_3 on a gold backing. A 44 cm^3 Ge(Li) detector inside a split annular NaI(Tl) detector for detecting γ-rays. Measured Eγ, Iγ. Deduced level energy, branching, $T_{1/2}$ using DSAM.

1973Al22: $^{32}S(\alpha,p\gamma)$, E=12-16 MeV alphas produced from the 80 cm cyclotron at the Research Institute for Physics in Stockholm and the Uppsala tandem accelerator. Targets of sulphur (99.9% ^{32}S) on lead backings. An ortec 60 cm^3 Ge(Li) detector, FWHM=2.2 keV at Eγ=1333 keV. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma(\theta)$. Deduced levels, J^π, branchings, mixing-ratios.

1969In04: $^{32}S(\alpha,p\gamma)$ E=6-8 MeV alpha beam produced from the Chalk River MP tandem accelerator. A thick target (270 $\mu g/cm^2$) of natural sulfur on a tantalum backing and a thin target (50 $\mu g/cm^2$ of Sb_2S_3 on a gold backing. Two Ge(Li) detectors of 15 and 40 cm^3 for detecting γ-rays. Measured Eγ, Iγ. Deduced levels, branchings, half-lives using Doppler Shift Attenuation Method (DSAM) and Recoil Distance Method (RDM).

1970In01: $^{32}S(\alpha,p\gamma)$ E=10 MeV alpha beam produced at the Chalk River Nuclear Laboratories. Targets of 340 $\mu g/cm^2$ Sb_2S_3 on a gold backing. A 44 cm^3 Ge(Li) detector inside a split annular NaI(Tl) detector for detecting γ-rays. Measured Eγ, Iγ. Deduced level energy, J^π, branching, $T_{1/2}$ using DSAM for the level of 3942 keV.

1973Br26: $^{32}S(\alpha,p\gamma)$, E=11.2 MeV alphas produced from the Legnaro (Padova) Van de Graaff generator. Targets of natural CdS. Ge(Li) detector. Measured Eγ, Iγ. Deduced half-life for the level of 3163 keV using Recoil Distance Method (RDM).

1973An01: $^{32}S(\alpha,p\gamma)$, E=5.5 and 8.6 MeV alpha beams of 100-200 nA produced from either from the Oxford Vertical Van de Graaff (Injector), or the Oxford EN Tandem. Targets of natural sulphur in AgS. Ge(Li) detector. Measured Eγ, Iγ. Deduced half-life for the level of 3163 keV using the RDM.

1974Lo17: $^{32}S(\alpha,p\gamma)$, E=11.0, 12.0 and 14.7 MeV alphas produced at the Oliver Lodge Laboratory at the University of Liverpool. Targets of natural sulphur in CdS. An annular ΔE-E telescope for detecting protons (FWHM=80 keV) and five 5 in by 6 in NaI(Tl) and a Ge(Li) detector for detecting γ-rays. Measured Eγ, Iγ, p$\gamma(\theta)$, γ-polarization. Deduced level energies, J^π, branchings, mixing ratios, half-lives using DSAM for the levels of 4348, 5408 and 6088 keV.

^{35}Cl Levels

E(level)[†]	J^π[#]	$T_{1/2}$[a]	E(level)[†]	J^π[#]	$T_{1/2}$[a]
0	$3/2^+$		4620.3 *10*	(3/2,5/2)	40[b] fs *17*
1219.5 *5*	$1/2^+$	146 fs *62*	4770[‡] *15*		
1763.5 *5*	$5/2^+$	0.38 ps *11*	4884.2 *11*	7/2	194[b] fs *42*
2645.9 *6*	$7/2^+$	208 fs *62*	5015[‡] *20*		
2695.1 *6*	(3/2,5/2)	49[b] fs *21*	5175[‡] *20*		
3003.2 *6*	$5/2^+$	33[b] fs *6*	5230 *20*	(1/2,3/2,5/2)	
3163.2 *6*	$7/2^-$	34[d] ps *3*	5407.5 *13*	$11/2^-$[@]	277[c] fs *69*
3914.9 *8*		<15[b] fs	5535[‡] *20*		
3942.8 *10*	$9/2^+$	229[b] fs *35*	5600[‡] *20*		
3967.9 *8*		<38[b] fs	5650[‡] *20*		
4045[‡] *10*			5850[‡] *25*	(5/2,9/2)	
4058.1 *7*		21[b] fs *9*	5927.2 *18*	$11/2^{(-)}$[&]	
4110.4 *8*	(3/2,7/2)	49[b] fs *11*	6087.7 *13*	$13/2^-$[@]	6.4[c] ps *6*
4171.0 *8*		47[b] fs *17*	6402[‡] *4*		
4347.9 *10*	$9/2^-$[@]	2.0[b] ps *7*			

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$^{32}S(\alpha,p\gamma)$ 1970Ho09,1972Br33,1973Al22 (continued)

^{35}Cl Levels (continued)

† From least-squares fit to Eγ′s, unless otherwise noted.
‡ From 1970Ho09.
# From pγ(θ) in 1970Ho09, unless otherwise noted.
@ From pγ(θ) in 1974Lo17.
& From γ(θ) in 1973Al22.
[a] From 1969In04 using DSAM, unless otherwise noted.
[b] From 1972Br33 using DSAM.
[c] From 1974Lo17 using DSAM.
[d] Weighted average of 42 ps *5* (1969In04), 29 ps *2* (1973Br26) and 37 ps *4* (1973An01), using RDM.

$\gamma(^{35}Cl)$

E_i(level)	J^π_i	Eγ†	Iγ‡	E_f	J^π_f	Mult.	δ‡	Comments
1219.5	1/2+	1219.5 *10*	100	0	3/2+			B(M1)(W.u.)=0.083 *38* (1969In04). B(M1)(W.u.)=0.11 *3*, B(E2)(W.u.)=2.3 *3* (1972Br33).
1763.5	5/2+	544#	<0.5#	1219.5	1/2+			
		1763.1 *10*	100	0	3/2+	M1+E2	−3.0 *1*	B(M1)(W.u.)=0.0014 *4*, B(E2)(W.u.)=11.2 *4* (1969In04).
2645.9	7/2+	882.4@ *10*	10@ *2*	1763.5	5/2+	M1+E2	−0.25 *5*	B(M1)(W.u.)≤0.033, B(E2)(W.u.)≤156 (1969In04). B(M1)(W.u.)=0.012 *5*, B(E2)(W.u.)=3.4 *20* (1972Br33).
		1427#	<1#	1219.5	1/2+			
		2646.0 *20*	90 *2*	0	3/2+			B(E2)(W.u.)=2.6 *8* (1969In04). B(E2)(W.u.)=2.8 *9* (1972Br33).
2695.1	(3/2,5/2)	930.5 *15*	14 *2*	1763.5	5/2+			B(M1)(W.u.)=0.078 *37*, B(E2)(W.u.)=2.7 *22* (1972Br33).
		1476	9 *2*	1219.5	1/2+			B(M1)(W.u.)=0.009 *5*, B(E2)(W.u.)=6 *5* (1972Br33).
		2694.6	77 *3*	0	3/2+	D+Q	−0.17 *8*	δ: for J=3/2; +0.26 *5* for J=5/2 (1970Ho09). B(M1)(W.u.)=0.017 *8*, B(E2)(W.u.)=0.26 *26* (1972Br33).
3003.2	5/2+	308#	<5#	2695.1	(3/2,5/2)			
		357#	<1#	2645.9	7/2+			
		1240#	<2#	1763.5	5/2+			
		1784#	<2#	1219.5	1/2+			
		3003	100	0	3/2+	M1+E2	−0.09 *3*	B(M1)(W.u.)≥0.02, B(E2)(W.u.)≥0.42 (1969In04). B(M1)(W.u.)=0.024 *4*, B(E2)(W.u.)=0.08 *6* (1972Br33).
3163.2	7/2−	160#	<0.5#	3003.2	5/2+			
		468#	<0.5#	2695.1	(3/2,5/2)			
		517.4 *15*	10 *3*	2645.9	7/2+			B(E1)(W.u.)≤1×10^{-5} (1969In04).
		1400#	<1#	1763.5	5/2+			B(E1)(W.u.)≤2×10^{-8} (1969In04).
		3162.6 *15*	90 *3*	0	3/2+	M2+E3	+0.14 *2*	
3914.9		2695&	16& *4*	1219.5	1/2+			B(E2)(W.u.)<6, assuming pure E2 (1972Br33).
		3915&	84& *4*	0	3/2+			B(M1)(W.u.)>0.02, assuming pure M1 (1972Br33).

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$^{32}S(\alpha,p\gamma)$ 1970Ho09,1972Br33,1973Al22 (continued)

$\gamma(^{35}Cl)$ (continued)

E_i(level)	J^π_i	E_γ†	I_γ‡	E_f	J^π_f	Mult.	δ‡	Comments
3942.8	9/2+	1297.4 *15*	7.5 *20*	2645.9	7/2+	M1+E2	−3.0 *1*	I_γ: weighted average from 1970Ho09 and 1972Br33. B(M1)(W.u.)=0.0014 *8*, B(E2)(W.u.)=2.6 *18* (1972Br33).
		2179	92.5 *20*	1763.5	5/2+			I_γ: weighted average from 1970Ho09 and 1972Br33. B(E2)(W.u.)=6.8 *11* (1972Br33).
3967.9		2748&	100&	1219.5	1/2+			B(M1)(W.u.)<0.0028 (1972Br33).
		3968&	<2&	0	3/2+			
4058.1		2295&	7& *4*	1763.5	5/2+			
		2838&	93& *4*	1219.5	1/2+			
		4058&	<2&	0	3/2+			
4110.4	(3/2,7/2)	2347@	14@ *4*	1763.5	5/2+			
		4110@	86@ *4*	0	3/2+			
4171.0		2951		1219.5	1/2+			
		4171		0	3/2+			
4347.9	9/2−	1184.6 *10*	66 *2*	3163.2	7/2−	M1+E2	−0.38 *3*	I_γ: weighted average from 1970Ho09, 1972Br33 and 1974Lo17. δ: weighted average of −0.42 *4* (1970Ho09), −0.40 *9* (1973Al22) and −0.36 *3* (1974Lo17). Others: +1.2 *4* for J=5/2 (1970Ho09); +0.7 *7* for J=5/2 (1973Al22). pol=−0.005 *40* (1974Lo17). A_2=−0.95 *3*, A_4=+0.08 *3* (1974Lo17). B(M1)(W.u.)=4.0×10^{-3} *15*, B(E2)(W.u.)=1.3 *5* (1974Lo17).
		1702.1 *15*	34 *2*	2645.9	7/2+	D+Q	0.00 *3*	I_γ: weighted average from 1970Ho09, 1972Br33 and 1974Lo17. δ: from 1974Lo17. pol=0.36 *7* (1974Lo17). A_2=−0.34 *5*, A_4=+0.04 *5* (1974Lo17).
4620.3	(3/2,5/2)	4620	100	0	3/2+			δ: −0.08 *14* for J=3/2; +0.36 *15* for J=5/2 (1970Ho09). B(M1)(W.u.)=0.0049 *25*, B(E2)(W.u.)=0.11 *10*, assuming J^π=5/2+ (1972Br33).
4884.2	7/2	2239@	34@ *6*	2645.9	7/2+			
		3117.4 *20*	66 *6*	1763.5	5/2+			δ: 0.0 *4* (1970Ho09).
5230	(1/2,3/2,5/2)	5230@	100@	0	3/2+			
5407.5	11/2−	1059.3 *10*	9 *2*	4347.9	9/2−	M1+E2	+0.25 *8*	I_γ,δ: from 1974Lo17. pol=−0.40 *14* (1974Lo17). A_2=+0.19 *11*, A_4=−0.01 *13* (1974Lo17). B(M1)(W.u.)=5.0×10^{-3} *13*, B(E2)(W.u.)=1.1 *3* (1974Lo17).
		2244 *3*	91 *2*	3163.2	7/2−	E2(+M3)	+0.02 *9*	I_γ: from 1974Lo17. δ: from 1973Al22. A_2=+0.44 *3*, A_4=−0.19 *3* (1974Lo17). B(M1)(W.u.)=4.0×10^{-3} *15*, B(E2)(W.u.)=14.5 *11* (1974Lo17).
5850	(5/2,9/2)	2687	100	3163.2	7/2−			δ: −0.28 *4* for J=9/2; +2.2 *5* or +0.6 *1* for J=5/2 (1970Ho09).
5927.2	11/2(−)	1579.3 *15*	100	4347.9	9/2−	D+Q	−0.8 *4*	δ: from 1973Al22. Other: +1.1 *5* for J=7/2 (1973Al22).

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$^{32}S(\alpha,p\gamma)$ 1970Ho09,1972Br33,1973Al22 (continued)

$\gamma(^{35}Cl)$ (continued)

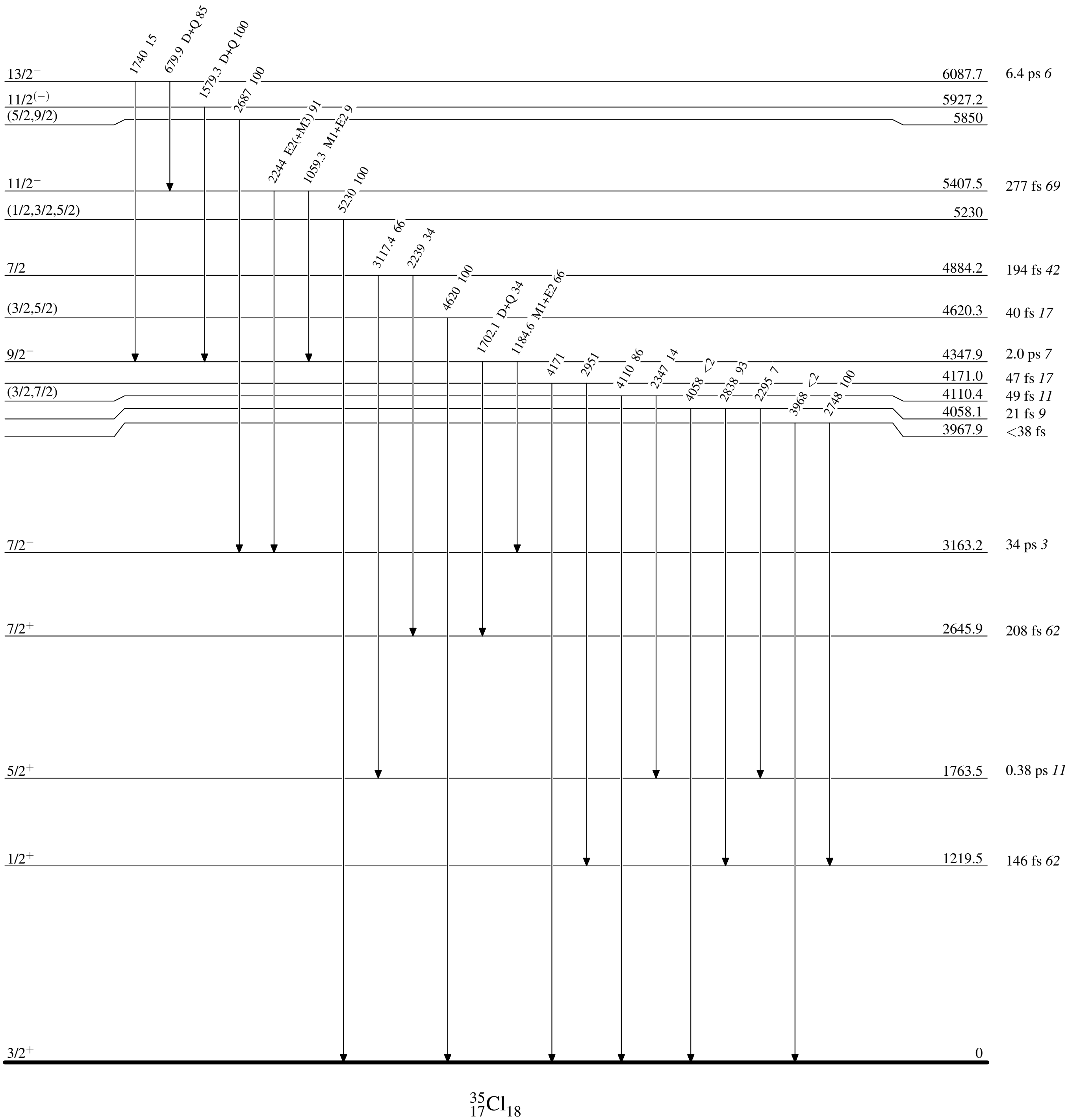
E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.	δ[‡]	Comments
6087.7	13/2⁻	679.9 *10*	85 *5*	5407.5	11/2⁻	D+Q	+0.02 *1*	I_γ,δ: from 1974Lo17. pol=−0.45 *5* (1974Lo17). A_2=−0.22 *1*, A_4=+0.005 *15* (1974Lo17).
		1740	15 *5*	4347.9	9/2⁻			E_γ,I_γ: from 1974Lo17. B(M1)(W.u.)=8.5×10^{-3} *10*, B(E2)(W.u.)=0.05 *5* (1974Lo17).

† Values with uncertainties are from 1973Al22 and others are from level-energy differences.
‡ From 1970Ho09, unless otherwise noted. Mixing ratios from $\gamma(\theta)$.
# From 1969In04.
@ From 1970Ho09.
& From 1972Br33.

$^{32}S(\alpha,p\gamma)$ 1970Ho09,1972Br33,1973Al22

Level Scheme

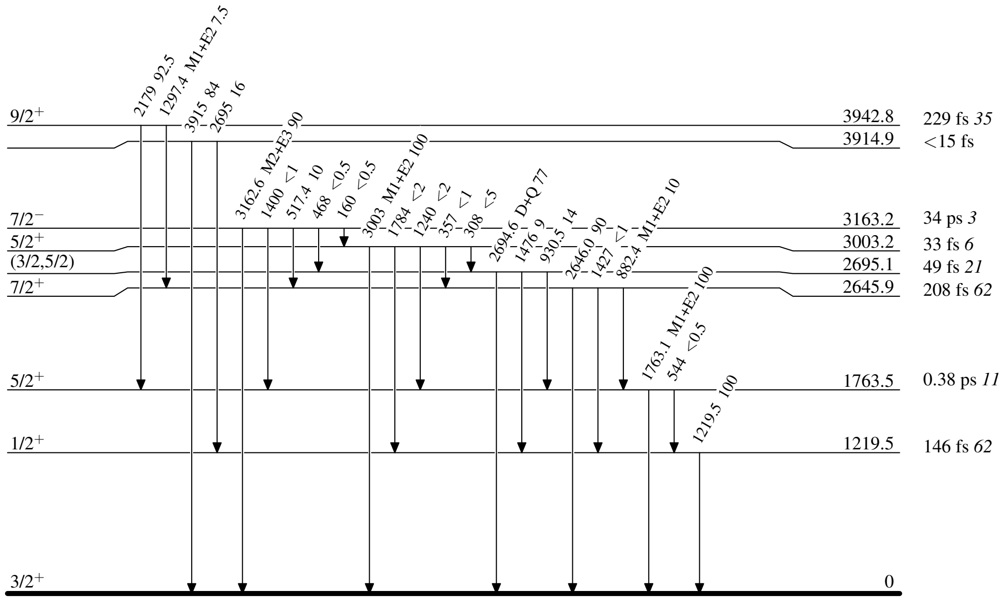
Intensities: % photon branching from each level



$^{32}S(\alpha,p\gamma)$ 1970Ho09,1972Br33,1973Al22

Level Scheme (continued)

Intensities: % photon branching from each level



$^{35}_{17}Cl_{18}$