

Shell evolution along Ar isotopic chain.

D. Mengoni ...

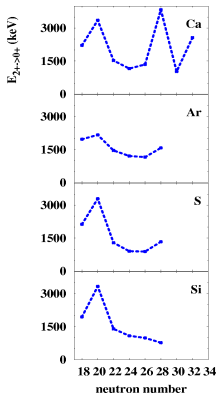
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Outline

- 1 Physics
- 2 Results
 - ^{48}Ar
- 3 Exp. details
 - Cross Sections
 - Rates

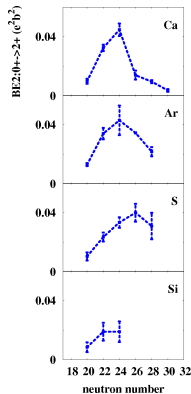
Systematic



- Shell evolution
- Magic number migration

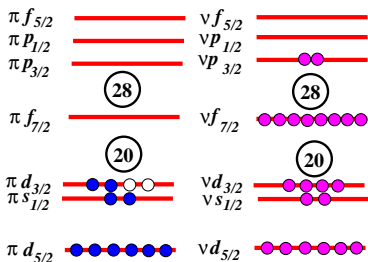
Cr47 80.0m 5.2 ⁺	Cr48 79.9m 21.9m	Cr49 21.9m 5.2 ⁺	Cr50 1.6217y IC	Cr51 3.7024y IC	Cr52 59.72d 4 ⁺	Cr53 8.01h 3.2 ⁺	Cr54 1.16h 4 ⁺	Cr55 3.407m 3.2 ⁺	Cr56 3.38m 0 ⁺	Cr57 3.111s 30.52,70 6 ⁺	Cr58 7.1s 6 ⁺
V46 82.27m 6 ⁺	V47 32.4m 5.2 ⁺	V48 18.973s 6 ⁺	V49 1.6217y IC	V50 1.6217y IC	V51 1.6217y IC	V52 3.70m 3.2 ⁺	V53 1.41m 3.2 ⁺	V54 46.3s 3s	V55 6.6s 15.1	V56 6 ⁺	V57 6 ⁺
T145 13.02m 5.2 ⁺	T146 5.2 ⁺	T147 7.2 5.2 ⁺	T148 7.2 5.2 ⁺	T149 7.2 5.2 ⁺	T150 8.4 5.2 ⁺	T151 7.2m 3.2 ⁺	T152 1.2m 3.2 ⁺	T153 2.2s 0.7p	T154 0.7p	T155 6 ⁺	T156 6 ⁺
Sc44 3.027s 2 ⁺	Sc45 3.027s 2 ⁺	Sc46 3.027s 2 ⁺	Sc47 3.027s 2 ⁺	Sc48 3.027s 2 ⁺	Sc49 3.027s 2 ⁺	Sc50 3.027s 2 ⁺	Sc51 3.2s 2 ⁺	Sc52 3.2s 2 ⁺	Sc53 3.2s 2 ⁺	Sc54 3.2s 2 ⁺	Sc55 3.2s 2 ⁺
Ca43 8.18h 7.2 ⁺	Ca44 3.09h 7.2 ⁺	Ca45 10.24h 7.2 ⁺	Ca46 8.90h 7.2 ⁺	Ca47 8.29h 7.2 ⁺	Ca48 8.29h 7.2 ⁺	Ca49 3.11h 3.2 ⁺	Ca50 3.11h 3.2 ⁺	Ca51 3.11h 3.2 ⁺	Ca52 3.11h 3.2 ⁺	Ca53 3.11h 3.2 ⁺	Ca54 3.11h 3.2 ⁺
K42 12.36h 2 ⁺	K43 12.3h 2 ⁺	K44 12.3h 2 ⁺	K45 12.3h 2 ⁺	K46 12.3h 2 ⁺	K47 12.3h 2 ⁺	K48 12.3h 2 ⁺	K49 12.3h 2 ⁺	K50 12.3h 2 ⁺	K51 12.3h 2 ⁺	K52 12.3h 2 ⁺	K53 12.3h 2 ⁺
Ar41 69.34m 5.2 ⁺	Ar42 3.27h 5.2 ⁺	Ar43 3.27h 5.2 ⁺	Ar44 3.27h 5.2 ⁺	Ar45 3.27h 5.2 ⁺	Ar46 3.27h 5.2 ⁺	Ar47 3.27h 5.2 ⁺	Ar48 3.27h 5.2 ⁺	Ar49 3.27h 5.2 ⁺	Ar50 3.27h 5.2 ⁺	Ar51 3.27h 5.2 ⁺	Ar52 3.27h 5.2 ⁺
Cl40 1.05m 2 ⁺	Cl41 3.27h 0.73,9.7p	Cl42 4.51 2 ⁺	Cl43 3.27h 2 ⁺	Cl44 3.27h 2 ⁺	Cl45 3.27h 2 ⁺	Cl46 3.27h 2 ⁺	Cl47 3.27h 2 ⁺	Cl48 3.27h 2 ⁺	Cl49 3.27h 2 ⁺	Cl50 3.27h 2 ⁺	Cl51 3.27h 2 ⁺

- Shape change

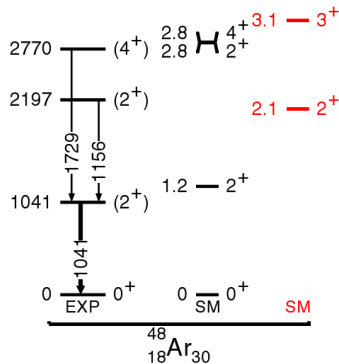


N=28 isotopes: ^{48}Ar

spectroscopic information



^{48}Ar



- Inverse kinematics (GANIL) and fragmentation (MSU) reaction.
- Triaxial structure.

A. Gade *et al.*, Phys.Rev.Lett. **102**, 182502 (2009), S. Bhattacharyya, Phys.Rev.Lett **101**, 032501 (2008)

Experiment details

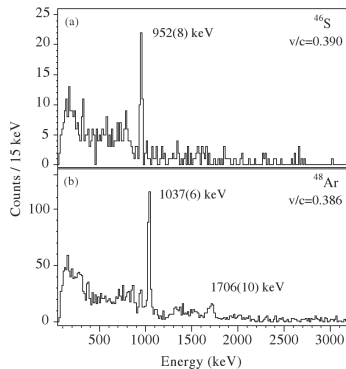
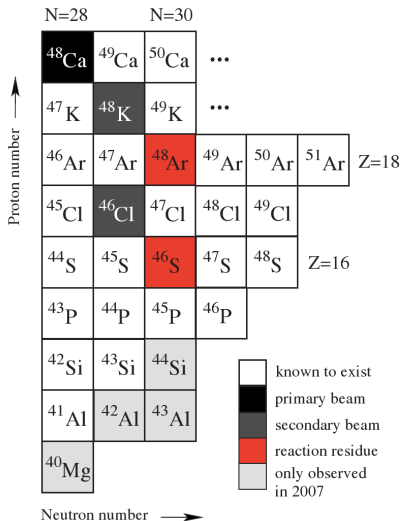
Cross section (b) using EPAX calculations

	^{48,49} Ar
⁶⁴ Ni, 10^{10} p/s	2E-8, 2E-9
⁷⁶ Ge, 10^9 p/s	1E-8, 1E-9
⁸² Se, 10^9 p/s	1E-8, 2E-9
⁸⁶ Kr, 10^{10} p/s	4E-9, 4E-10

S4 rate: 50 p/s (4E6 p/day)

- Cross section 10^{-7} b
- 10^{10} p/s primary beam
- 1.5 g/cm^2 primary target
- 30% FRS transmission, focus on the fragment

Charge-exchange neutron-pick-up reaction



PRL 102, 182502 (2009)

PHYSICAL REVIEW LETTERS

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In-Beam γ -Ray Spectroscopy of Very Neutron-Rich Nuclei: Excited States in ^{46}S and ^{48}Ar

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We report on the first in-beam γ -ray spectroscopy study of the very neutron-rich nucleus ^{46}S . The $N = 30$ isotopes ^{46}S and ^{48}Ar were produced in a novel way in two steps that both necessarily involve nucleon exchange and neutron pick-up reactions $^{10}\text{Be}^{10}\text{Ca}$, $^{10}\text{K}^{10}\text{Ar}$ followed by $^{10}\text{Be}^{10}\text{K}$, $^{10}\text{Ar} + \gamma$ X at 85.7 MeV/u midtarget energy and $^{10}\text{Be}^{10}\text{Ca}$, $^{10}\text{Cl}^{10}\text{X}$ followed by $^{10}\text{Be}^{10}\text{Cl}$, $^{10}\text{S} + \gamma$ X at 87.0 MeV/u midtarget energy, respectively. The results are compared to large-scale shell-model calculations in the sd pf shell using the SDPF-NR effective interaction and Z-dependent modifications.

Secondary reaction

Beam

10^{10} p/s of ^{64}Ni , unless ^{82}Se more intense beam is developed

Possible reactions

	target	E	Cross section
Knock-out	$^9\text{Be}/\text{H}_2$	100 MeVu	\approx mb
Fragm. (*)	^9Be	100 MeVu	$100 \mu\text{b}$
Coulex	$^{208}\text{Pb}/^{197}\text{Au}$	100 MeVu	50 mb

*

A. Gade *et al.*, Phys.Rev.Lett.**102**, 182502 (2009), G. A. Souliotis *et al.*, Phys. Rev. C 46, 1383 (1992). R. Pfaff *et al.*, Phys. Rev. C 51, 1348 (1995).

Rate calculations

Coulex: $5\text{E-6 Hz } \gamma/p$

- 50 mb
- 1 p/s
- 500 mg/cm² ¹⁹⁷Au
- ϵ_γ 20%

Fragm: $1\text{E-3 Hz } \gamma/p$

- 100 μb
- 100 p/s
- 1 g/cm², ⁹Be
- ϵ_γ 20%

^{48,49}Ar

Knock-out: $1\text{E-2 Hz } \gamma/p$

- 1 mb
- $10^2\text{-}10^3$ p/s
- 1 g/cm², ⁹Be
- ϵ_γ 20%

⁴⁸Ar