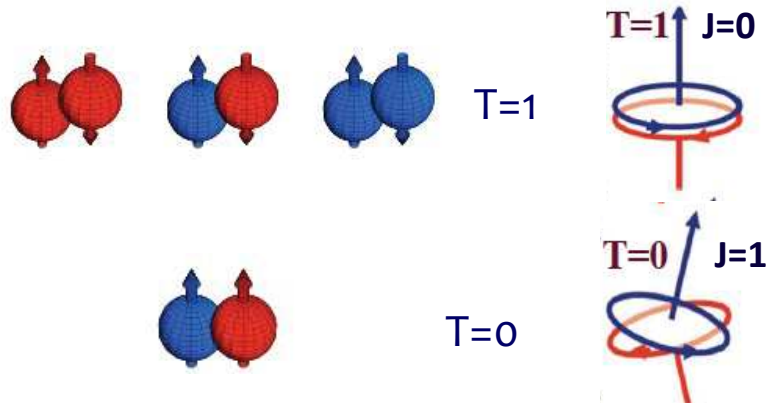


Experimental and theoretical aspects of neutron-proton pairing

Workshop Summary

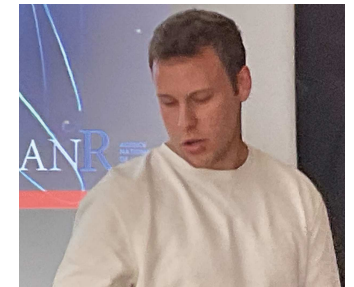
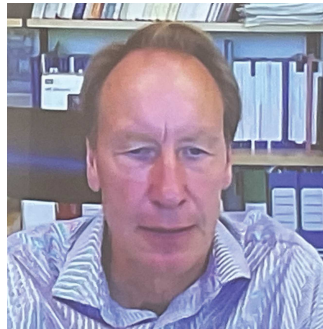
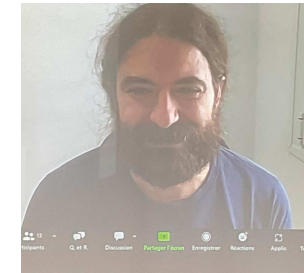
Experimental and theoretical aspects of neutron-proton pairing

Workshop Summary



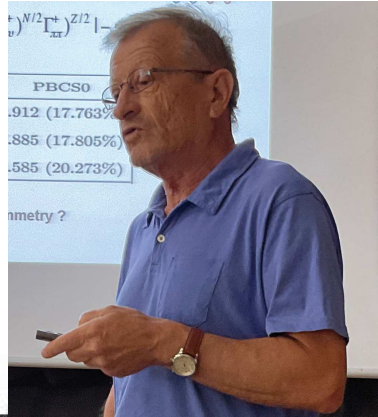
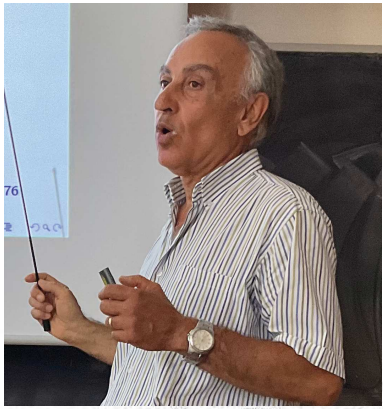
I'm hunting
neutron-proton
pairs!

We heard talks both experimental.....

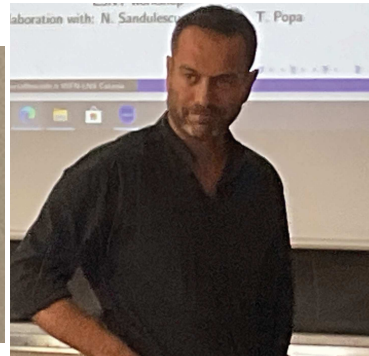
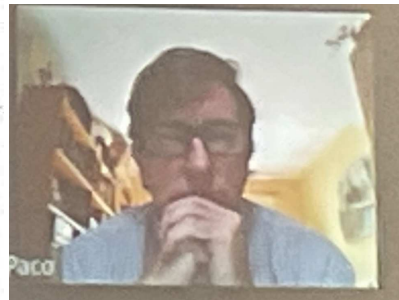
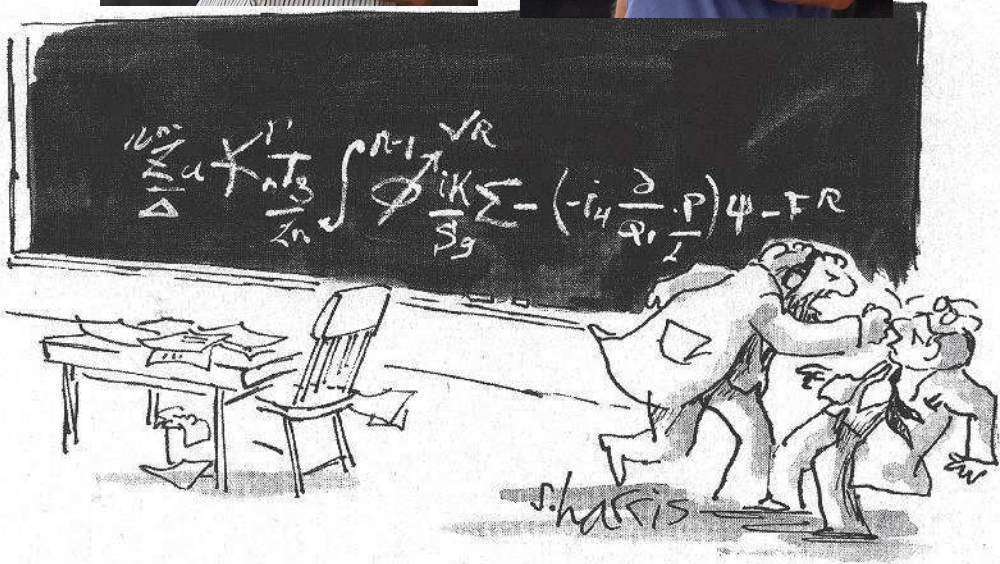
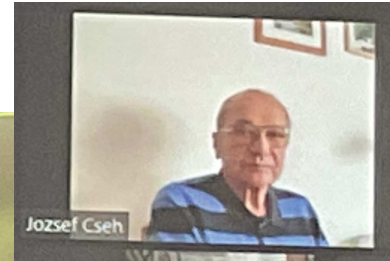
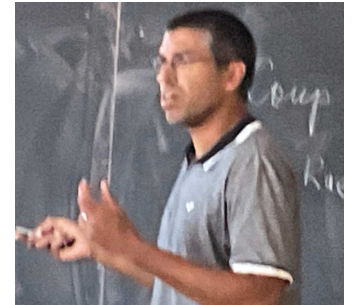
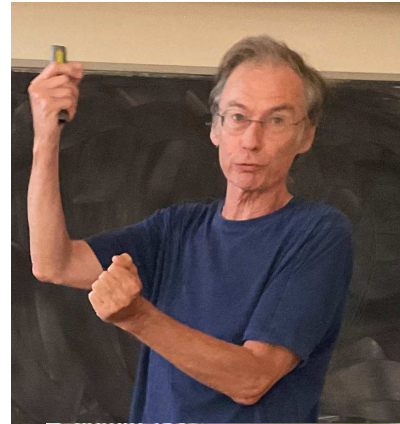
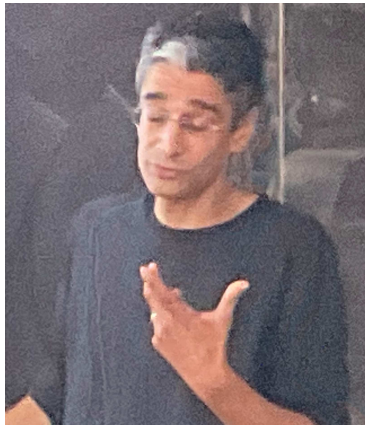


"The trouble is, professor, you see the Erlenmeyer flask half empty and I see it half full."

...and theoretical



PBCS0
.912 (17.763%)
.885 (17.805%)
.585 (20.273%)
metry?

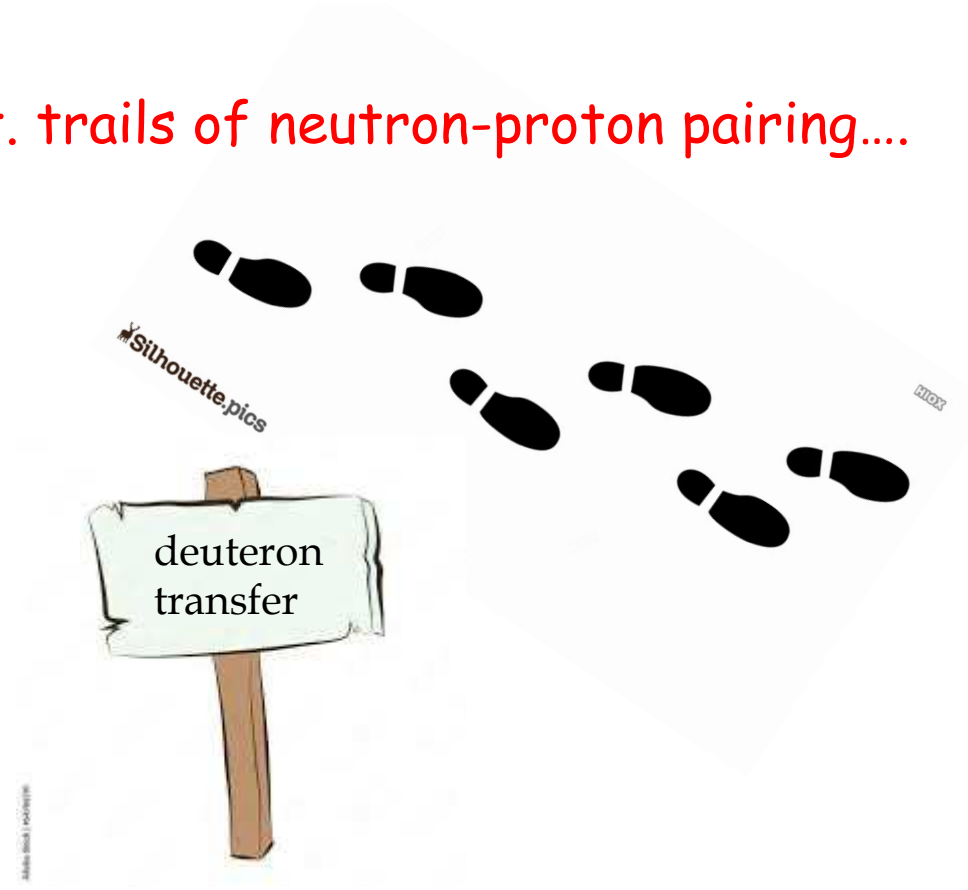


"YOU WANT PROOF? I'LL GIVE YOU PROOF!"

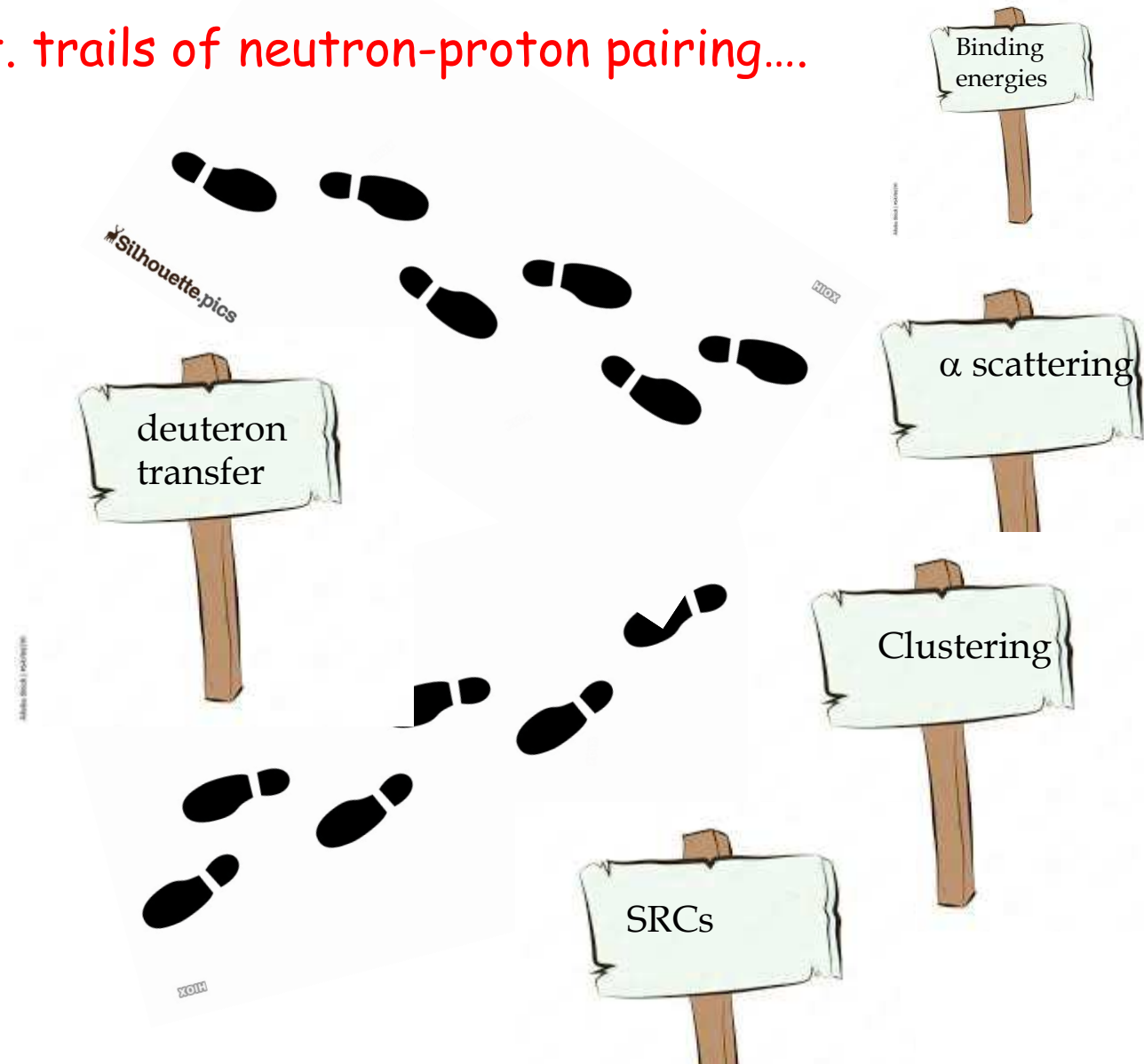
We mapped out possible expt. trails of neutron-proton pairing....



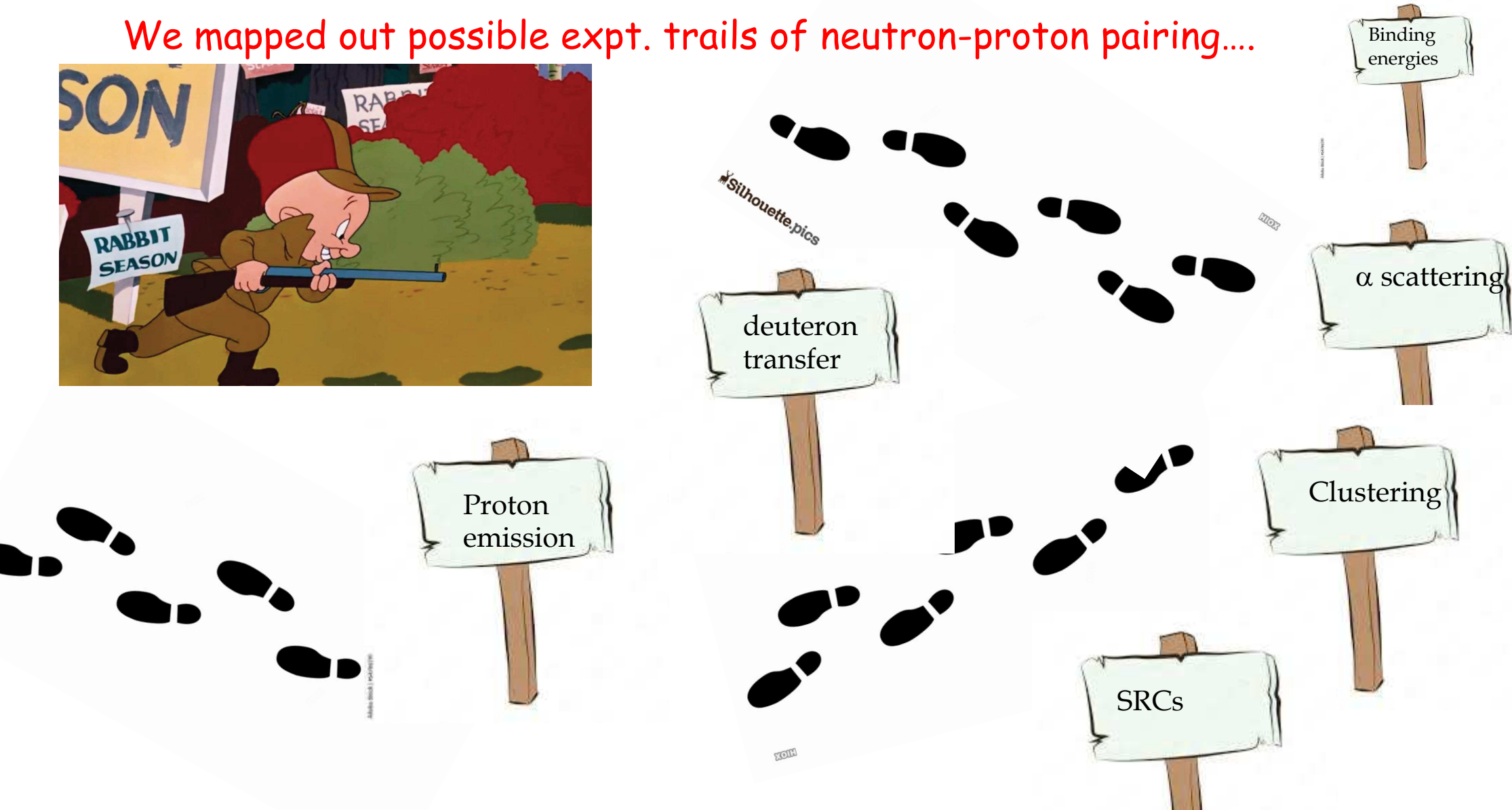
We mapped out possible expt. trails of neutron-proton pairing....



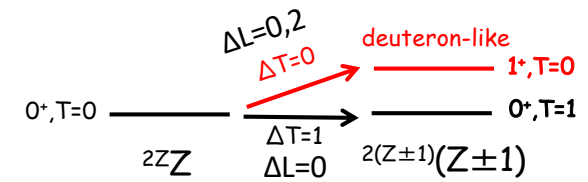
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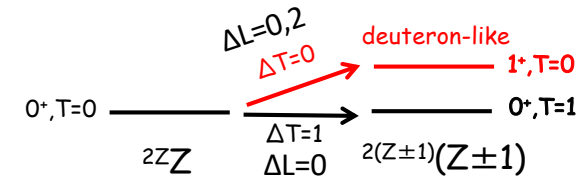


Some talks were directly on the trail of neutron-proton pairing....

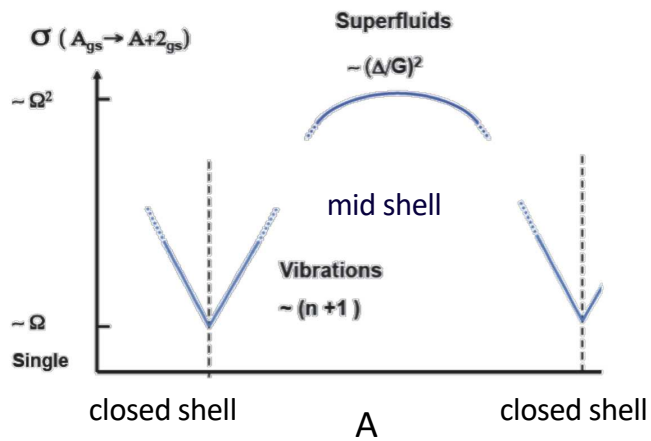


$2n$ transfer reactions: (t,p) & (p,t)
 deuteron transfer reactions: (^3He ,p) and (p, ^3He)

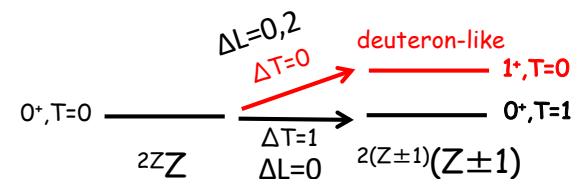
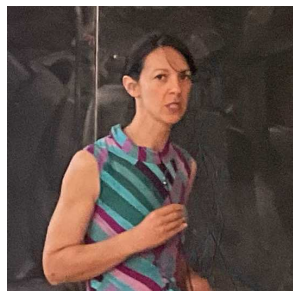
Some talks were directly on the trail of neutron-proton pairing....



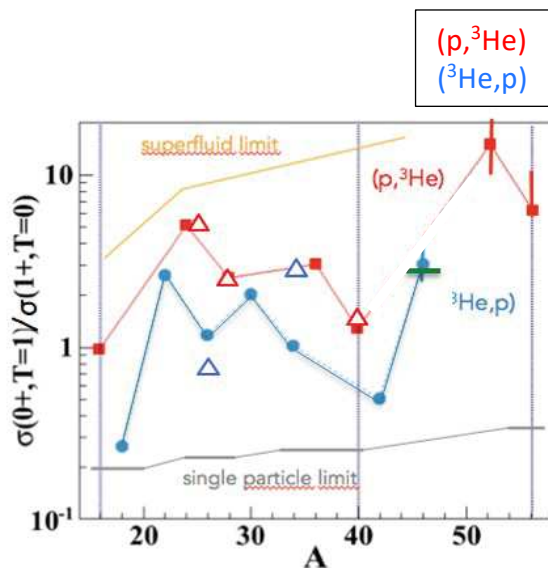
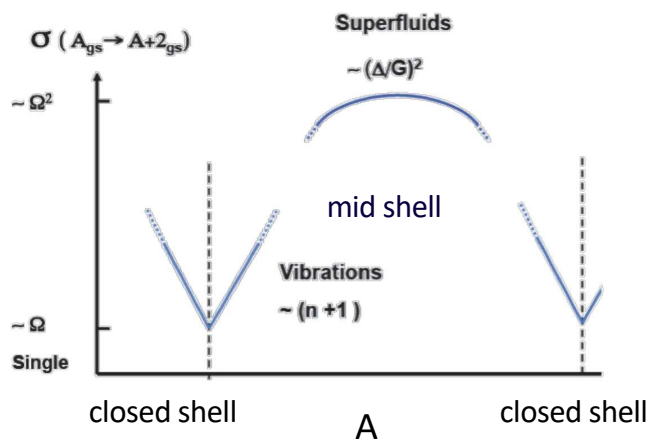
2n transfer reactions: (t,p) & (p,t)
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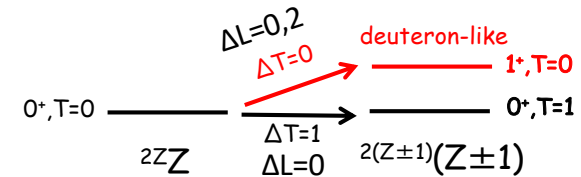
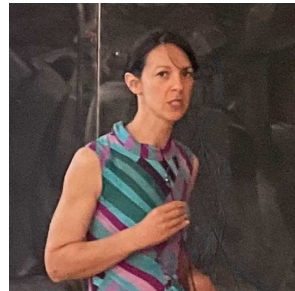
Some talks were directly on the trail of neutron-proton pairing....



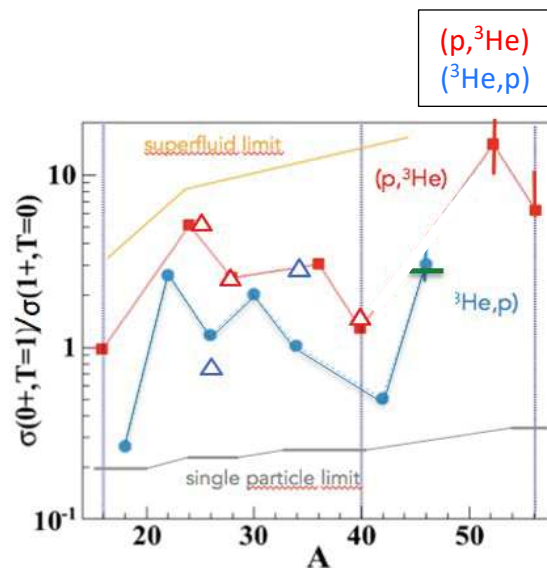
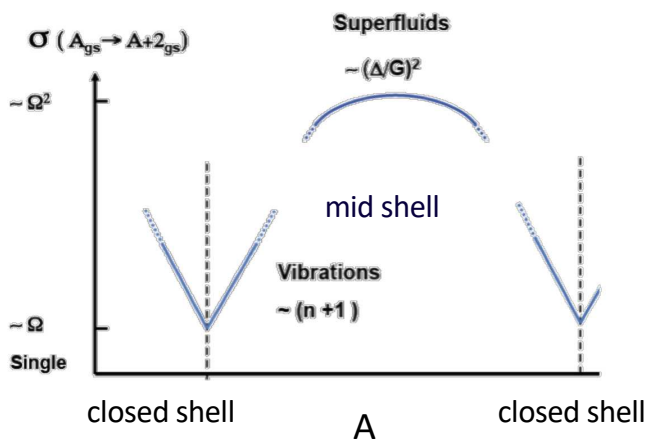
2n transfer reactions: (t,p) & (p,t)
 deuteron transfer reactions: (^3He ,p) and (p, ^3He)



Some talks were directly on the trail of neutron-proton pairing....



2n transfer reactions: (t,p) & (p,t)
 deuteron transfer reactions: (³He,p) and (p,³He)

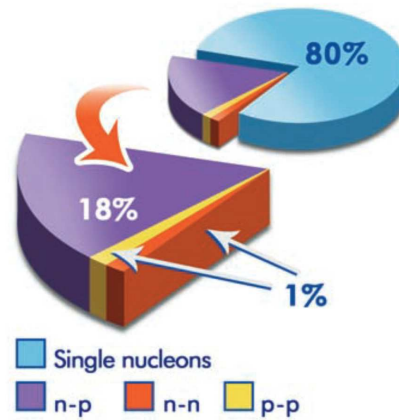
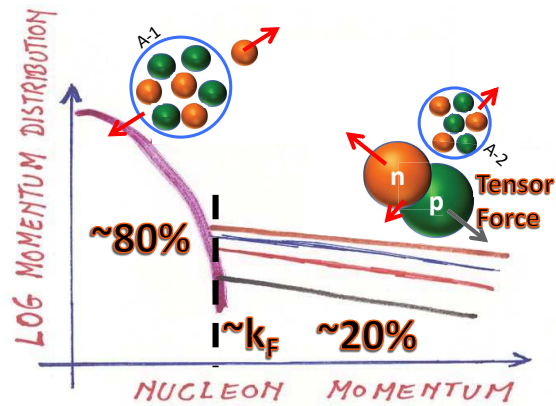


	$\sigma(0+, T=1)$ (μb)	$\sigma(1+, T=0)$ (μb)	Ratio
⁵⁶Ni(p, ³He)⁵⁴Co			
this work	109 ^{stat} ± 5 ± 10 ^{sys}	17 ^{stat} ± 7 ± 2 ^{sys}	6.3 ^{+3.1} _{-2.1}
SP	73	19	3.8
GXPFI	136	21	6.4
⁵²Fe(p, ³He)⁵⁰Mn			
this work	145 ^{stat} ± 12 ± 15 ^{sys}	16 ⁺²⁹ ₋₁₆ ± 2 ^{sys}	9.1 ^{+∞} _{-3.7}
SP	69	16	4.3
GXPFI	257	17	15.1

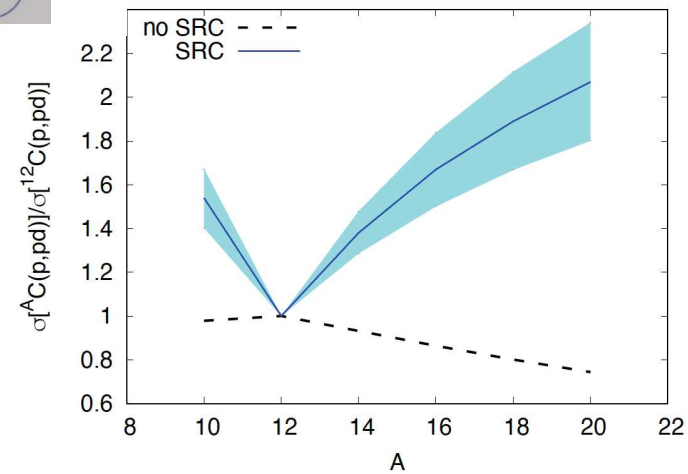
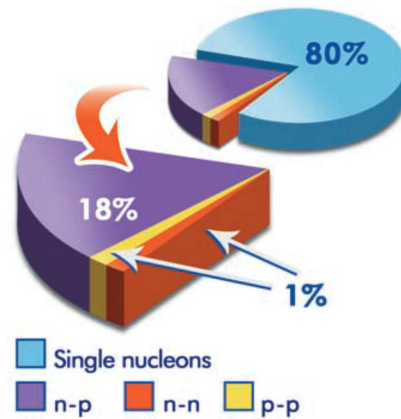
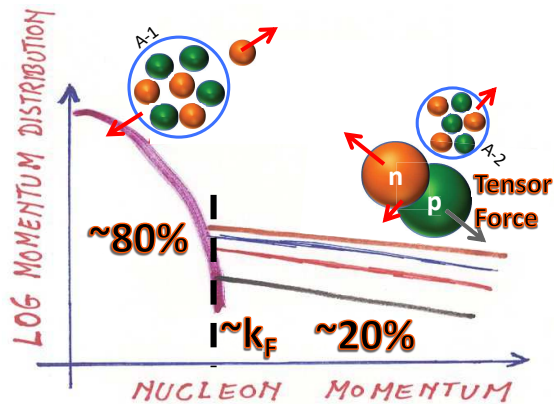
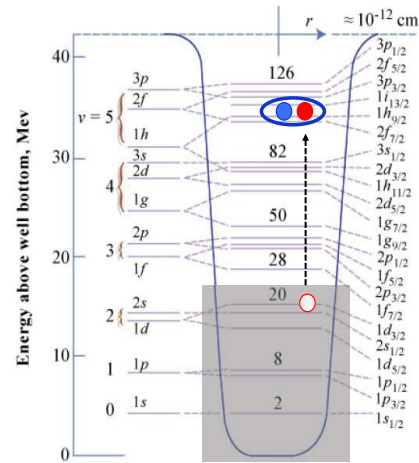
Some talks were directly on the trail of neutron-proton pairing....



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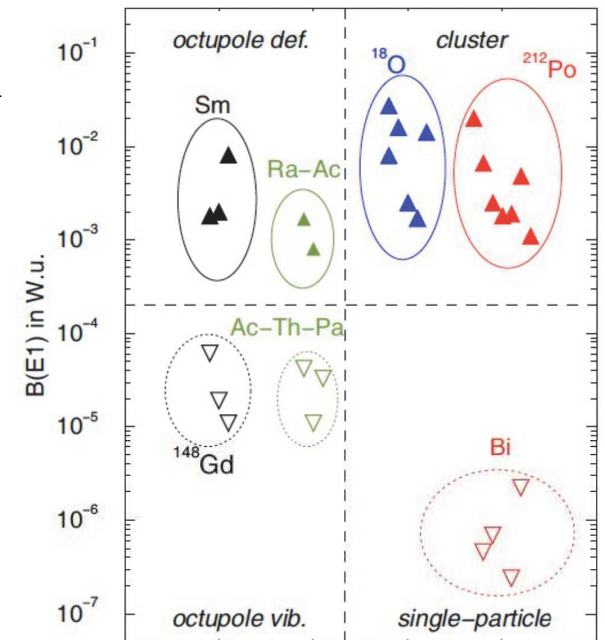
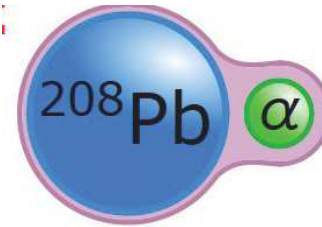
A prediction

...some were adjacent to the neutron proton pairs, often through clusters



C. Petrache: clusters in heavy nuclei

E1's too large to be explained by S.M., need alpha clusters

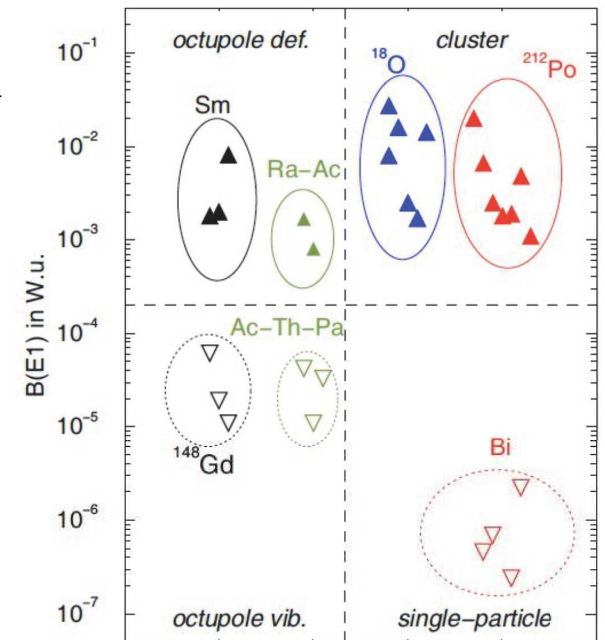
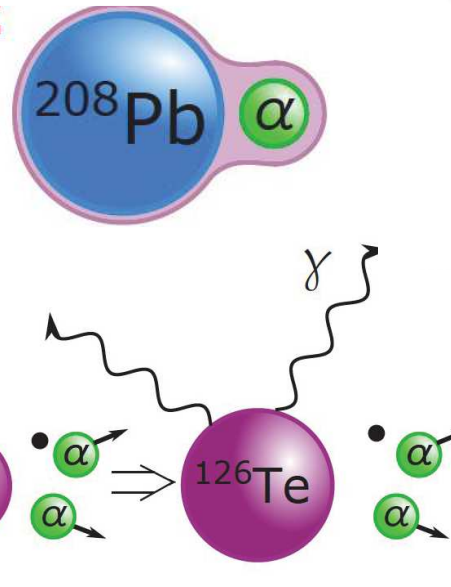


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C. Petrache: clusters in heavy nuclei

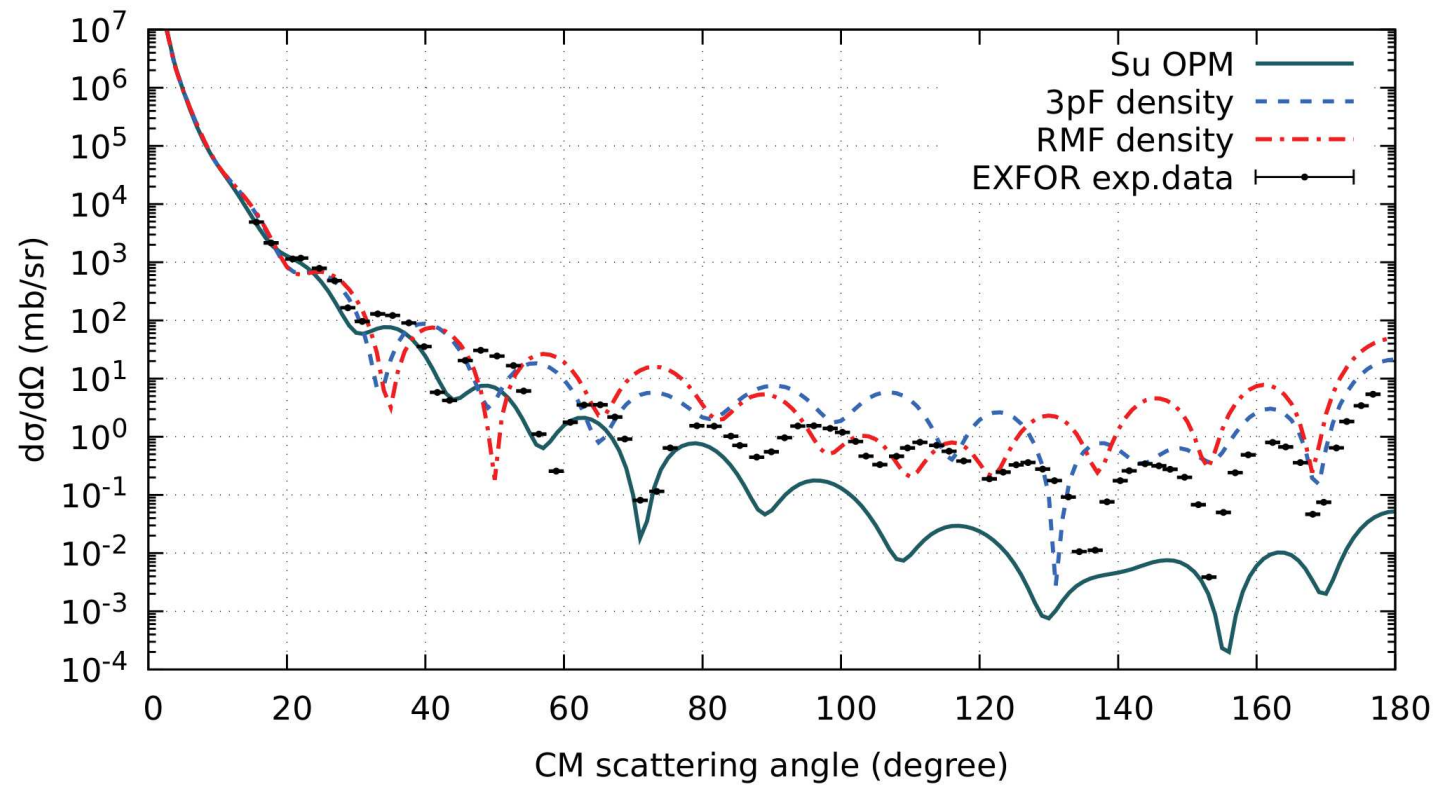
E1's too large to be explained by S.M., need alpha clusters



...some were adjacent to the neutron proton pairs, often through clusters



A. Serban: improved α -scattering through improved imaginary part of optical potential



...we also mapped out theoretical approaches..



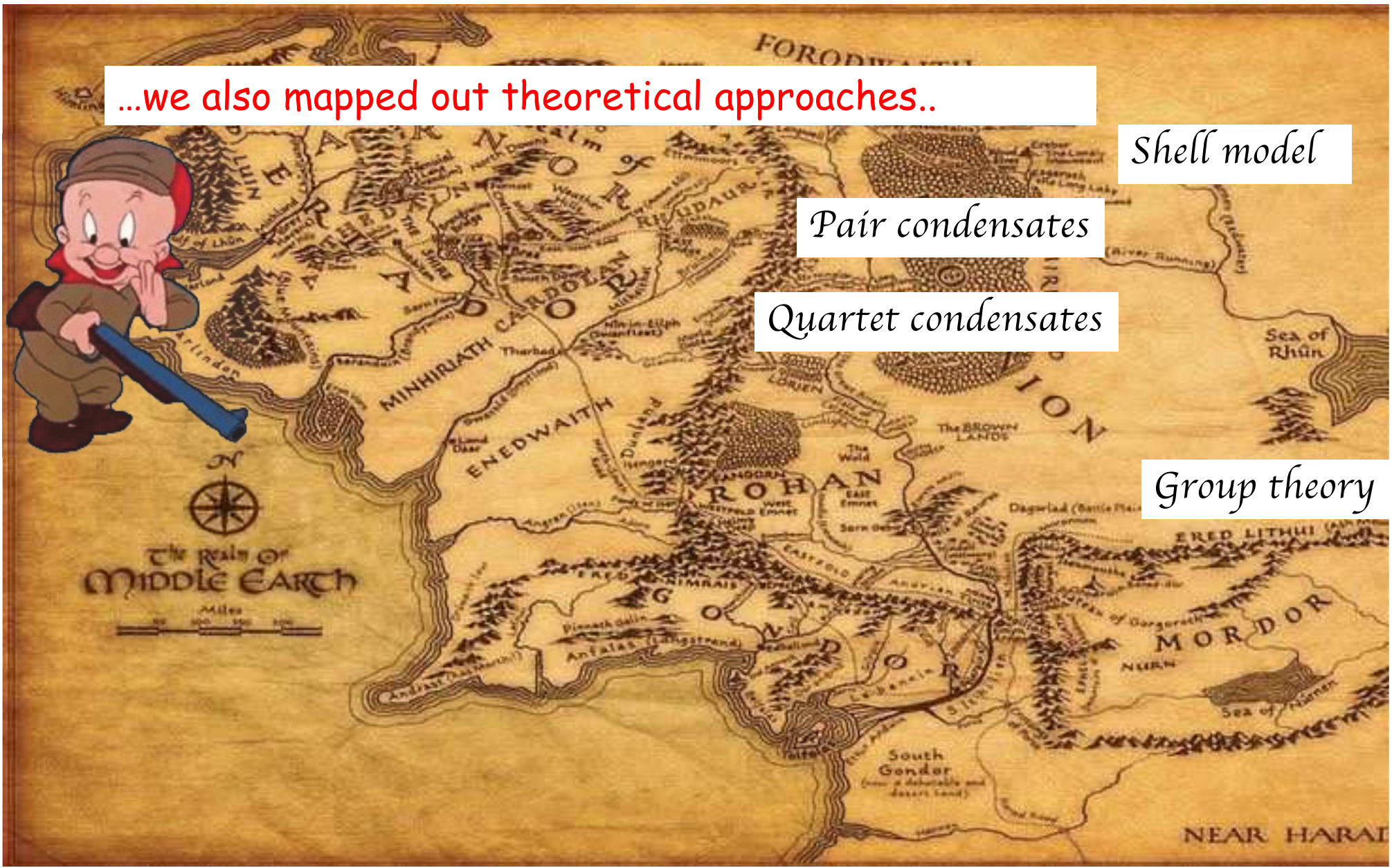
...we also mapped out theoretical approaches..

Shell model

Pair condensates

Quartet condensates

Group theory



...we also mapped out theoretical approaches..

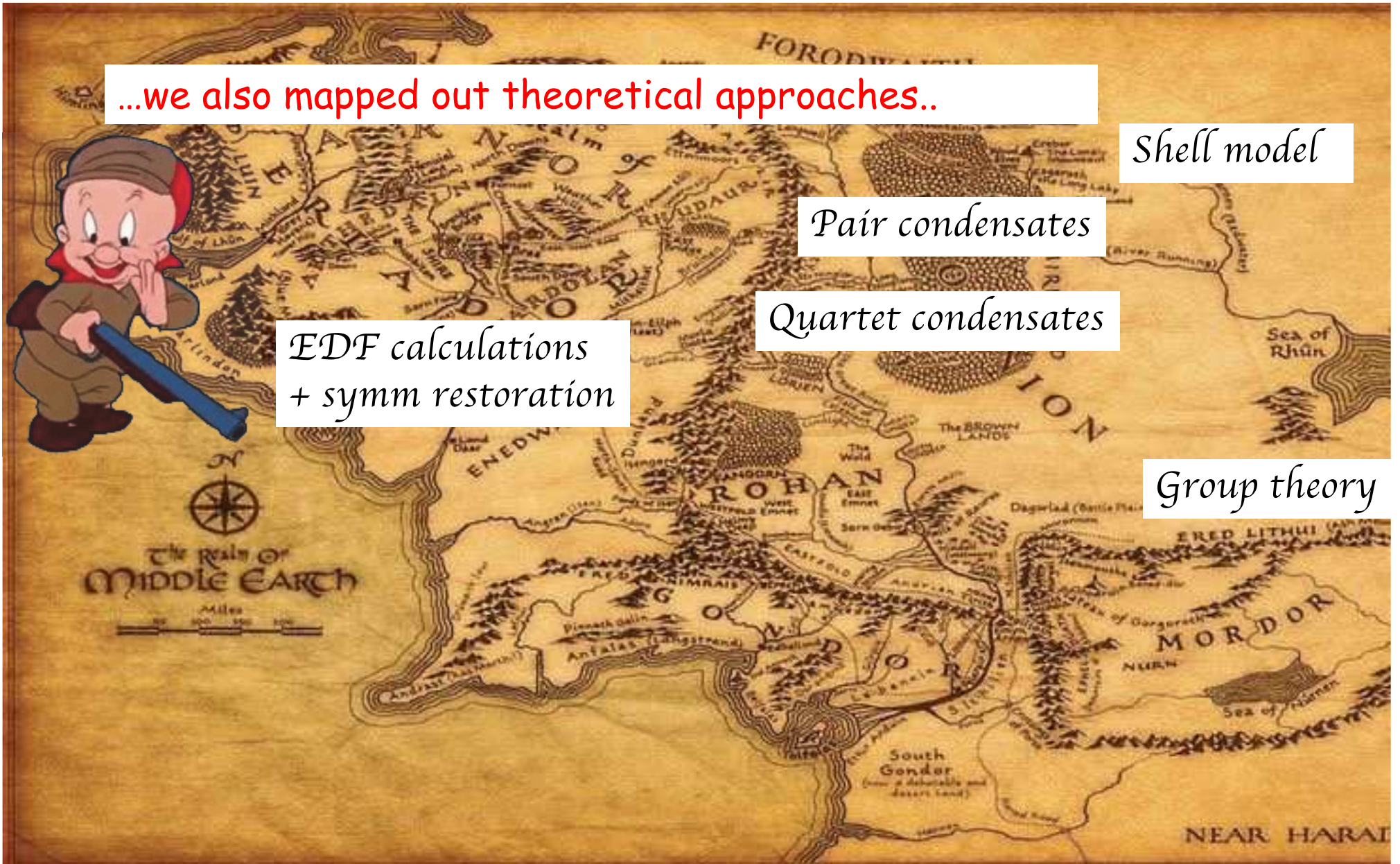
Shell model

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Quartet condensates

EDF calculations
+ symm restoration

Group theory



...we also mapped out theoretical approaches..

Shell model

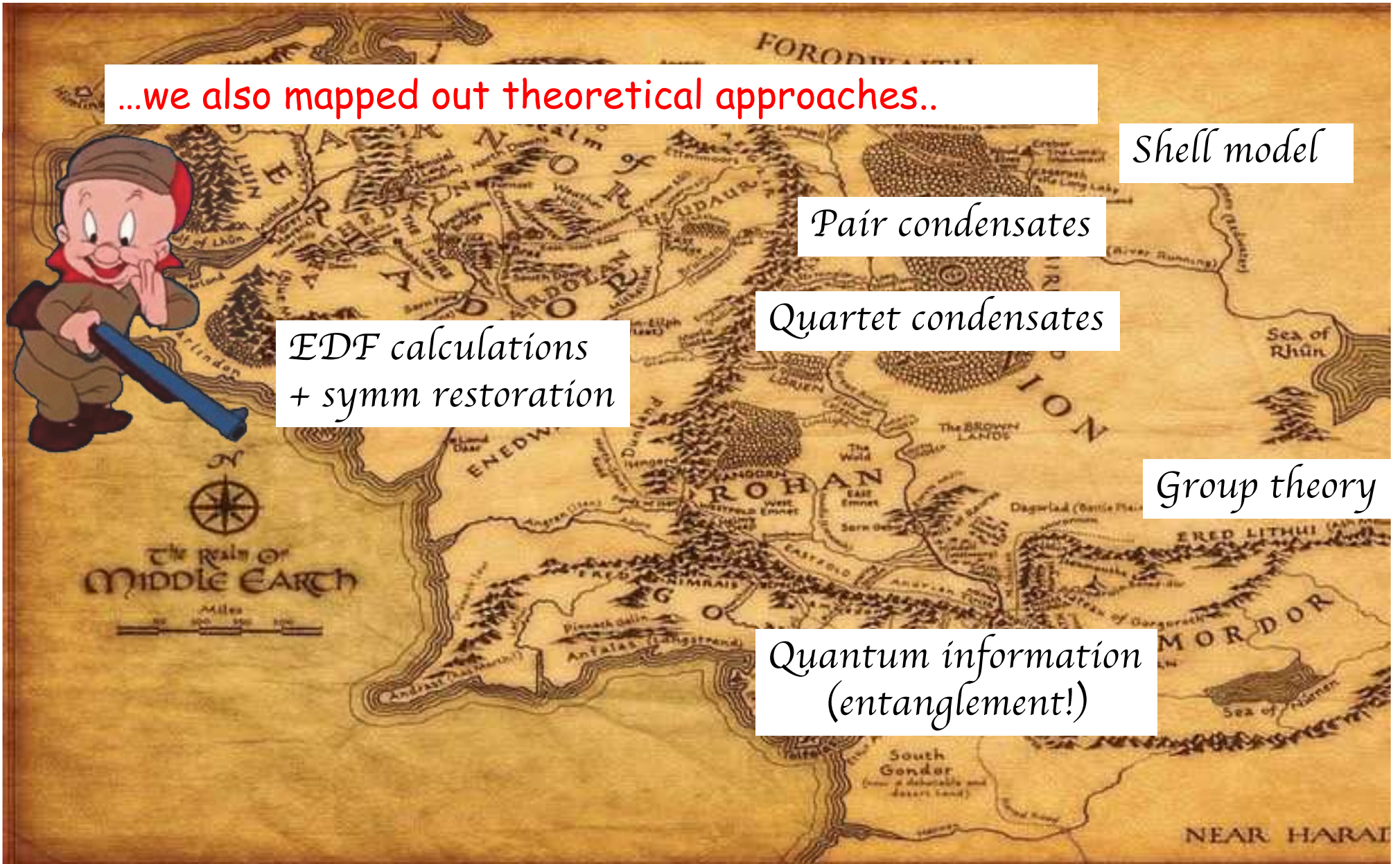
Pair condensates

Quartet condensates

EDF calculations
+ symm restoration

Group theory

Quantum information
(entanglement!)



A key idea is that neutron-proton pairs were often in disguise



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$$\bar{Q}_1^+ = 2\Gamma_1^+\Gamma_{-1}^+ - (\Gamma_0^+)^2,$$

After isospin projection,
pairs (especially np-pairs)
manifest as quartets!

A key idea is that neutron-proton pairs were often in disguise



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After isospin projection, pairs (especially np-pairs) manifest as quartets!



+

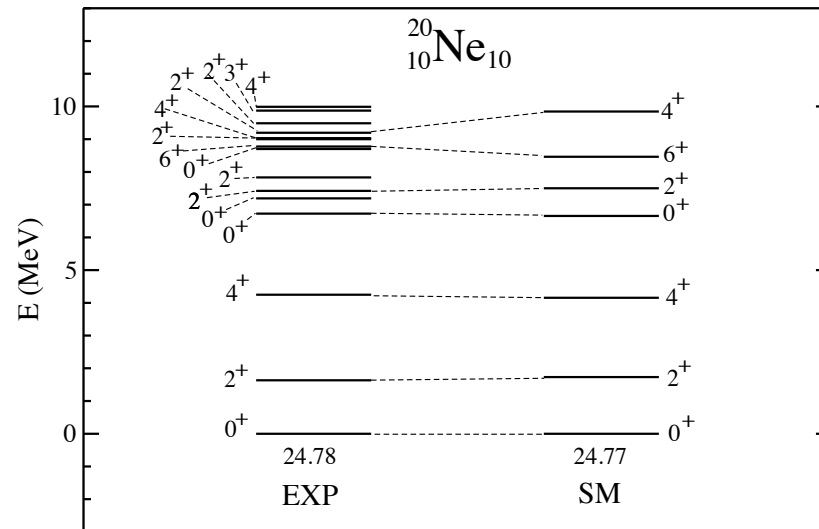


quartet model

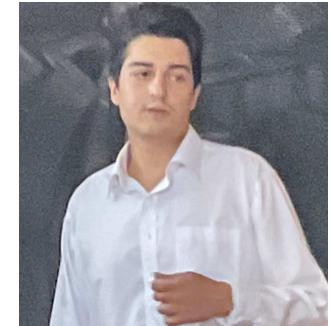
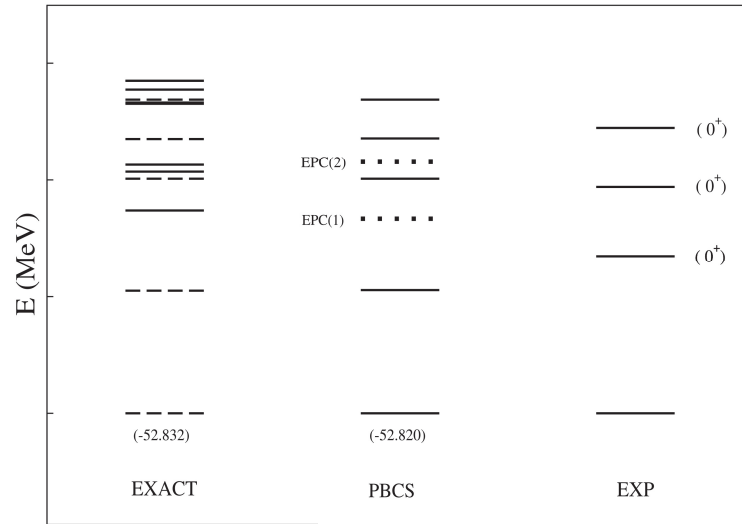
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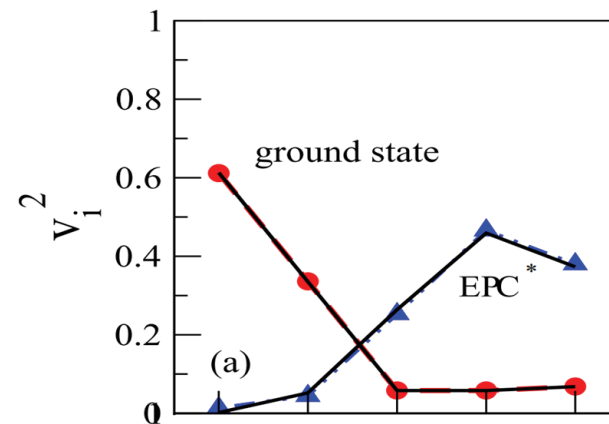
quartet model



A key idea is that neutron-proton pairs were often in disguise



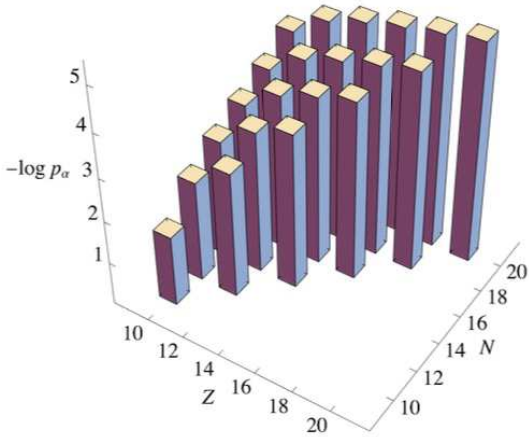
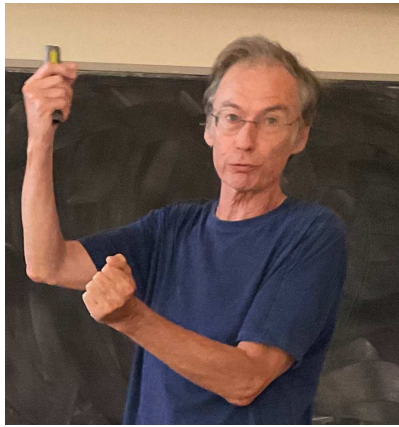
Occupation probabilities



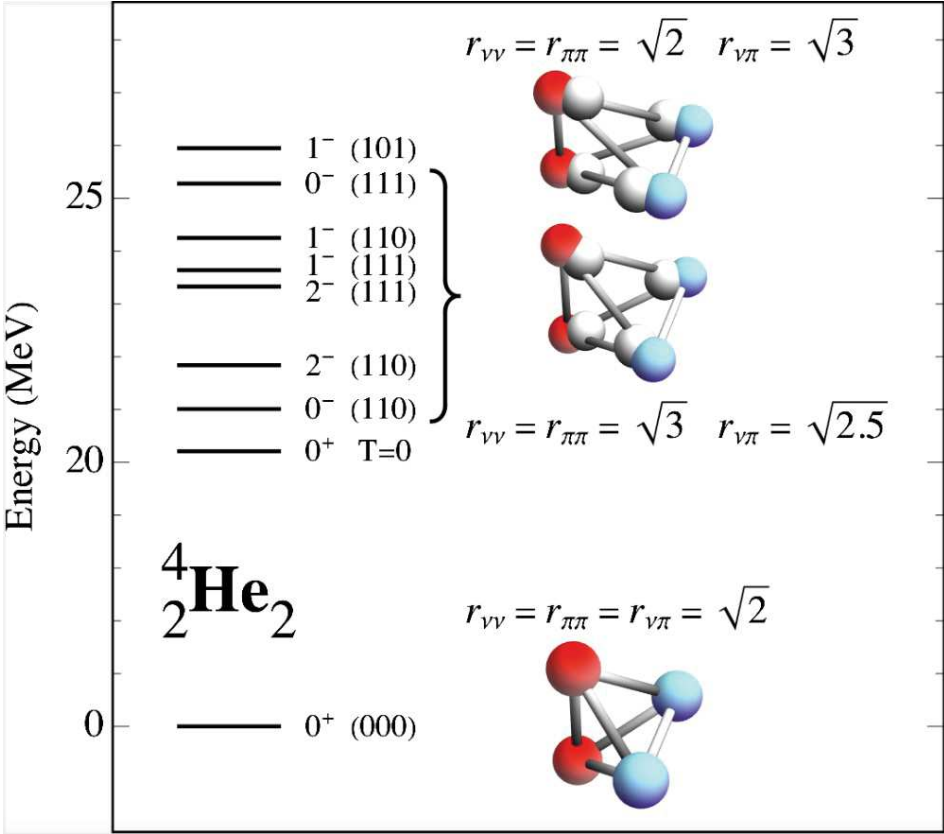
So much of our work was hunting for alpha and alpha-like clusters



So much of our work was hunting for alpha and alpha-like clusters



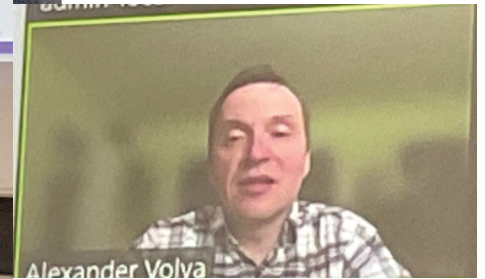
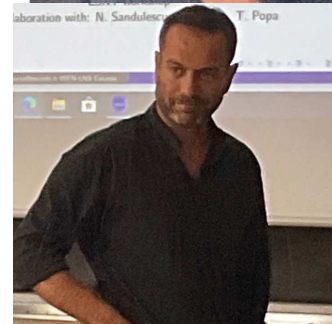
Tiny!



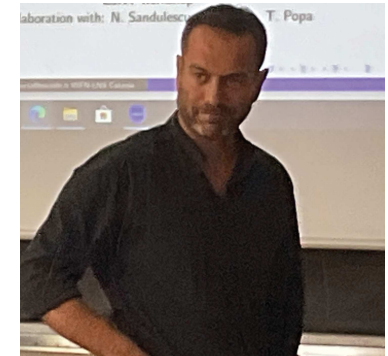
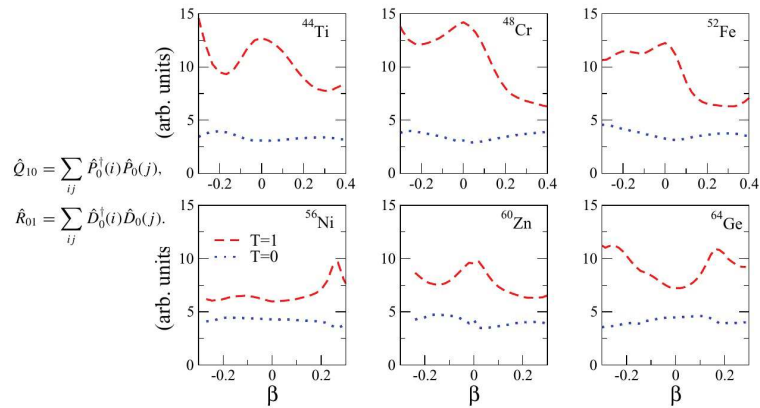
Hence we had clusters of talks on clusters....



Hence we had clusters of talks on clusters....



Hence we had clusters of talks on clusters.....



T=1 pairs stronger than T=0 pairs

Many of these followed the theme of projection to get clusters

Hence we had clusters of talks on clusters.....

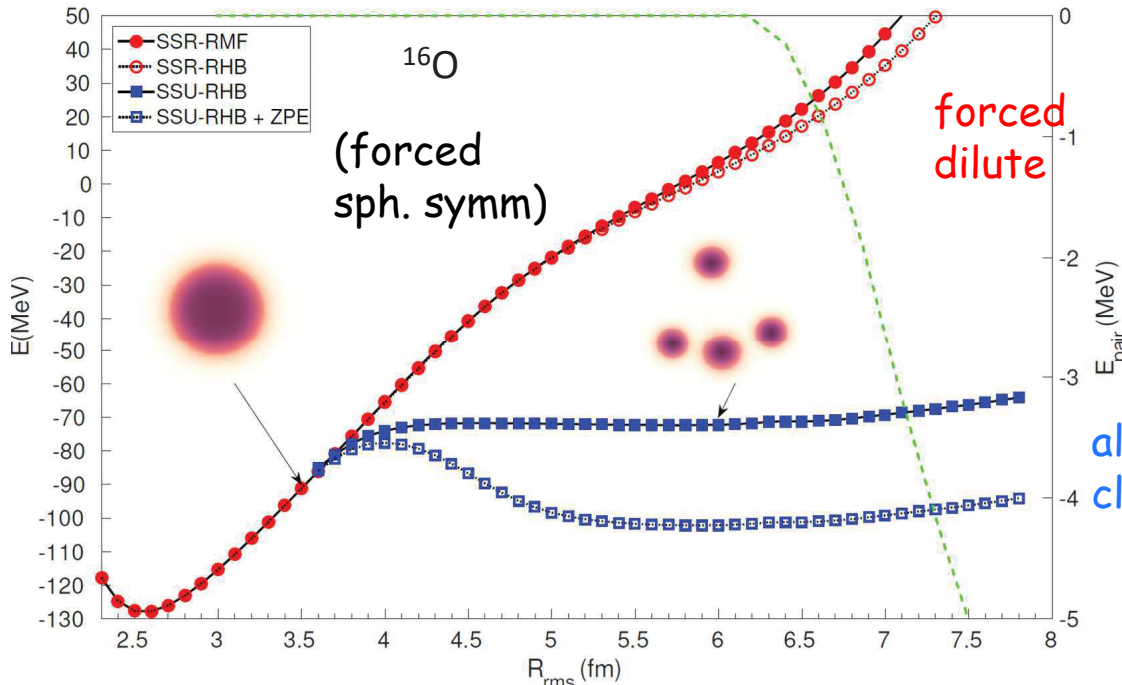
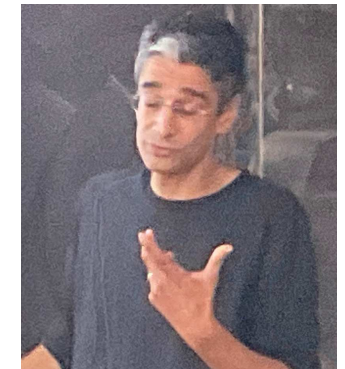
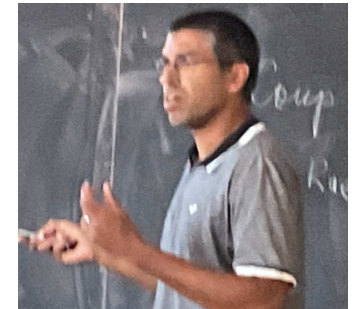
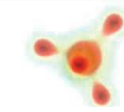
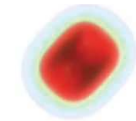


Strength of correlations measured by dimensionless ratios

$$\sqrt{\Lambda} \equiv \sqrt{\frac{\langle V \rangle}{\langle T \rangle}} \sim \alpha_{\text{loc}}$$

small

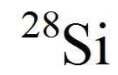
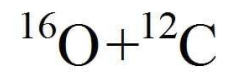
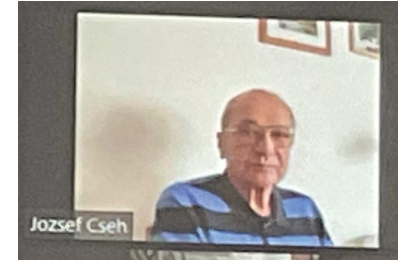
large



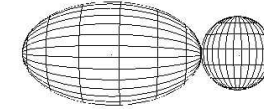
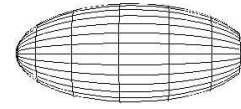
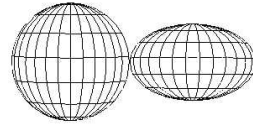
allowed to clusterize

Many of these followed the theme of projection to get clusters

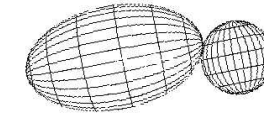
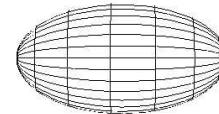
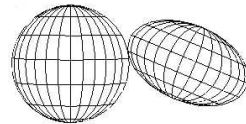
Hence we had clusters of talks on clusters....



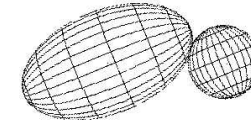
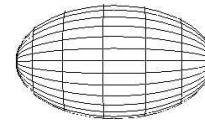
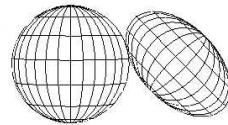
Quant. no.



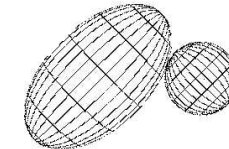
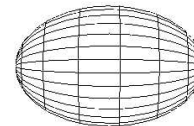
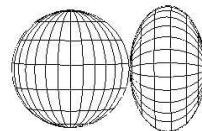
4[28,8,4]



2[24,8,6]



1[22,8,7]



0[20,8,8]

Finally, other talks were more ... 'abstract'



Finally, other talks were more ... 'abstract'



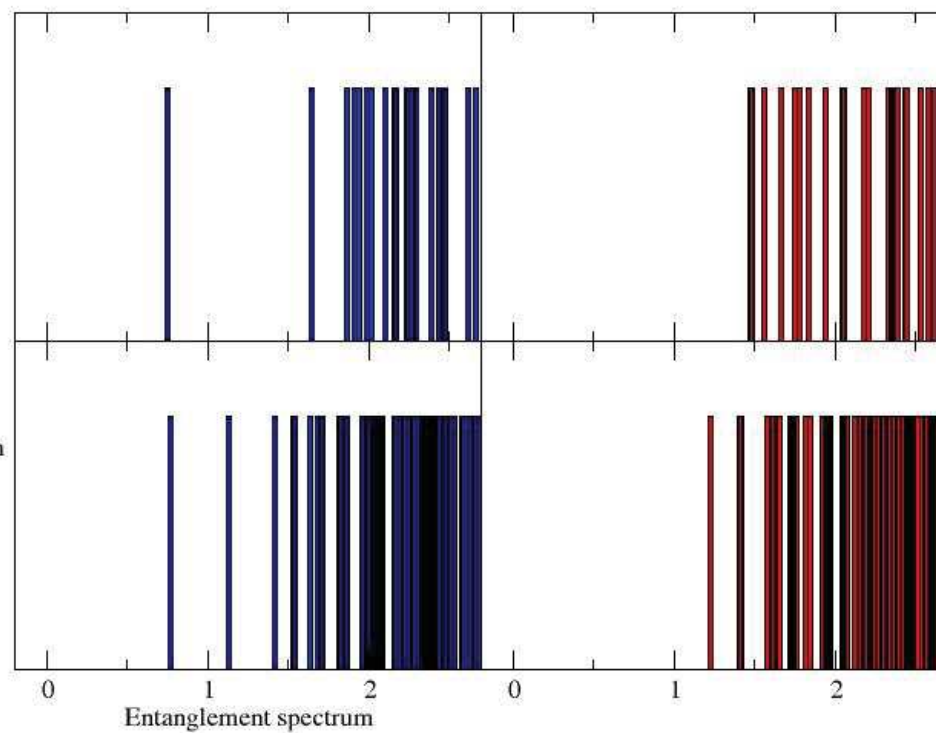
'ENTANGLEMENT!'



Adobe Stock / 180581538

USDB (traceless)

random



Any good workshop
adds more questions
than it answers





Are we using
the right
tools?



Are we using
the right
tools?



Shell
model



Algebraic
models



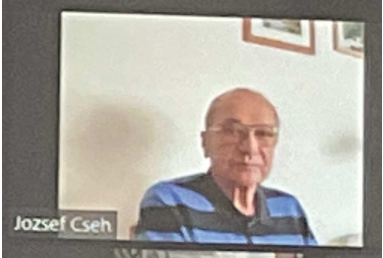
Cluster
condensates



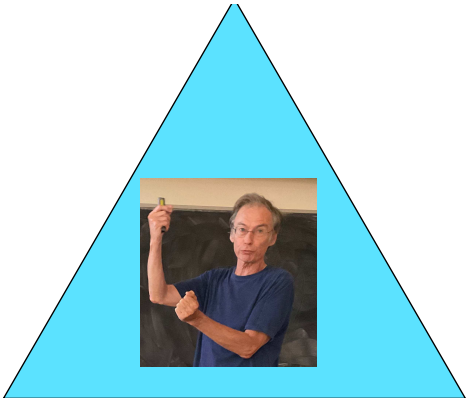
Mean-field
+ projection



Are we using
the right
tools?



(non-interacting shell model)



SU(2)
(pairing)

SU(3)
(deformation)

SO(3)

cluster
model

SU(3)

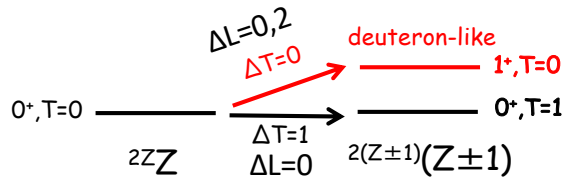
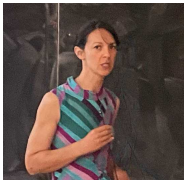
O(4)



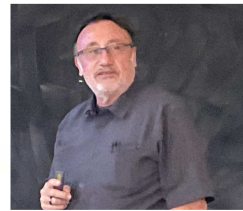
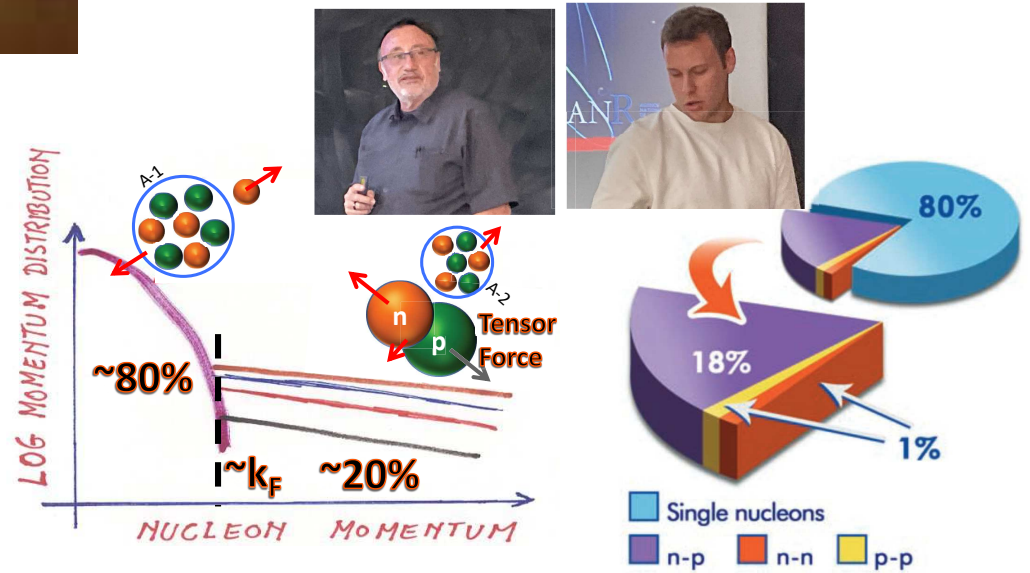
Are we
looking in the
right places?



Are we looking in the right places?



2n transfer reactions: (t,p) & (p,t)
 deuteron transfer reactions: (³He,p) and (p,³He)

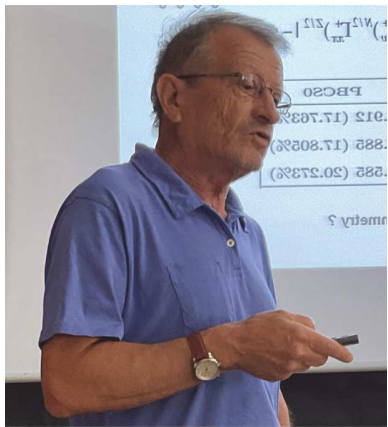




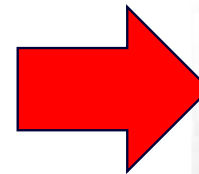
Could something
block the
'fingerprint' we're
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Or could some structures be disguised as something else?

We're still waiting to see if
neutron-pairing plays a strong role in
nuclear physics....

or is just some fantastical story we tell

