^{9}Be(^{36}Si,^{35}Siγ) 2014St18,2015St06

^{36}Si->n+^{35}Si from $J^{\pi}=0^{+}$ ^{36}Si ground state.

2014St18: A ^{36}Si secondary beam was produced via the projectile fragmentation of a 140-MeV/nucleon ^{48}Ca primary beam impinging on a ^{9}Be target at NSCL, MSU and was selected by the A1900 separator. The states of ^{35}Al and ^{35}Si were populated by the one-proton/neutron knockout reactions, respectively, from the ^{36}Si beam at a midtarget energy of 97.7(5) MeV/nucleon on a 287-mg/cm^{2} ^{9}Be secondary target. Knockout residues were identified from their energy loss measured by an ionization chamber at the focal plane of the S800 spectrometer and from their ToF measured between two scintillators at the object position and at the focal plane of the S800 spectrometer. The position and angle of the residues were measured using two cathode-readout drift chambers. Prompt γ rays from the deexcitation of the residues were detected by the GRETINA Ge array. Measured Doppler-corrected Eγ, Iγ, (^{35}Si)γ-coin, $\gamma\gamma$-coin, the parallel momentum distributions of populated states in ^{35}Si residues. Deduced levels, J, π, L-transfers, inclusive and exclusive knockout cross section for producing ^{35}Si from ^{36}Si. Calculations using eikonal reaction model and shell model spectroscopic strengths with SDPF-U and SDPF-MU interactions.

2015St06: Further theoretical discussions on the data from 2014St18.

^{35}Si Levels

Total knockout σ=81 mb *2* for producing ^{35}Si from ^{36}Si.

E(level)[†]	J^{π}[‡]	$T_{1/2}$	L[#]	Comments
0	(7/2^{-})		3	Partial knockout σ=52 mb *4*, including an unresolved population of the 3/2^{+} isomer at 973 keV (2014St18). Partial knockout σ=23 mb *6*, resolved by the fitting parallel momentum distribution subtracting all events that decay by prompt γ emission with a linear combination of the theoretical distributions for neutron removal from the $f_{7/2}$ and $d_{3/2}$ orbits together via the χ^{2} minimization method (2015St06).
908 *4*	(3/2^{-})	55 ps *14*	1	$T_{1/2}$: lifetime=80 ps *20* extracted from fitting Geant4 simulation to broadened line shapes via the maximum likelihood method (2014St18). Partial knockout σ=8 mb *3*.
973 *7*	(3/2^{+})			Partial knockout σ=29 mb *6*, resolved by 2015St06.
1688 *6*	1/2^{+}		0	Partial knockout σ=13 mb *1*.
1970 *6*				Partial knockout σ=1.1 mb *2*.
2042 *7*	(1/2^{-})		0,1	Partial knockout σ=1.3 mb *2*.
2164 *6*	(5/2^{+})		2,3	Partial knockout σ=1.1 mb *2*.
2275 *6*				Partial knockout σ=1.6 mb *2*.
2377 *7*				Partial knockout σ=2.1 mb *2*. L: 2014St18 showed L=0,1,2,3 fits to the measured parallel momentum distribution but did not specify L. L=0 seems unlikely.
3611? *8*				Partial knockout σ=0.8 mb *2*.

† From a least-squares fit to γ-ray energies.
‡ As given in 2014St18 based on L-transfers and shell-model predictions.
\# 2014St18 deduced L by comparing the measured and eikonal-calculated parallel momentum distributions of residuals.

γ(^{35}Si)

E_{γ}[†]	I_{γ}[†]	E_i(level)	J^{π}_{i}	E_f	J^{π}_{f}	Comments
715 *4*	1.9 *2*	1688	1/2^{+}	973	(3/2^{+})	
780 *4*	13 *1*	1688	1/2^{+}	908	(3/2^{-})	
908 *4*	25 *2*	908	(3/2^{-})	0	(7/2^{-})	B(E2)↓=0.0017 *+4−5* (2014St18)
1134 *5*	1.5 *2*	2042	(1/2^{-})	908	(3/2^{-})	
1970 *6*	1.4 *2*	1970		0	(7/2^{-})	
2164 *6*	1.4 *2*	2164	(5/2^{+})	0	(7/2^{-})	
2275 *6*	2.0 *3*	2275		0	(7/2^{-})	
2377 *7*	2.5 *3*	2377		0	(7/2^{-})	

Continued on next page (footnotes at end of table)

^{9}Be(^{36}Si,^{35}Siγ) 2014St18,2015St06 (continued)

γ(^{35}Si) (continued)

E_γ †	I_γ †	E_i(level)	E_f	J^π_f	Comments
3611 *8*	1.0 *2*	3611?	0	(7/2$^-$)	2014St18 observed one γ transition at 3611 keV, which must depopulate a state that is unbound to neutron emission by at least 1.1 MeV. One possible explanation is this ^{35}Si level is populated by 1n knockout from the deeply-bound 1d$_{5/2}$ orbit in ^{36}Si and followed by the emission of the other 1d$_{5/2}$ neutron, resulting in a 2p-2h configuration dominated by two holes in the deeply bound neutron 1d$_{5/2}$ orbit. Such a configuration should have a small overlap with the ground state in ^{34}Si that has a large contribution of 0p-0h configurations, leading to a significantly hindered neutron decay. The γ decay, on the other hand, would be a fast 5/2$^+$ -> 7/2$^-$ g.s. E1 decay and could potentially compete with the neutron emission. A second possible explanation could be that this state is weakly populated in a more complicated multistep reaction pathway. The 3611-keV γ results predominantly from events with residue momenta in the tail of the momentum distribution. The low-momentum tail is associated with more inelastic reactions, which would be consistent with a multistep process.

† From 2014St18, unless otherwise noted.

$^{9}Be(^{36}Si,^{35}Si\gamma)$ 2014St18,2015St06

Level Scheme

Intensities: Yield/100 ions