^{9}Be(^{36}S,^{35}Pγ) 2016Mu03

$J^\pi=0^+$ for ^{36}S ground state.

2016Mu03: a secondary beam ^{36}S was produced via the projectile fragmentation of a 140-MeV/nucleon ^{48}Ca primary beam impinging on a 846-mg/cm^2 ^{9}Be target at the coupled cyclotron facility at NSCL, MSU. ^{48}Ca beam. The ^{36}S nuclei were selected using the A1900 separator with an intensity of 8.1×10^5 pps and a purity of 89.7%. The excited states of ^{35}P were populated by the one-proton knockout reaction from the ^{36}S beam at 88 MeV/nucleon (midtarget energy) on a 100-mg/cm^2 ^{9}Be secondary target located at the reaction target position of the S800 spectrometer. The projectile-like residues were identified from their energy loss measured by an ionization chamber located at the focal plane of the S800 spectrometer and from their ToF measured between two scintillators situated at the object position and at the focal plane of the S800 spectrometer. Prompt γ-rays from the de-excitation of the ^{35}P residues were detected by seven modules of the GRETINA Ge array. Measured Eγ, Iγ, (^{35}P)γ-coin, $\gamma\gamma$-coin, the inclusive knockout cross section for producing ^{35}P from ^{36}S, the fractional populations and parallel momentum distributions of 8 populated states in ^{35}P residues. Deduced levels, J, π, L-transfers, partial knockout cross sections and spectroscopic factors. Calculated single-particle cross sections (σ_{sp}) for proton removal and parallel momentum distributions using the eikonal model. This work is also part of the thesis 2015MuZY.

^{35}P Levels

The inclusive cross section σ^{exp}_{inc} for producing ^{35}P from ^{36}S is measured to be 51 mb *1*. 95.3% is attributed to a direct knockout process from the p-sd shell, i.e., $\sigma^{exp}_{inc,KO}=0.953\times\sigma^{exp}_{inc}$. The remaining 4.7% is possibly attributed to a charge-exchange or a two-step process: ^{36}S core excitation by inelastic scattering, followed by a proton removal. This is proposed based on their shifted parallel momentum distributions, their decay modes to negative parity states, their high excitation energy (around 4.7 MeV), and the fact that they were not observed in the ^{36}S(d,^{3}He) reaction study (1985Kh04).

E(level)†	J^π@	L#	C^{2}S&	Comments
0.0	1/2$^+$	0	2.2 *7*	b$_f$=31.4% *72*, σ_f^{sp}=13.5 mb, R$_s$=0.55 *11*.
2388 *1*	3/2$^+$	2	0.7 *3*	b$_f$=7.8% *36*, σ_f^{sp}=10.2 mb, R$_s$=0.52 *10*.
3862 *1*	5/2$^+$	2	2.7 *8*	b$_f$=27.3% *58*, σ_f^{sp}=10.6 mb, R$_s$=0.49 *10*.
4101 *2*	(7/2$^-$)‡			b$_f$=−0.7% *7*.
4383 *3*	(5/2$^-$)‡			b$_f$=2.0% *4*.
4494 *2*	(7/2$^-$)	(3)	0.30 *7*	L: 3 reported in 2016Mu03. The parentheses are added by evaluators based on the statement in 2016Mu03 that the parallel momentum distribution has limited statistics and seems more consistent with L=3. b$_f$=2.9% *5*, σ_f^{sp}=10.7 mb, R$_s$=0.48 *10*.
4667 *2*	5/2$^+$	2	1.0 *2*	b$_f$=9.5% *10*, σ_f^{sp}=10.3 mb, R$_s$=0.47 *9*.
4768 *2*	(9/2$^-$)‡			b$_f$=0.9% *3*.
4962 *3*	(9/2$^-$)‡			b$_f$=0.3% *2*.
5089 *3*	(11/2$^-$)‡			b$_f$=1.5% *2*.
5200 *2*	5/2$^+$	2	1.5 *3*	b$_f$=14.5% *14*, σ_f^{sp}=10.2 mb, R$_s$=0.47 *9*.
5710 *2*	(1/2$^-$)	(1)	0.21 *16*	b$_f$=1.4% *10*, σ_f^{sp}=10.8 mb, R$_s$=0.47 *9*. J^π: interpted as the deeply bound 1p$_{1/2}$ proton removal. L: 1 reported in 2016Mu03. The parentheses are added by evaluators based on the parallel momentum distribution (Fig. 3) in 2016Mu03.
7527 *2*	(1/2$^-$)	(1)	0.20 *6*	b$_f$=1.2% *3*, σ_f^{sp}=10.2 mb, R$_s$=0.44 *9*. J^π: interpted as the deeply bound 1p$_{1/2}$ proton removal. L: 1 reported in 2016Mu03. The parentheses are added by evaluators based on the parallel momentum distribution (Fig. 3) in 2016Mu03.

† From a least-squares fit to γ-ray energies.

‡ Populated by a two-step reaction mechanism. 2016Mu03 states that they are likely to have J≥5/2 and negative parities.

The orbital angular momentum was deduced by comparing the experimental and calculated parallel momentum distributions of each ^{35}P state.

@ From the Adopted Levels, also assumed by 2016Mu03 for deducing C^{2}S.

Continued on next page (footnotes at end of table)

^{9}Be(^{36}S,^{35}Pγ) 2016Mu03 (continued)

^{35}P Levels (continued)

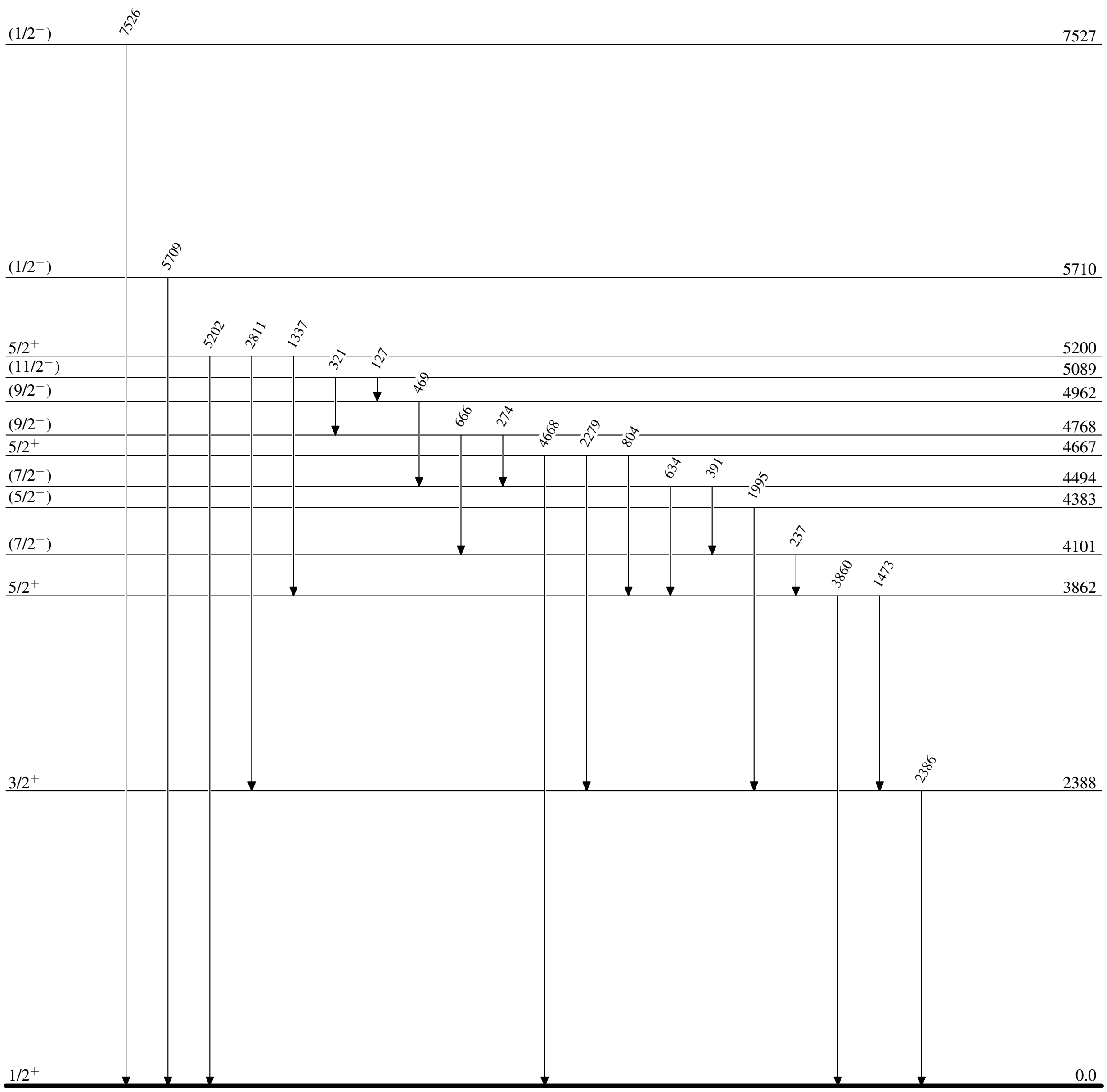
& The spectroscopic factor $C^2S=b_f\sigma_{inc}^{exp}/R_s\sigma_f^{sp}$, where b_f is the population fraction, σ_{inc}^{exp} is the measured total inclusive cross section, R_s is the quenching factor from a systematics study 2014To14, and σ_f^{sp} is the eikonal model calculated single-particle cross section.

γ(^{35}P)

E_γ	E_i(level)	J_i^π	E_f	J_f^π
127 *2*	5089	(11/2$^-$)	4962	(9/2$^-$)
237 *2*	4101	(7/2$^-$)	3862	5/2$^+$
274 *2*	4768	(9/2$^-$)	4494	(7/2$^-$)
321 *2*	5089	(11/2$^-$)	4768	(9/2$^-$)
391 *2*	4494	(7/2$^-$)	4101	(7/2$^-$)
469 *2*	4962	(9/2$^-$)	4494	(7/2$^-$)
634 *2*	4494	(7/2$^-$)	3862	5/2$^+$
666 *2*	4768	(9/2$^-$)	4101	(7/2$^-$)
804 *2*	4667	5/2$^+$	3862	5/2$^+$
1337 *2*	5200	5/2$^+$	3862	5/2$^+$
1473 *2*	3862	5/2$^+$	2388	3/2$^+$
1995 *2*	4383	(5/2$^-$)	2388	3/2$^+$
2279 *2*	4667	5/2$^+$	2388	3/2$^+$
2386 *2*	2388	3/2$^+$	0.0	1/2$^+$
2811 *2*	5200	5/2$^+$	2388	3/2$^+$
3860 *2*	3862	5/2$^+$	0.0	1/2$^+$
4668 *2*	4667	5/2$^+$	0.0	1/2$^+$
5202 *2*	5200	5/2$^+$	0.0	1/2$^+$
5709 *2*	5710	(1/2$^-$)	0.0	1/2$^+$
7526 *2*	7527	(1/2$^-$)	0.0	1/2$^+$

$^{9}Be(^{36}S,^{35}P\gamma)$ 2016Mu03

Level Scheme



$^{35}_{15}P_{20}$