^{32}Ar εp decay (98 ms)　　　2021Bl02,2008Bh08,1985Bj01

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

Parent: ^{32}Ar: E=0; J$^{\pi}$=0^{+}; T$_{1/2}$=98 ms 2; Q(εp)=9553.2 18; %εp decay=35.58 22

^{32}Ar-T$_{1/2}$: From Adopted Levels of ^{32}Ar in the ENSDF database (2011Ou01).

^{32}Ar-Q(εp): From 2021Wa16.

^{32}Ar-%εp decay: %εp=35.58 22 (2008Bh08). Other: 43 3 estimated by (1985Bj01) assuming the superallowed transition was followed uniquely by proton decay. Normalization factor for absolute intensities derived from the measurement of the total branching ratio to the ground state of 20.50 13 (2008Bh08).

2021Bl02: ^{32}Ar beam produced in projectile fragmentation of ^{36}Ar beam at 95 MeV/nucleon with a graphite target, followed by separation of fragments using the NANOGAN-III ECR ion source and isotopic identification system of SPIRAL1 at GANIL facility. Measured β^{+}-delayed proton spectra, E(p), I(p), Eγ, Iγ, pγ-coin using cube of six double-sided silicon strip detectors (DSSSDs) for protons, and EXOGAM clover detector array for γ detection. Deduced absolute intensities of β^{+}-delayed proton branches, γ-ray branching ratios, β^{+}+ε feedings to levels in ^{32}Cl and log ft values.

2020Ar04: measured $\beta^{+}\nu(\theta)$ based on the kinetic-energy shift of protons emitted in parallel or antiparallel directions with respect to the positrons in ^{32}Ar β^{+} decay at ISOLDE-CERN facility. Angular-correlation coefficients a$_{\beta\nu}$=1.007 32(stat) 25(syst) for the 0^{+} to 0^{+} superallowed β^{+} transition, and -0.222 86(stat) 16(syst) for a Gamow-Teller β^{+} transition were obtained from this experiment, and compared with the predictions of the standard model.

2008Bh08: ^{32}Ar produced in the reaction ^{9}Be(^{36}Ar,X) with a 100 MeV/nucleon beam at NSCL. A1200 fragment separator. 53.28 MeV/nucleon ^{32}Ar beam implanted in a P/N silicon detector. Measured Eγ, Iγ, delayed protons, pγ coin using HPGe detectors (3 four-fold segmented clovers and 2 monolithic crystals) and silicon detectors. The ft value of T=2, superallowed transition from 0^{+} parent state of ^{32}Ar to 0^{+} excited state at 5246 keV in ^{32}Cl was determined. Absolute intensities of proton groups measured from the determination of total number of implanted ^{32}Ar ions and detector efficiencies. From this experiment 2008Bh08 deduced isospin symmetry breaking correction in ^{32}Ar decay δ_{C}^{exp}=2.1% 8.

1985Bj01: E=600 MeV protons on CaO target producing ^{32}Ar through spallation. Mass separated through ISOLDE-I. Measured half-life, Ep, Eγ, Ip, Iγ, p$\beta\gamma$ coincidences, branching ratio. Proton energies measured using silicon detectors; germanium detector for γ-rays.

1993Sc16: E=600 MeV protons on CaO target producing ^{32}Ar through spallation. Mass separated through ISOLDE-II. Measured Ep and Ip using Si detector. Proton energies seem in 1993Sc16 seem generally lower than in 2021Bl02, 2008Bh08 and 1985Bj01.

2007DoZX: Measured proton energies and intensities of 19 groups at GANIL facility, pγ coin. The protons range from 594.1 to 6056 keV. Most of these groups are in agreement with those from 2008Bh08 and earlier studies. However, one severe discrepancy is noted that 1203.7-keV proton group is shown to be in coin with a 2230-keV γ ray (presumably corresponding to known 2236γ in ^{31}S), but in 2008Bh08, this proton group was observed strongly in coin with 1248γ from the first excited state of ^{31}S. Moreover the deduced level excitation energy quoted by 2007DoZX as 6295 for the 1203.7 proton group seems to be in error if this group is in coin with 2236γ. In view of the lack of sufficient details in 2007DoZX and noted inconsistencies, the evaluators feel that it is premature to consider data from 2007DoZX for current evaluation.

1979Ca16: discovered ^{32}Ar activity, and measured its half-life.

Other: 1977Ha29.

^{31}S Levels

E(level)	J$^{\pi \dagger}$	T$_{1/2}$†	Comments
0.0	1/2^{+}	2.5534 s 18	
1248.60 8	3/2^{+}	0.50 ps 12	E(level),J$^{\pi}$,T$_{1/2}$: from the Adopted Levels.
2236?			
3079?			

† From the Adopted Levels.

^{32}Ar εp decay (98 ms)   **2021Bl02,2008Bh08,1985Bj01 (continued)**

$\gamma(^{31}$S)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α[‡]	Comments
1248.4 *3*	1.9 *2*	1248.60	$3/2^+$	0.0	$1/2^+$	M1+E2	+0.35 *2*	3.58×10^{-5} *5*	α(K)=2.123×10^{-5} *30*; α(L)=1.637×10^{-6} *23*; α(M)=1.381×10^{-7} *20* α(IPF)=1.276×10^{-5} *20* E_γ,I_γ: from 1985Bj01. Mult.,δ: from the Adopted Gammas.

[†] Absolute intensity per 100 decays.
[‡] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

Delayed Protons (^{31}S)

Particle normalization: Deduced by evaluators from total proton emission probability of 35.58% *22* measured by 2008Bh08 and a correction factor 1.033 *14* deduced by 2021Bl02 as a ratio of all protons to the sum of all observed proton peaks.

$E(p)$[†]	$E(^{31}$S)	$I(p)$[#]	$E(^{32}$Cl)[‡]	Comments
	2236?	0.14		
	3079?	0.008 *4*		
606.9 *60*	0.0	1.88 *4*	2208	607 *10* (1985Bj01). Others:≈610 (2008Bh08),602 *5* (1993Sc16) E(p): weighted average of 606.8 *60* (2021Bl02), 607 *10* (1985Bj01). Others: ≈610 (2008Bh08), 602 *5* (1993Sc16). I(p): 3.2 *17* (2021Bl02), 1.88 *4* (2008Bh08), 2.0 *10* (1993Sc16), 1.70 *31* (1985Bj01). Weighted average is 1.88 *4*.
912 *5*	1248.60	0.07 *4*	3771	E(p): 912 *5* (2008Bh08). I(p): 0.07 *4* (2008Bh08).
1210.8 *42*	1248.60	1.57 *10*	4082	E(p): weighted average of 1205.5 *41* (2021Bl02), 1218 *5* (2008Bh08), 1214 *10* (1985Bj01). Other: 1207 *5* (1993Sc16). I(p): 1.47 *8* (2021Bl02), 1.90 *22* (2008Bh08), 2.2 *5* (1993Sc16), 1.79 *18* (1985Bj01). Weighted average is 1.57 *10*.
1677 *12*	1248.60	0.14 *7*	4561	E(p): from 2021Bl02 only. I(p): 0.14 *7* (2021Bl02).
2121.3 *40*	0.0	17.66 *30*	3771	2124 *10*, I(p)=18.8 *22* (1985Bj01) for a doublet E(p),I(p): from (2021Bl02). Others: 2118 *3*, I(p)=17.8 *50* (1993Sc16), 2124 *10*, I(p)=18.8 *22* (1985Bj01) for a doublet.
2145.5 *50*	1248.60	1.29 *6*	5044	Weighted average is 1.29 *6*. Others: I(p)=1.0 *5* (1993Sc16), E(p): weighted average of 2146.0 *52* (2021Bl02), 2145 *5* (2008Bh08). Others: 2142 *5* (1993Sc16), 2124 *10* (1985Bj01); composite peak. I(p): 1.87 *40* (2021Bl02), 1.28 *4* (2008Bh08). Weighted average is 1.29 *6*. Others: I(p)=1.0 *5* (1993Sc16), 18.8 *22* (1985Bj01) for a composite peak.
2395.1 *41*	1248.60	0.58 *11*	5303	E(p): weighted average of 2395.9 *41* (2021Bl02), 2394 *5* (2008Bh08). I(p): 0.97 *47* (2021Bl02), 0.56 *11*: weighted average is 0.58 *11*.
2422.9 *40*	0.0	35.7 *6*	4082	E(p): weighted average of 2422.9 *40* (2021Bl02), 2423 *10* (1985Bj01). Other: 2419 *3* (1993Sc16). I(p): 35.28 *47* (2021Bl02), 37.7 *6* (1993Sc16), 35.8 *39* (1985Bj01). NRM weighted average of 35.7 *6*. Note: 1985Bj01 do not report the weak lower peak at 2395 keV.
2511.9 *40*	1248.60	3.49 *20*	5425	average is 3.25 *20*, but with reduced χ^2=6.2 E(p): weighted average of 2510.0 *40* (2021Bl02), 2515 *5* (2008Bh08), 2511 *10* (1985Bj01). Other: 2508 *5* (1993Sc16). I(p): 3.62 *12* (2021Bl02), 2.93 *11* (2008Bh08), 3.9 *9* (1985Bj01), 3.5 *8* (1993Sc16): unweighted average of 3.49 *20*. Weighted average is 3.25 *20*, but with reduced χ^2=6.2.

^{32}**Ar εp decay (98 ms)**   **2021Bl02,2008Bh08,1985Bj01 (continued)**

Delayed Protons (continued)

E(p)[†]	E(^{31}S)	I(p)[#]	E(^{32}Cl)[‡]	Comments
2616 *9*	1248.60	0.25 *6*	5531	E(p): from 2021Bl02 only. I(p): 0.25 *6* (2021Bl02).
2775.4 *65*	1248.60	0.43 *8*	5700	E(p): weighted average of 2778.5 *65* (2021Bl02), 2768 *10* (1985Bj01). Other: 2870 *5* (2008Bh08, broad peak with a much larger intensity as compared to that in 2021Bl02 and 1985Bj01). I(p): 0.383 *50* (2021Bl02), 0.57 *9* (1985Bj01). Other: 3 *1* (2008Bh08) for a broad peak. Weighted average is 0.43 *8*.
3117 *11*	1248.60	0.076 *41*	6065	E(p),I(p): from 2021Bl02. In 1985Bj01, a 3113 *10* peak with I(p)=0.26 *4*, assigned to the g.s. only, whereas 2021Bl02 assigned to the g.s. as well as 1249 level, based on their pγ-coin data.
3117.4 *47*	0.0	0.132 *13*	4800	I(p)=0.26 *4*,assigned to the g.s. only,whereas 2021Bl02 assigned E(p),I(p): from 2021Bl02. In 1985Bj01, 3113 *10* proton peak with I(p)=0.26 *4*, assigned to the g.s. only, whereas 2021Bl02 assigned to the g.s. as well as 1249 level, based on their pγ-coin data.
3352.7 *30*	0.0	100.0 *4*	5044	E(p): weighted average of 3352.7 *40* (2021Bl02), 3353.5 *30* (1985Bj01), 3350.5 *50* (1977Ha29). Other: 3348.5 *20* (1993Sc16). I(p): from 2021Bl02. Others: 100 (2008Bh08), 100 *7* (1985Bj01), 100.0 *2* (1993Sc16).
3583 *5*	1248.60	0.25 *4*	6529	E(p): weighted average of 3584 *24* (2021Bl02), 3581 *5* (2008Bh08), 3592 *10* (1985Bj01). I(p): 0.35 *19* (2021Bl02), 0.24 *4* (2008Bh08). Other: 0.83 *9* for a composite line (1985Bj01). Weighted average is 0.25 *4*.
3605 *8*	0.0	0.356 *45*	5303	E(p),I(p): from 2021Bl02. Other: 3643 *10*, I(p)=0.83 *9* (1985Bj01) for a composite line.
3649 *5*	1248.60	0.325 *30*	6597	E(p): weighted average of 3651.8 *68* (2021Bl02), 3649 *5* (2008Bh08), 3643 *10* (1985Bj01). I(p): 0.321 *37* (2021Bl02), 0.32 *3* (2008Bh08), 0.39 *9* (1985Bj01); weighted average is 0.325 *30*.
3725.9 *48*	0.0	0.403 *17*	5425	E(p),I(p): from 2021Bl02. Other: 3732 *10*, I(p)=0.96 *9* (1985Bj01) for a composite line.
3782 *5*	1248.60	0.37 *15*	6732	E(p): weighted average of 3778.2 *63* (2021Bl02), 3785 *5* (2008Bh08). Other: 3732 *10* (1985Bj01) for a composite line. I(p): 0.201 *33* (2021Bl02), 0.52 *5* (2008Bh08). Other 0.96 *9* (1985Bj01) for a composite line. unweighted average is 0.37 *15*.
3991 *5*	0.0	1.04 *7*	5700	E(p): weighted average of 3997.8 *50* (2021Bl02), 3984 *5* (2008Bh08), 3991 *6* (1993Sc16), 3994 *10* (1985Bj01). I(p): 0.904 *21* (2021Bl02), 1.1 *1* (2008Bh08), 1.0 *2* (1993Sc16), 1.18 *9* (1985Bj01). NRM weighted average is 1.04 *7*.
4344.9 *41*	0.0	0.494 *18*	6065	4341 *10*, I(p)=0.70 *9* (1985Bj01) for a doublet E(p),I(p): from 2021Bl02. Others: 4340 *5*, I(p)=0.71 *7* (2008Bh08), 4341 *10*, I(p)=0.70 *9* (1985Bj01) for a doublet.
4348 *10*	1248.60	0.13 *4*	7320	4341 *10*, I(p)=0.70 *9* (1985Bj01) for a doublet E(p),I(p): from 2021Bl02. Others: 4340 *5*, I(p)=0.71 *7* (2008Bh08), 4341 *10*, I(p)=0.70 *9* (1985Bj01) for a doublet.
4526 *5*	0.0	0.458 *17*	6254	0.52 *4* (1985Bj01). Other: 2008Bh08 assigned I(p)<0.03 for possible E(p): 4524.6 *61* (2021Bl02), 4529 *5* (2008Bh08), 4521 *10* (1985Bj01). Other: 4518 *6* (1993Sc16). I(p): 0.445 *13*, 0.54 *5* (2008Bh08), 0.5 *1* (1993Sc16), 0.52 *4* (1985Bj01). Other: 2008Bh08 assigned I(p)<0.03 for possible to 1249 level. Weighted average is 0.458 *17*.
4625 *5*	1248.60	0.17 *4*	7600	E(p): weighted average of 4622.0 *46* (2021Bl02), 4630 *5* (2008Bh08), 4621 *10* (1985Bj01). I(p): 0.15 *7* (2021Bl02), 0.16 *5* (2008Bh08), 0.18 *4* (1985Bj01). weighted average is 0.17 *4*.
4867 *5*	1248.60	0.26 *3*	7852	E(p): weighted average of 4863 *18* (2021Bl02), 4869 *5* (2008Bh08), 4858 *10* (1985Bj01).

^{32}Ar εp decay (98 ms)　　2021Bl02,2008Bh08,1985Bj01 (continued)

Delayed Protons (continued)

E(p)[†]	E(^{31}S)	I(p)[#]	E(^{32}Cl)[‡]	Comments
				I(p): 0.20 *14* (2021Bl02), 0.26 *3* (2008Bh08), 0.26 *4* (1985Bj01). Weighted average is 0.26 *3*.
4977 *9*	0.0	0.063 *17*	6732	E(p): weighted average of 4966.7 *79* (2021Bl02), 4997 *10* (2008Bh08), 4975 *10* (1985Bj01).
				I(p): 0.038 *17* (2021Bl02), 0.10 *2* (2008Bh08), 0.061 *17* (1985Bj01). Weighted average is 0.063 *17*.
5558 *4*	0.0	0.547 *20*	7320	E(p): weighted average of 5556.1 *41* (2021Bl02), 5567 *5* (2008Bh08), 5549 *8* (1993Sc16), 5552 *10* (1985Bj01).
				I(p): 0.539 *13* (2021Bl02), 0.76 *8* (2008Bh08), 0.7 *1* (1993Sc16), 0.56 *4* (1985Bj01). NRM weighted average is 0.547 *20*.
5684 *10*	0.0	0.021 *8*	7450	E(p): weighted average of 5673 *13* (2021Bl02), 5699 *10* (2008Bh08), 5675 *10* (1985Bj01).
				I(p): 0.020 *5* (2021Bl02), 0.18 *8* (2008Bh08), 0.05 *3* (1985Bj01). Weighted average is 0.021 *8*.
5822 *6*	0.0	0.425 *32*	7600	E(p): weighted average of 5815.3 *44* (2021Bl02), 5833 *5* (2008Bh08), 5817 *10* (1985Bj01).
				I(p): 0.400 *21* (2021Bl02), 0.54 *5* (2008Bh08), 0.44 *4* (1985Bj01). Weighted average is 0.425 *32*.
6068 *7*	0.0	0.109 *11*	7852	E(p): NRM weighted average of 6066.2 *52*, 6097 *10* (2008Bh08), 6060 *10* (1985Bj01).
				I(p): 0.115 *11* (2021Bl02), 0.11 *2* (2008Bh08), 0.092 *18* (1985Bj01). Weighted average of 0.109 *11*.
6358 *9*	0.0	0.057 *8*	8146	E(p): NRM weighted average of 6358.6 *73* (2021Bl02), 6396 *10* (2008Bh08), 6347 *10* (1985Bj01).
				I(p): 0.056 *8* (2021Bl02), 0.06 *2* (2008Bh08), 0.061 *17* (1985Bj01). Weighted average is 0.057 *8*.

[†] Proton energies in lab system.

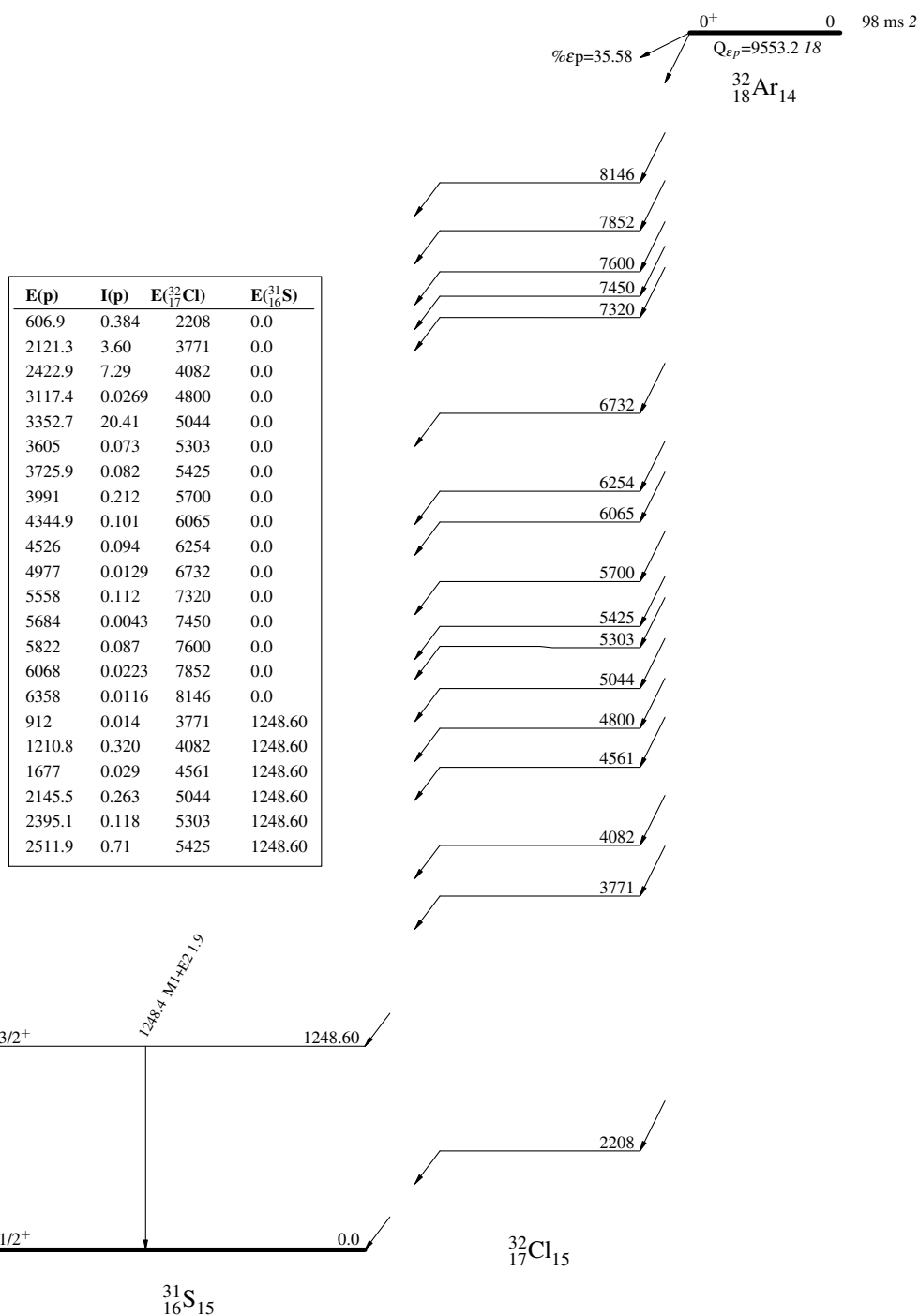[‡] From E(c.m.)+S(p)(^{32}Cl)+E(level)(^{31}S), where S(p)=1581.1 *5* (2021Wa16) and E(c.m.) deduced from E(p) listed under comments using E(c.m)=[1+mass(p)/mass(^{31}S)]×E(p). Weighted average is taken where there are more than one decay branches from a level in ^{32}Cl.

[#] For absolute intensity per 100 decays, multiply by 0.2041 *33*.

[@] Placement of transition in the level scheme is uncertain.

^{32}Ar εp decay (98 ms)　　　2021Bl02,2008Bh08,1985Bj01

Decay Scheme

γ Intensities: I$_{(\gamma+ce)}$ per 100 parent decays
I(p) Intensities: I(p) per 100 parent decays

E(p)	I(p)	E($^{32}_{17}$Cl)	E($^{31}_{16}$S)
606.9	0.384	2208	0.0
2121.3	3.60	3771	0.0
2422.9	7.29	4082	0.0
3117.4	0.0269	4800	0.0
3352.7	20.41	5044	0.0
3605	0.073	5303	0.0
3725.9	0.082	5425	0.0
3991	0.212	5700	0.0
4344.9	0.101	6065	0.0
4526	0.094	6254	0.0
4977	0.0129	6732	0.0
5558	0.112	7320	0.0
5684	0.0043	7450	0.0
5822	0.087	7600	0.0
6068	0.0223	7852	0.0
6358	0.0116	8146	0.0
912	0.014	3771	1248.60
1210.8	0.320	4082	1248.60
1677	0.029	4561	1248.60
2145.5	0.263	5044	1248.60
2395.1	0.118	5303	1248.60
2511.9	0.71	5425	1248.60

0^+　　　　0　98 ms 2

%εp=35.58

Q$_{\varepsilon p}$=9553.2 18

$^{32}_{18}$Ar$_{14}$

8146
7852
7600
7450
7320
6732
6254
6065
5700
5425
5303
5044
4800
4561
4082
3771

1248.4 M1+E2 1.9

$3/2^+$　　　　1248.60

2208

$1/2^+$　　　　0.0

$^{32}_{17}$Cl$_{15}$

$^{31}_{16}$S$_{15}$

^{32}Ar εp decay (98 ms)   2021Bl02,2008Bh08,1985Bj01

Decay Scheme (continued)

γ Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
I(p) Intensities: I(p) per 100 parent decays

E(p)	I(p)	E($^{32}_{17}$Cl)	E($^{31}_{16}$S)
2616	0.051	5531	1248.60
2775.4	0.088	5700	1248.60
3117	0.016	6065	1248.60
3583	0.051	6529	1248.60
3649	0.066	6597	1248.60
3782	0.076	6732	1248.60
4348	0.027	7320	1248.60
4625	0.035	7600	1248.60
4867	0.053	7852	1248.60

0^+ 0   98 ms 2

%εp=35.58 $Q_{\varepsilon p}$=9553.2 18

$^{32}_{18}$Ar$_{14}$

7852
7600
7320
6732
6597
6529
6065
5700
5531

$^{32}_{17}$Cl$_{15}$

$3/2^+$ 1248.60

$^{31}_{16}$S$_{15}$