INSTITUTO GALEGO DE FÍSICA DE ALTAS ENERXÍAS

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$\nu 0p_{1/2} - \nu 0p_{3/2}$ spin-orbit splitting in ^{20}O

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AGENCIA ESTATAL DE INVESTIGACIÓN

EXCELENCIA MARÍA DE MAEZTU 2024-2029

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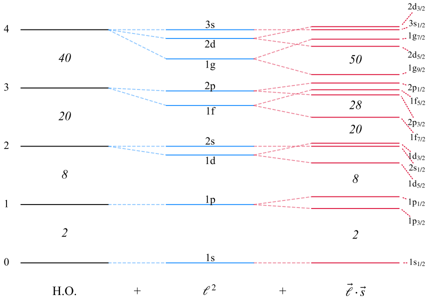
A recap on the SO splitting

Introduced by M. Goeppert-Mayer, the SO potential successfully reproduces magic numbers in stable nuclei.



It is mainly a surface effect:

$$\mathrm{V}_{\mathrm{SO}} = -\frac{1}{\hbar^2}\mathrm{V}_{\mathrm{so}}(\vec{l}\cdot\vec{s})\left(\frac{1}{r}\frac{dV}{dr}\right)$$

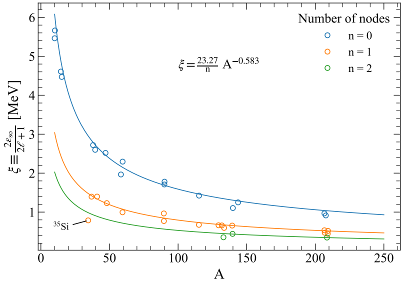
yielding a ℓ-dependent gap:

$$\Delta_{\mathrm{so}} = \frac{\hbar^2}{2}(2\ell+1)\xi$$

$\Rightarrow$ Expected to evolve towards more exotic nuclei, as surface blurs and hence $\xi \sim dV/dr$ changes.

A recap on the SO splitting

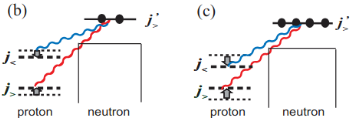
G. Mairle *et al.* (PLB 304 (1993)) found systematic trends easily parametrizable.



Deviations from the trend are found due to:

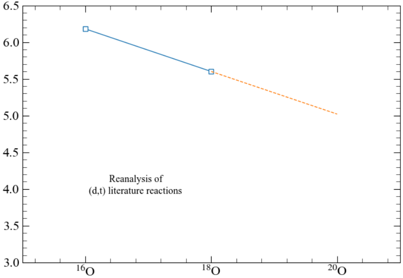
1. Loosely bound orbitals
2. Nuclear matter deplection (^{35}Si?)
3. Role of **tensor force**

Proton-neutron interactions drive **shell evolution**



SO gap for $Z = 8$ isotopes

Evolution of the SO gap is plotted below for neutron-rich O isotopes.



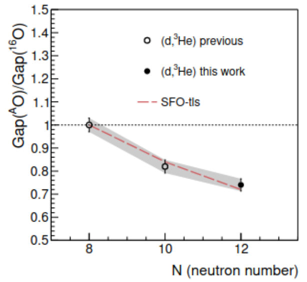
Will ^{20}O follow the trend?

Could be determine tensor $\pi\nu$ contribution?

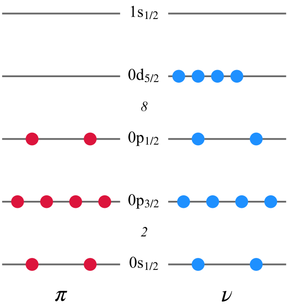
Physics case

Transfer reactions to probe single-particle occupancies in ^{20}O.

1 $Z = 6$ SO gap with $^{20}\mathrm{O}(\mathrm{d}, {}^{3}\mathrm{He})^{19}\mathrm{N}$



J. Lois-Fuentes, PhD thesis (2023)

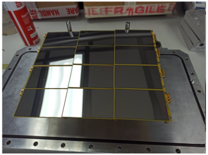


IPSM of ^{20}O

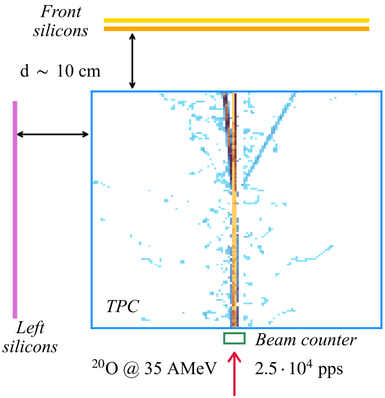
2 $N = 6$ SO gap through $^{20}\mathrm{O}(\mathrm{d}, \mathrm{t})^{19}\mathrm{O}$ main objective of this analysis

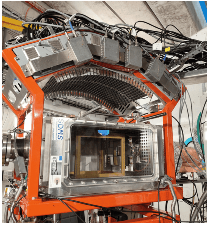
Experimental setup

E796 @ LISE in 2022. First transfer experiment with ACTAR TPC!



Silicon sizes:
$80 \times 50 \times 0.5\text{mm}^3$

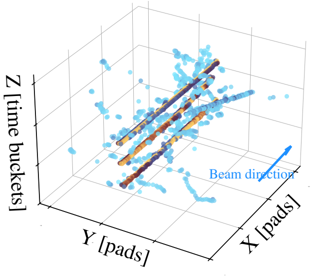


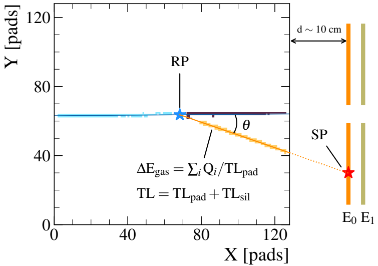


Gas setup:
$90\,\%$ D_2 + $10\,\%$
iC_4H_{10}
@ 950 mbar

A window to the analysis

Intricate analysis to extract reactions of interest out of noisy data.





Conversely, the TPC offers unique advantadges:

1 Precise **vertex** determination

2 Improved ΔE corrections

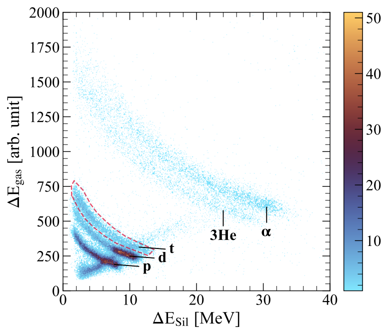
3 Factor 10 in target number

4 Implicit PID with ΔE_{gas}

A window to the analysis

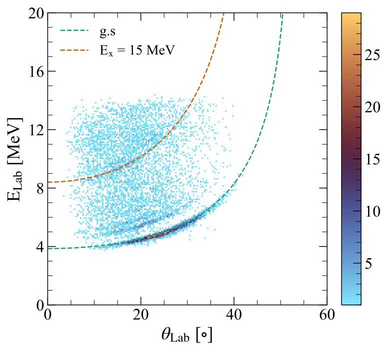
Two steps needed after data has been processed.

1 Triton identification in PID

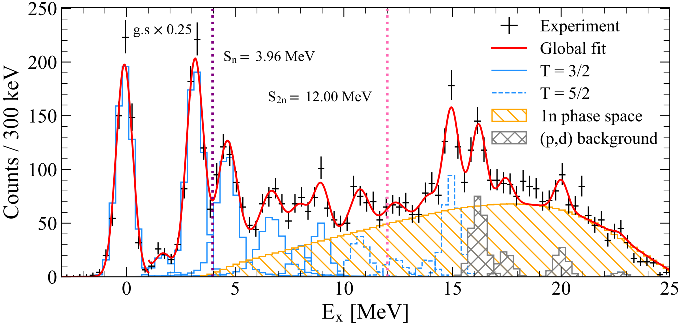


Vetoing punch-through to 2nd front layer

2 Reconstruct E_x by **missing-mass** technique



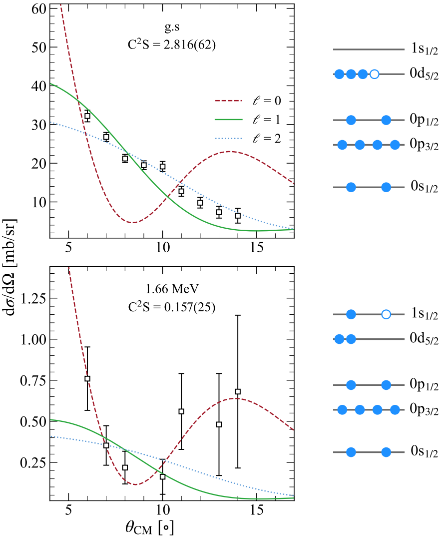
Results: E_x spectrum



11 observed states!
(p,d) background at high E_x

T assigments based on comparison with $^{20}O(d, ^{3}He)^{19}N$

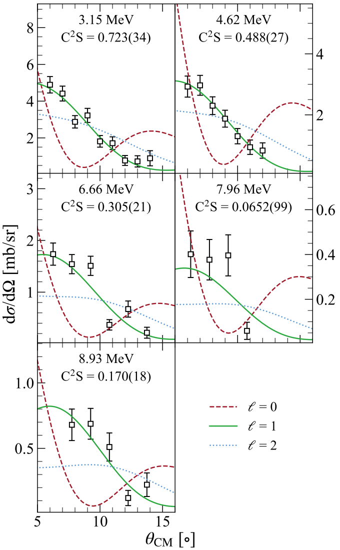
Results: cross-sections



Ground-state perfectly reproduced by $\ell = 2$ line

Lowly populated $\ell = 0$

Results: cross-sections



Ground-state perfectly reproduced by $\ell = 2$ line

Lowly populated $\ell = 0$

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