Quasielastic reactions: an interplay of reaction dynamics and nuclear structure

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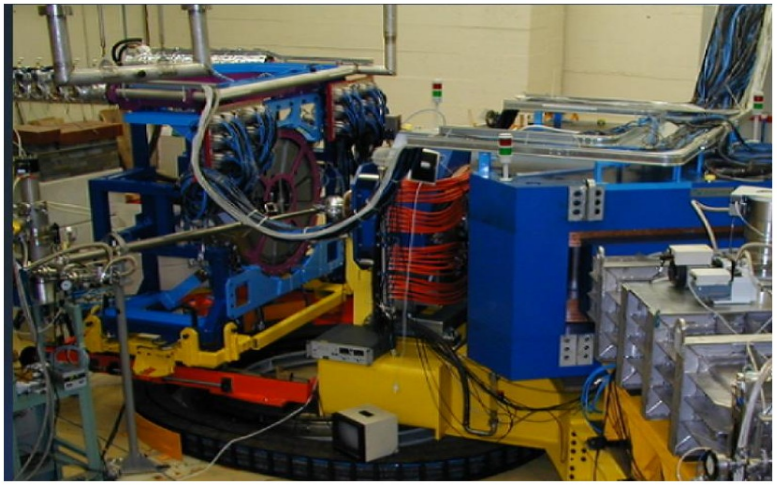
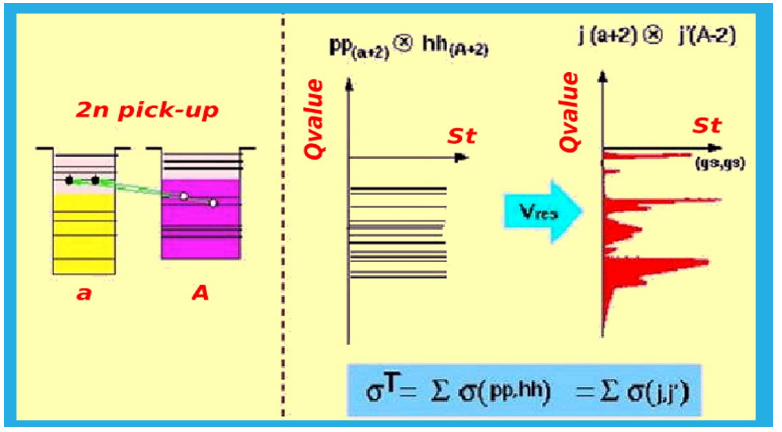


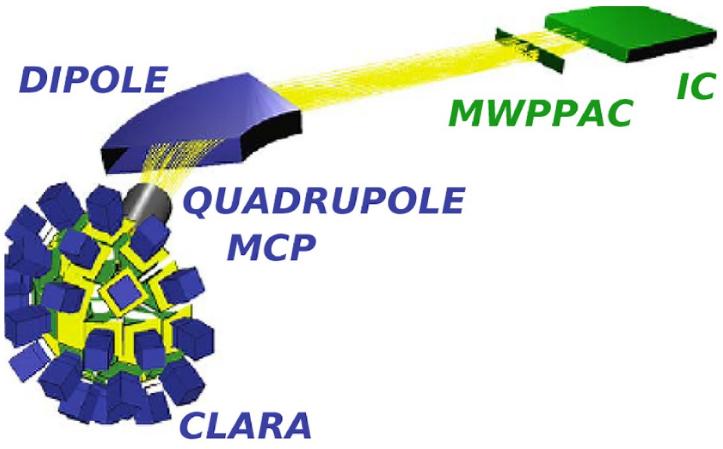
40Ar+208Pb
PRISMA+CLARA

A study of properties near shell closure:
single particle states
coupling of particle/hole to collective boson



EGAN
European Gamma and Ancillary detectors Network

PRISMA+CLARA set-up



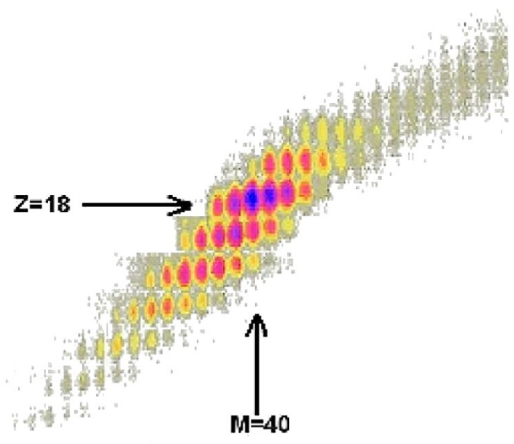
position at the entrance	x, y → (θ, ϕ)
position at the focal plane	X, Y
time of flight	ToF
energy and energy loss	ΔE, E
coincident γ-rays	Eγ

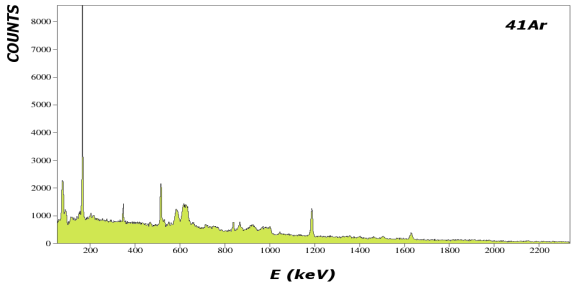
Trajectory reconstruction

Results:
A, q, Z, E of ions

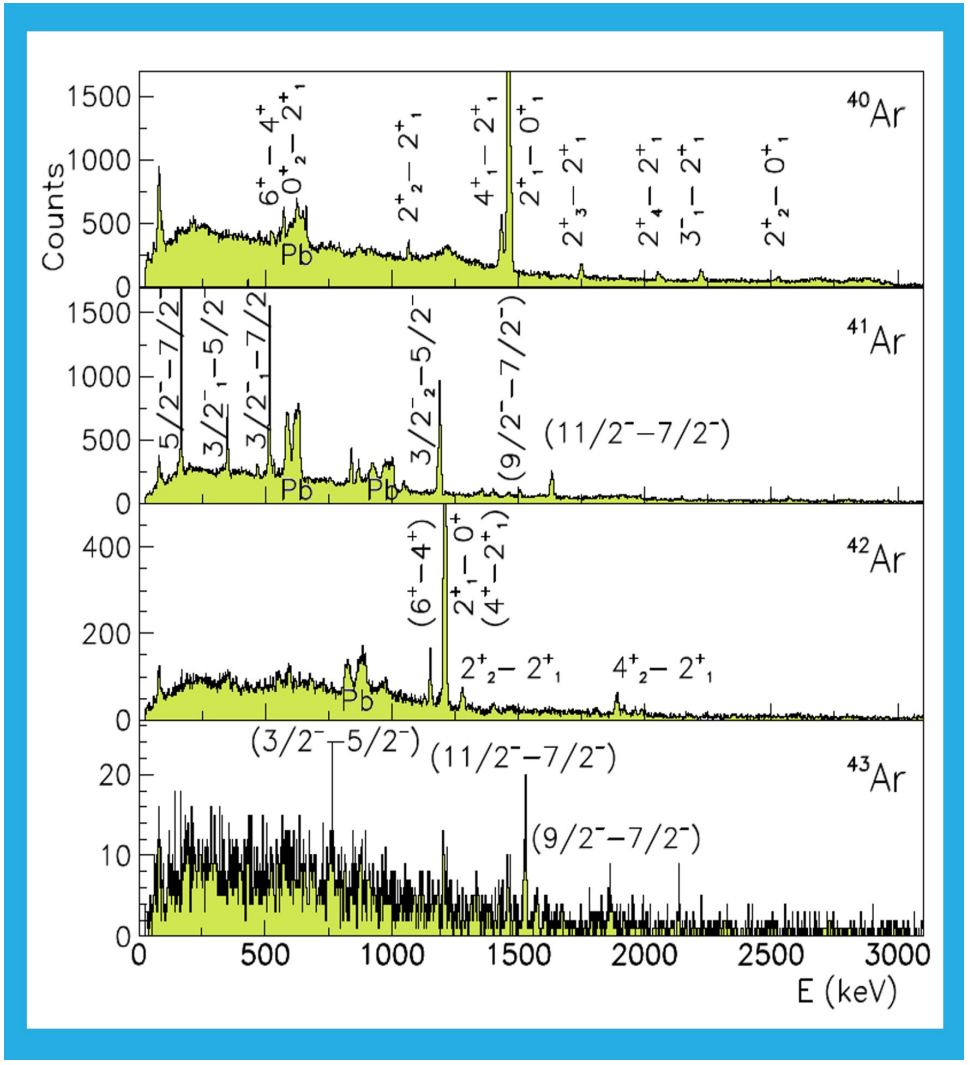
Results:
Doppler-corrected gamma-ray

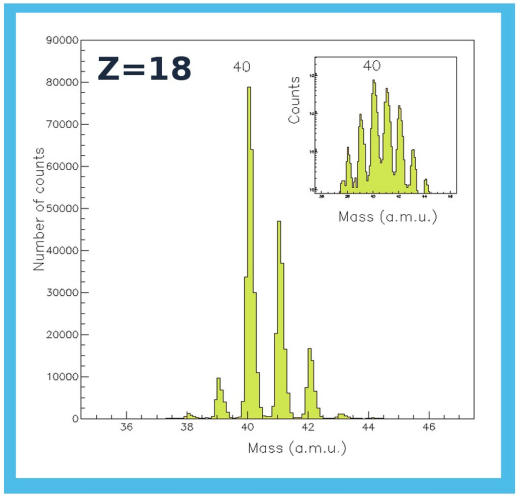
40Ar+208Pb
E(lab)=255 MeV





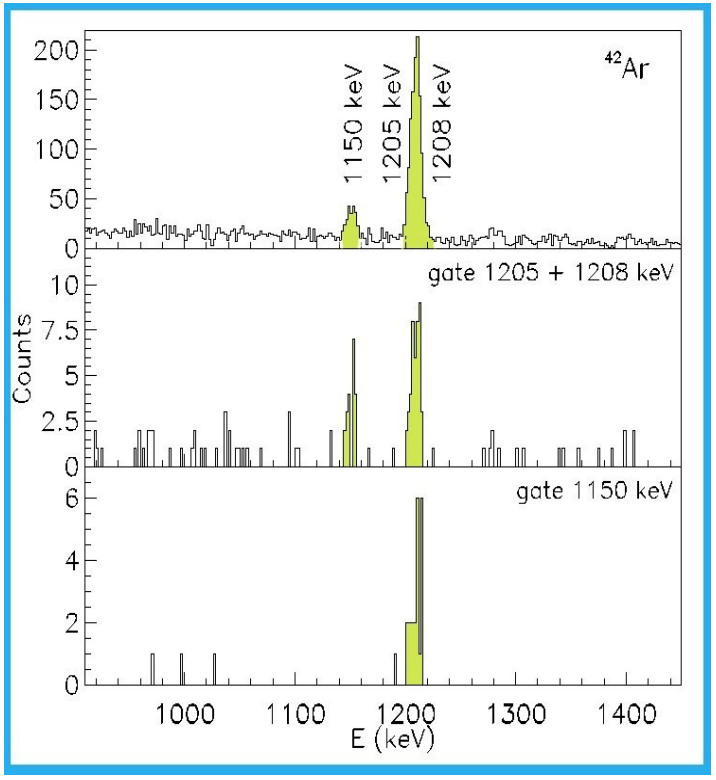
The character of states populated in transfer reactions

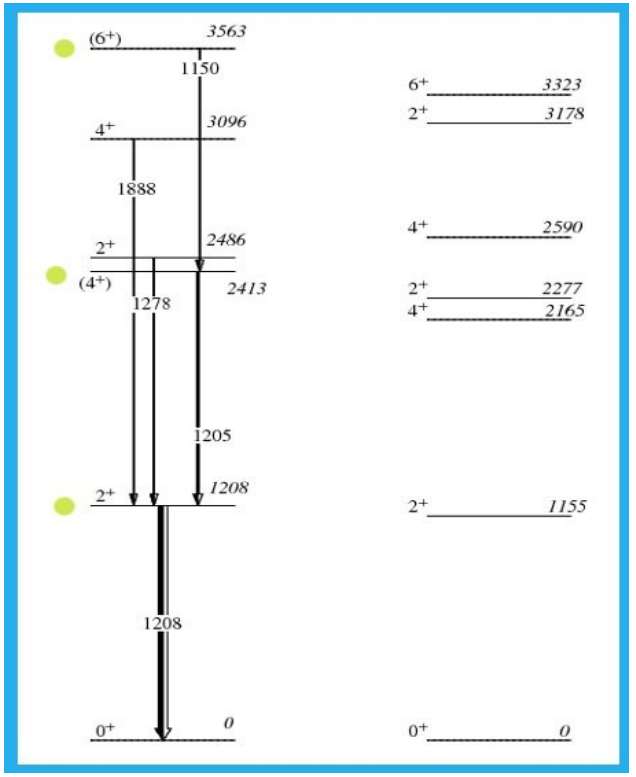




isotope	E_γ [keV]	E_i [keV]	J^π_i	E_f [keV]	J^π_f
^{41}Ar	1629.7(3)	1629.7(3)	$(11/2^-)$	0.0	$7/2^-$
	1504.8(6)	1504.8(6)	$(9/2^-)$	0.0	$7/2^-$
^{42}Ar	1150.4(3)	3563(1)	(6^+)	2413(1)	(4^+)
	1205(1)	2413(1)	(4^+)	1208(1)	2^+
^{43}Ar	762.3(4)	762.3(4)	$(3/2^-)$	0.0	$5/2^-$
	1527.4(5)	1527.4(5)+Δ	$(11/2^-)$	Δ	$(7/2^-)$
	1859(2)	1859(2)+Δ	$(9/2^-)$	Δ	$(7/2^-)$

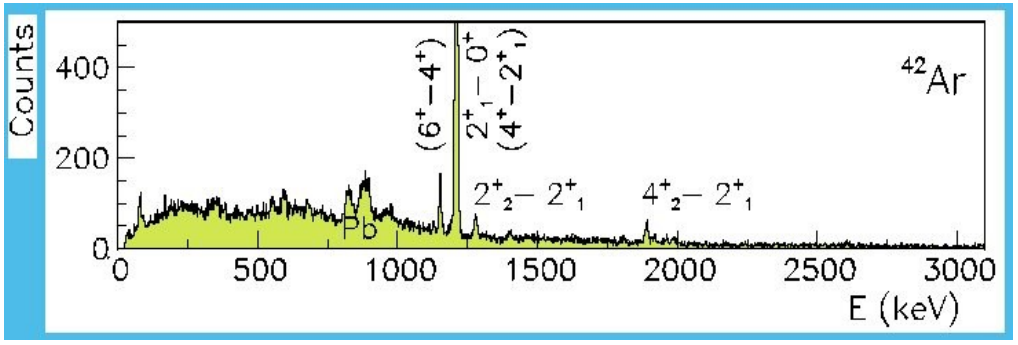
42Ar (+2n channel)





Nuclear Data Sheets 92, 1 (2001)

References:
A: ^{42}Cl β- decay (6.9 s)
B: ^{40}Ar(t,p)
C: ^{40}Ar(t,γp)
D: Pb(^{43}Ar,γn)
E: ^{42}Ar(p,p')

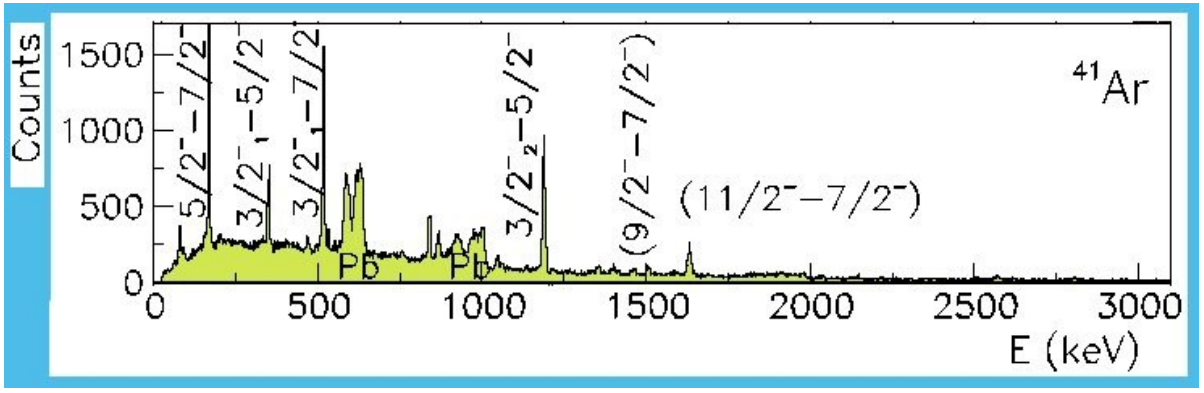


large scale SM calculations

$$0\hbar\omega \; sd - pf$$

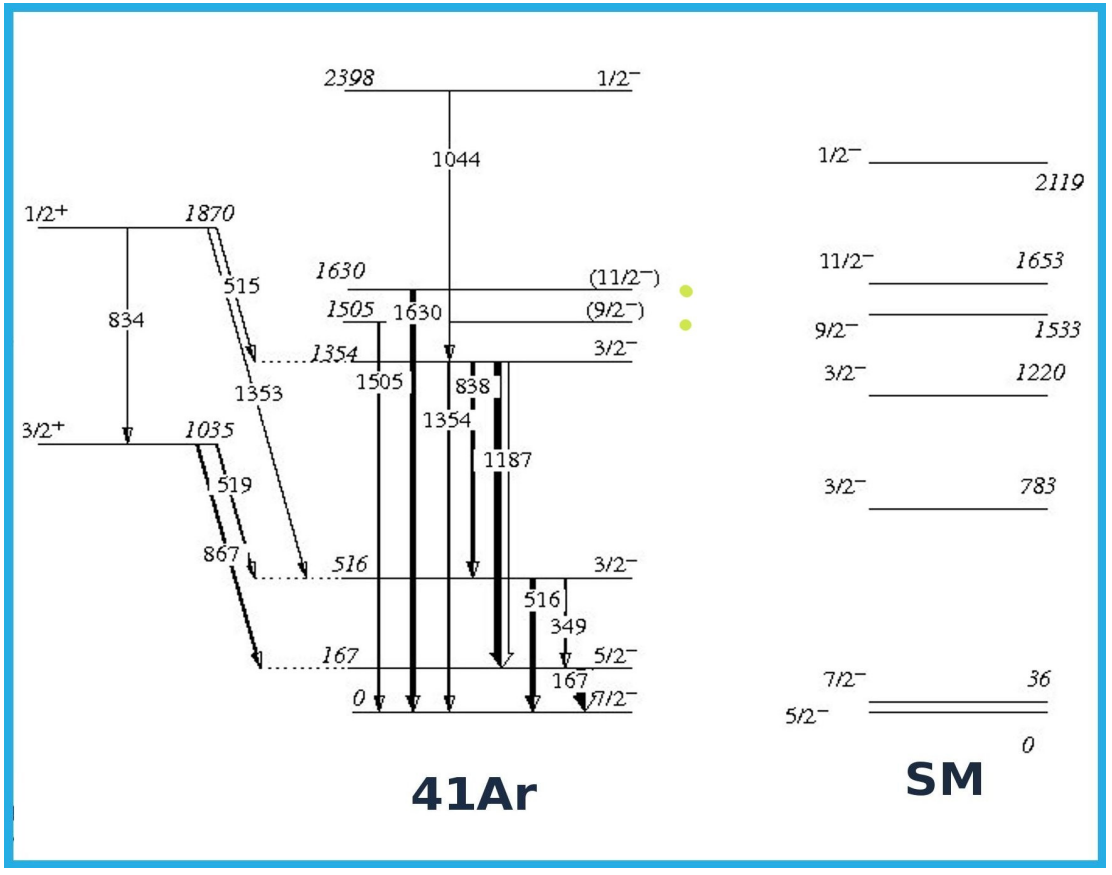
The recently developed SDPF-U effective interaction, with the valence space of the full sd shell for the protons and the full pf shell for the neutrons, has been used.

41Ar (+1n channel)



Nuclear Data Sheets 94, 429 (2001)

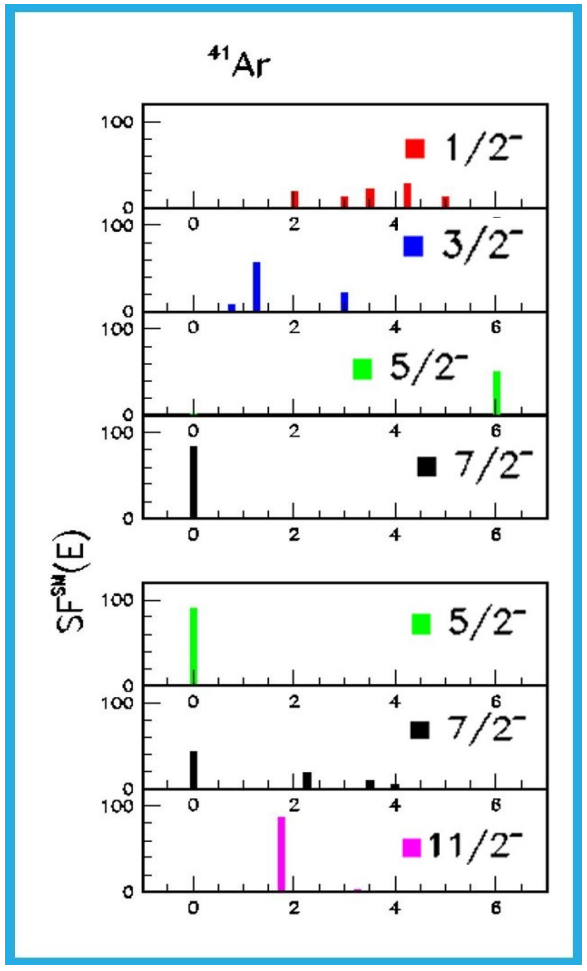
References:
A: ^{41}Cl β- decay (38.4 s)
B: ^{40}Ar(n,γ),(*polarized* n,γ) E=thermal
C: ^{40}Ar(d,p),(*polarized* d,p)
D: ^{40}Ar(d,γp),^{2}H(^{40}Ar,γp)
E: ^{40}Ar(^{13}C,^{12}C)
F: ^{40}Ar(n,γ) E=res

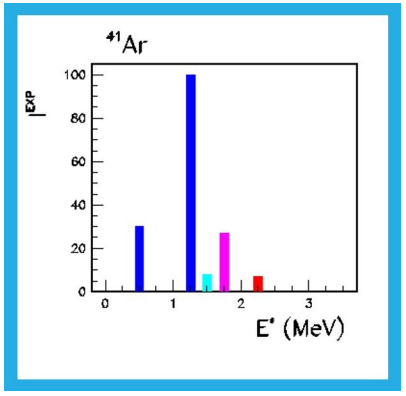


large scale SM calculations

$0\hbar\omega \; sd - pf$

Single-particle and collective excitations





Experimental intensities of the populated excited states:

- *subtractions of the feeding from above, if detected*
- *corrected for the CLARA eff.*
- *normalized to the strongest transitions*

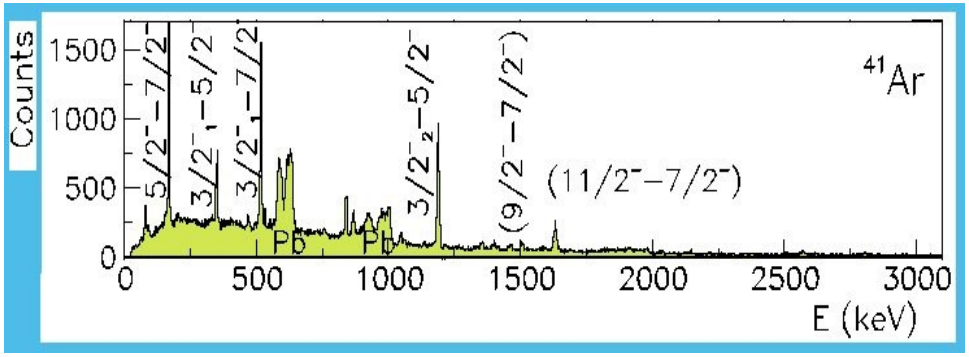
The strength functions calculated in the SM framework (displayed as % of the SF sum rule integrals)

TOP: SF of a neutron in p1/2, p3/2, f5/2 and f7/2 on the ground state of 40Ar

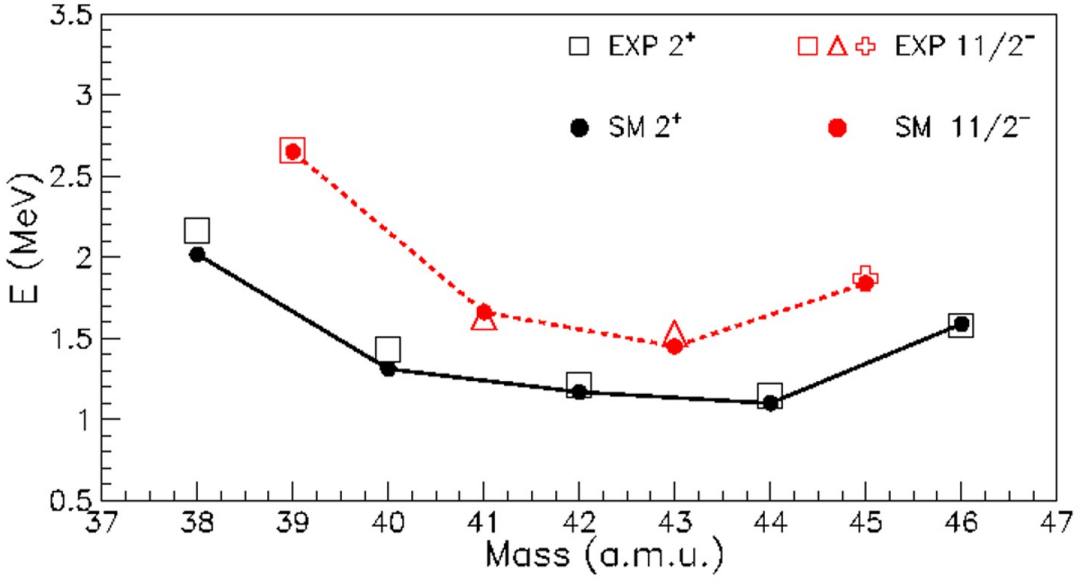
BOTTOM: SF of a neutron in f7/2 coupled to the 2+ of 40Ar

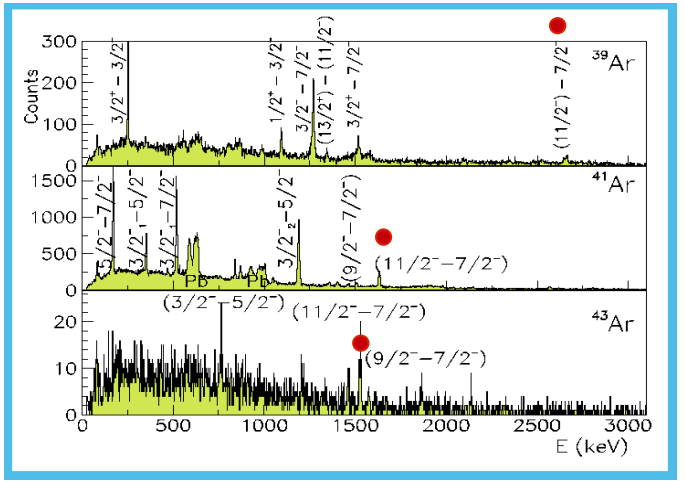
$2^+ \otimes \nu f_{7/2} \rightarrow 3/2^-, 5/2^-, 7/2^-, 9/2^-$, and $11/2^-$

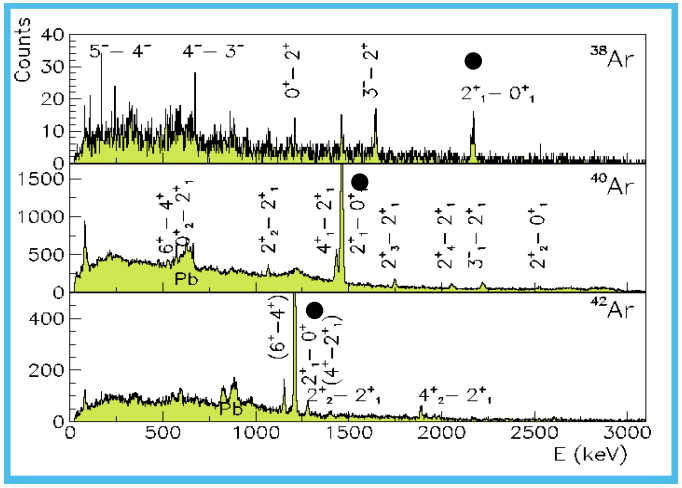
$\nu p_{1/2}, \nu p_{3/2}, \nu f_{7/2}$ and $\nu f_{5/2} \rightarrow 1/2^-, 3/2^-, 5/2^-, 7/2^-$



The evolution of the collectivity







In odd isotopes, a significant population of 11/2- states have been observed.
Their structure was explained in terms of coupling of the valence neutron to the vibration quanta.

This offers the possibility to follow the development of collectivity in odd Ar isotopes, a phenomenon widely discussed in even-even isotopes.

D. Mengoni et al, Phys. Rev. C 82 (2010) 024308.
S. Szilner et al, Phys. Rev. C in press.

Summary

Multinucleon transfer reactions have been investigated in 40Ar+208Pb with the Prisma+Clara set-up.

In even Ar isotopes we observed the strong population of yrast states.

In odd Ar isotopes, beside the state of single particle character, we reported a significant population of 11/2– states (new in 41Ar and 43Ar).

Their structure were described as a stretched configuration of the valence neutron coupled to vibration quanta (| 2+,f 7/2 >).

The individual state yield distribution in the final reaction products reflects a strong interplay between single-particle and collective degrees of freedom and reaction dynamics.

L. Corradi, E. Fioretto, A. Gadea, D. Montanari, E. Sahin, A.M. Stefanini, J.J. Valiente-Dobon, E. Farnea, G. Montagnoli, C.A. Ur, S. Lunardi, F. Recchia, G. Pollarolo, N. Marginean, F. Haas, S. Courtin, D. Lebhertz, A. Goasduff, M.-D. Salsac, D. Jelavić Malenica, T. Mijatović, N. Soić

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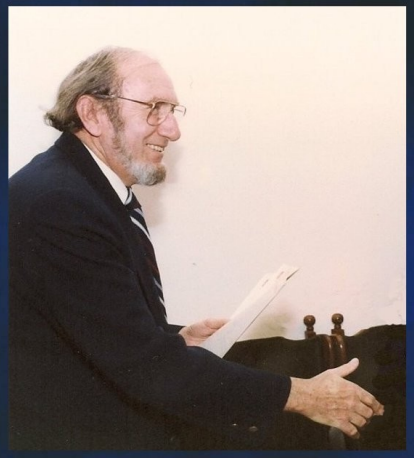
Highlights in Heavy-Ion Physics

Symposium in Honour of Nikola Cindro



TOPICS:

Clustering in nuclear structure and nuclear reactions
Nuclear matter

http://symposium-cindro.irb.hr/

September 22. - 24. 2011, Split, Croatia