^{9}Be(^{34}Si,^{33}Alγ) 2017Mu05,2015MuZY

History

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

Includes charge-exchange reaction ^{9}Be(^{34}Si,^{34}Al), followed by emission of neutron (2015MuZY).

First experimental evidence for a depletion of central density of protons or a bubble structure in ^{34}Si. This work also calls for a significant revision of the decay scheme of ^{33}Mg β^- decay to ^{33}Al, as proposed by 2008Tr07.

2017Mu05 (also 2015MuZY: thesis by the same first author): ^{34}Si beam was produced in ^{9}Be(^{48}Ca,X) with E=140 MeV/nucleon ^{48}Ca primary beam provided from NSCL at MSU on a 846 mg/cm^2 ^{9}Be target. Fragments were separated by A1900 fragment separator. The secondary target was 100 mg/cm^2 ^{9}Be. γ rays were detected using the GRETINA array; charged particles were analyzed by energy-loss measurement in an ionization chamber located at the focal plane of the S800 magnetic spectrograph. Measured Eγ, Iγ, (^{33}Al)γ-coin, $\gamma\gamma$-coin, longitudinal-momentum distributions. Deduced levels, J, π, L-transfers from analysis by eikonal method, spectroscopic factors, and proton occupancies. Proton and neutron density contours calculated using relativistic Hartree-Fock-Bogoliubov calculations with PKO2 interaction. Levels at 1838, 2585, 2787, 3284, 3472, 4046, and 4085 keV, populated in ^{34}Si to ^{34}Al charge-exchange reaction followed by one-neutron emission from ^{34}Al are reported only by 2015MuZY.

^{33}Al Levels

Level populations under comments are from 2017Mu05, unless otherwise noted.

E(level)[†]	J$^\pi$[‡]	L[#]	Normalized C^{2}S[@]	Comments
0	5/2$^+$	2[a]	4.6 *9*	Level population=77.5% *22*. C^{2}S(exp)/C^{2}S(theory)=0.42 *8* (2015MuZY).
1622 *4*	(5/2$^+$)	2[a]	0.19 *7*	Level population=2.8% *9*. C^{2}S(exp)/C^{2}S(theory)=0.39 *8* (2015MuZY).
1651 *4*	(5/2$^+$)	2[a]	0.9 *2*	Level population=13.8% *20*. C^{2}S(exp)/C^{2}S(theory)=0.39 *8* (2015MuZY).
1840[&] *4*				Level population=1.9% *8* (2015MuZY).
2101 *5*	(1/2$^+$)	0[b]	0.08 *3*	Level population=1.5% *4*. C^{2}S(exp)/C^{2}S(theory)=0.45 *9* (2015MuZY).
2366? *6*				Tentative (2017Mu05).
2587[&] *4*				Level population=2.2% *5* (2015MuZY).
2667 *5*				Level population=0.3% *1*.
2696 *5*				Level population=0.3% *1*.
2787[&] *7*				Level population=1.3% *4* (2015MuZY).
2817 *5*				Level population=0.2% *1*.
3191 *5*				Level population=0.5% *3*.
3284[&] *7*				Level population=0.3% *2* (2015MuZY).
3474[&] *5*				Level population=0.5% *3* (2015MuZY).
3702 *5*	(1/2$^+$)	0[b]	0.08 *2*	Level population=1.4% *3*. C^{2}S(exp)/C^{2}S(theory)=0.48 *10* (2015MuZY).
3927 *7*	(3/2$^+$)	2	0.11 *2*	Level population=1.4% *3*. Interpreted as proton knockout from the 1d$_{3/2}$ orbit. C^{2}S(exp)/C^{2}S(theory)=0.36 *7* (2015MuZY).
4047[&] *7*				Level population=0.7% *1* (2015MuZY).
4087[&] *5*				Level population=0.8% *2* (2015MuZY).

[†] From a least-square fit to γ-ray energies.

[‡] From 2017Mu05 based on deduced L-transfer and proposed proton orbital.

[#] Proposed by 2017Mu05, based on measured longitudinal-momentum distributions and analysis by eikonal method, unless otherwise noted.

Continued on next page (footnotes at end of table)

^{9}Be(^{34}Si,^{33}Alγ) 2017Mu05,2015MuZY (continued)

^{33}Al Levels (continued)

[@] Values are extracted from measured cross sections in 2017Mu05, unless otherwise noted. Summed spectroscopic factor for 1st three L=2 states=5.7 *10*, in agreement with 6 expected for full occupancy of the $1d_{5/2}$ orbit. In comparison, summed spectroscopic strength for L=0 states of 2101 and 3704 keV is 0.17 *3* (this value would only increase by 0.07 *3* if the unassigned and weakly populated states of 2666, 2696, 2816 and 3193 keV were all assumed as L=0). A small (≈8%) proton occupancy of the $2s_{1/2}$ orbital or about 10% of that in ^{36}S, reflects a large depletion of the central density of protons in ^{34}Si.

[&] Level reported in 2015MuZY, interpreted by authors as populated in ^{34}Si to ^{34}Al charge-exchange followed by one-neutron emission, while all the other levels as reported in 2017Mu05 (also 2015MuZY) are populated through one-proton removal from ^{34}Si. The distinction between the two sets of states is made by 2015MuZY from deduced shift of centroid of these momentum distributions towards low momentum.

[a] Interpreted as proton knockout from the $1d_{5/2}$ orbit.

[b] Interpreted as proton knockout from the $2s_{1/2}$ orbit.

γ(^{33}Al)

E_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Comments
497 *1*	3284		2787		
511 *2*	3702	(1/2$^+$)	3191		
595 *2*	2696		2101	(1/2$^+$)	E_γ: 596γ in 2008Tr07, but placed from a 4310 level.
613 *2*	4087		3474		
747 *2*	2587		1840		
763 *2*	4047		3284		
887 *2*	3474		2587		
1045 *3*	2667		1622	(5/2$^+$)	E_γ: 1046γ in 2008Tr07, but placed from a 4310 level.
1195 *3*	2817		1622	(5/2$^+$)	
1621 *4*	1622	(5/2$^+$)	0	5/2$^+$	E_γ: 1618 in 2008Tr07, 1617 in 2006AnZW.
1651 *4*	1651	(5/2$^+$)	0	5/2$^+$	E_γ: 1646 in 2006AnZW; 1647 in 2008Tr07, but placed from a 3264 level.
[x] 1838[‡] *5*					E_γ: From γ singles spectrum in Fig.1a of 2017Mu05. This γ is not assigned to ^{33}Al by 2017Mu05 as authors state that it is not produced by the one-proton removal, with no further argument. But a 1838γ was also reported by 2008Tr07 and 2006AnZW in ^{33}Mg β^- decay as a ground-state transition and a 1838.6γ was assigned to ^{33}Al by 2006FuZX in He(^{33}Al,^{33}Alγ). Therefore, the evaluators consider that the possibility of this 1838γ belonging to ^{33}Al cannot be ruled out, with its existence and placement questionable.
1841 *5*	1840		0	5/2$^+$	
2080 *5*	3702	(1/2$^+$)	1622	(5/2$^+$)	
2101 *5*	2101	(1/2$^+$)	0	5/2$^+$	E_γ: 2096 in 2006AnZW; 2096 also in 2008Tr07, but placed from a 3714 level.
2305 *6*	3927	(3/2$^+$)	1622	(5/2$^+$)	
2366 *6*	2366?		0	5/2$^+$	E_γ: 2365γ in 2008Tr07.
2586[‡] *7*	2587		0	5/2$^+$	
2787 *7*	2787		0	5/2$^+$	
3193 *8*	3191		0	5/2$^+$	

[†] Quoted uncertainty is systematic uncertainty of 0.25% estimated by 2017Mu05 on the energy centroid. No statistical uncertainty is given or explained in 2017Mu05. It is assumed by the evaluators that the total uncertainty is dominated by the large systematic uncertainty.

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

[x] γ ray not placed in level scheme.

Legend

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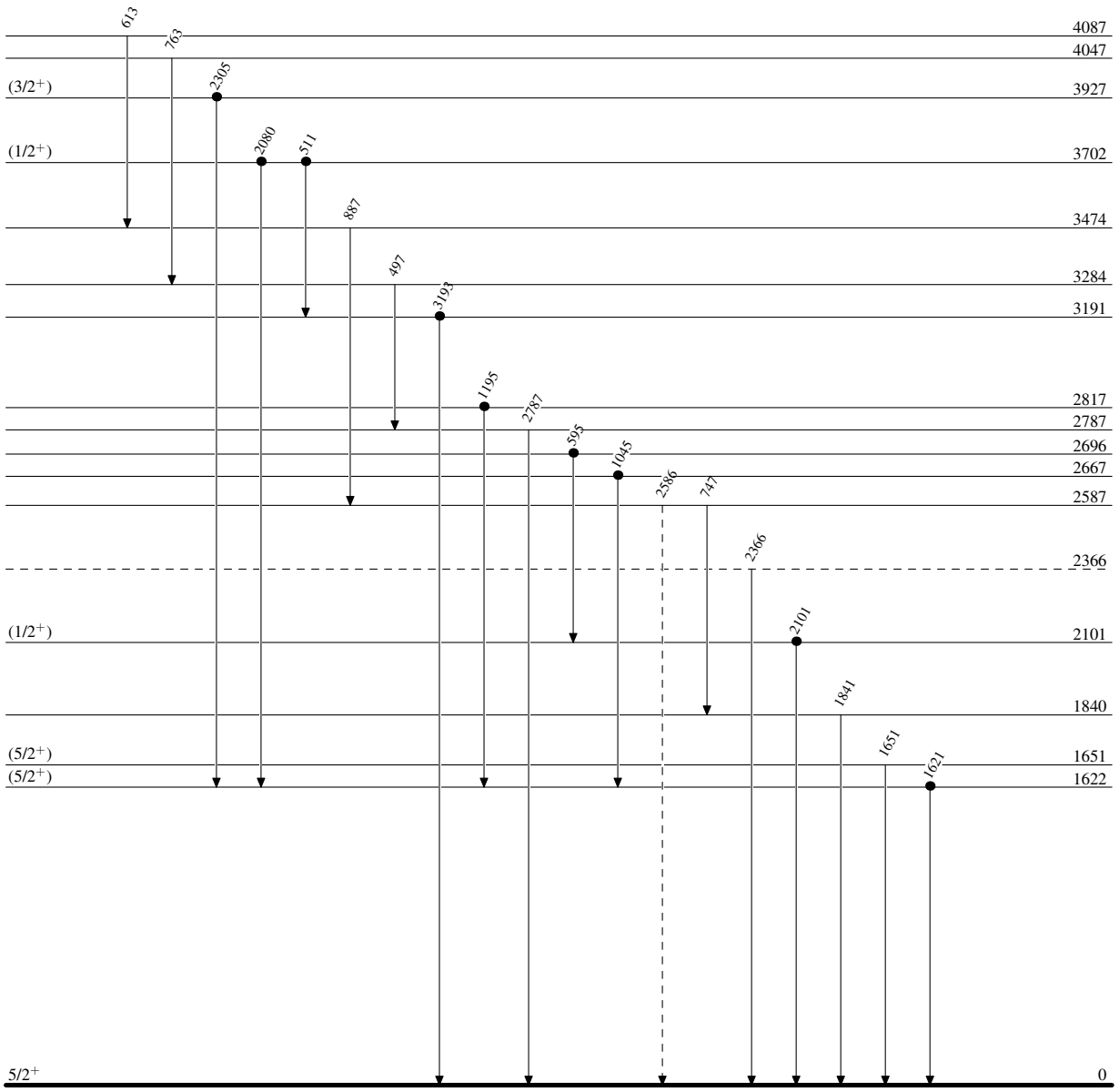
Level Scheme



$^{33}_{13}Al_{20}$