INSTITUTO GALEGO DE FÍSICA DE ALTAS ENERXÍAS

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Quenching of spectroscopic factors in ^{10,12}Be(d, ^{3}He) reactions

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AGENCIA ESTATAL DE INVESTIGACIÓN

EXCELENCIA MARÍA DE MAEZTU 2024-2029

XUNTA DE GALICIA

CENTROS

Cofinanciado por la Unión Europea

Fondos Europeos

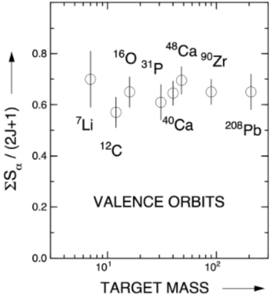
A recap on spectroscopic factors

Spectroscopic factors shed light on the occupancy of single-particle states:

$$\left.\frac{d\sigma}{d\Omega}\right|_{exp} = C^2S\cdot\left.\frac{d\sigma}{d\Omega}\right|_{s.p}, \quad C^2S = \begin{cases} (2j+1) & \text{removing} \\ 1 & \text{adding} \end{cases} \quad \text{in IPSM}$$

Experimentally:
Reduction of ~ 65 %!

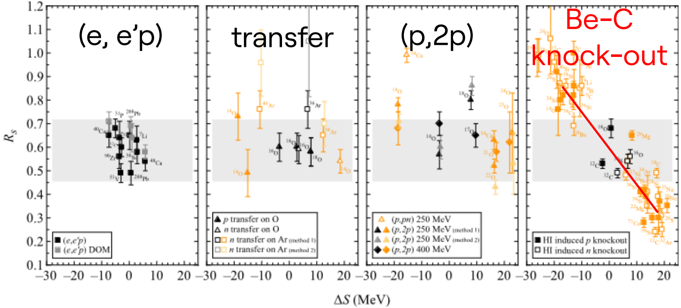
- **Short-range** correlations: tensor forces,...
- **Long-range**: vibrations, giant resonances,...



L. Lapikás, Nuclear Phys. A 553 (1993)

A long-standing puzzle

A trend with asymmetry energy $\Delta S \equiv S_n - S_p$ is found depending on the experimental **probe**!



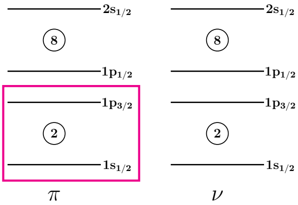
T. Aumann et al. Prog. Part. Nucl. Phys. 118 (2021)

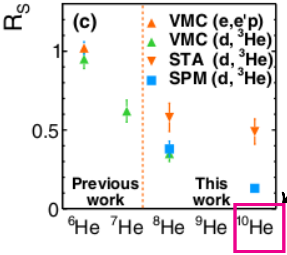
$\Rightarrow$ measure towards more exotic nuclei: $|\Delta S| \uparrow$

Status with light isotopes

Several experiments allowed for the extraction of C^2S with Li-induced (d, ^{3}He) reactions:

Explored region





Unbound!

A. Matta et al., Phys. Rev. C 92 (2015)

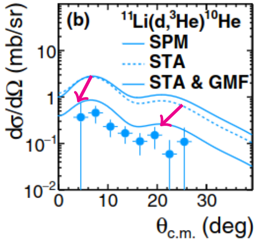
Several challenges in this region:

1 Dealing with **unbound** nuclei (^{10}He)

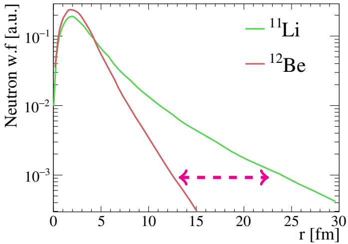
2 Many-body dynamics and/or core excitations

Importance of GMF

Towards exotic nuclei (loosely bound or halo), a ***geometrical mismatch factor*** emerges from the very different w.f. in the overlap:



A.Matta et al., Phys. Rev. C 92 (2015)



N. K. Timofeyuk, private communication (in E748 proposal)

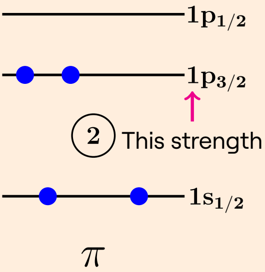
⇒ Need to establish more systematics for this parameter

Physics case of E748

E748 @ GANIL back in 2017. Using ^{10,12}Be(d,^{3}He) reactions to:

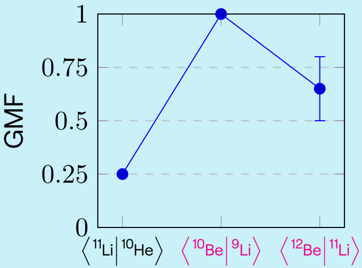
Overlaps:

- $\left\langle {}^{10}\text{Be} \middle| {}^{9}\text{Li} \right\rangle, \Delta S = -12.8\,\text{MeV}$
- $\left\langle {}^{12}\text{Be} \middle| {}^{11}\text{Li} \right\rangle, \Delta S = -19.8\,\text{MeV}$



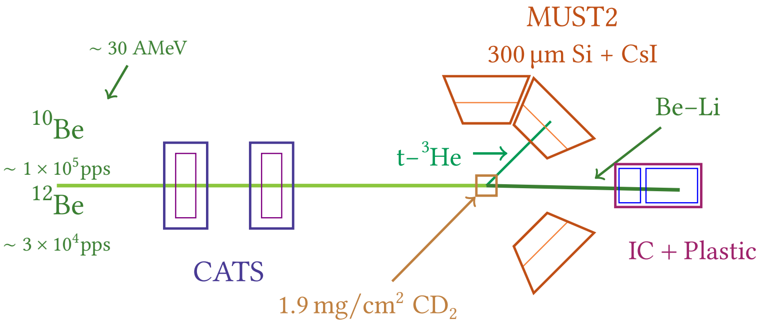
Explore effects of GMF:

- $\left\langle {}^{10}\text{Be} \middle| {}^{9}\text{Li} \right\rangle$, GMF ~ 1
- $\left\langle {}^{12}\text{Be} \middle| {}^{11}\text{Li} \right\rangle$, GMF $\sim 0.5?$



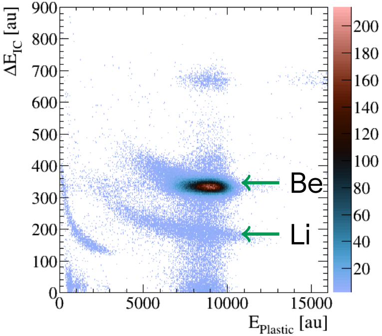
Experimental setup

Tradional solid target experiment @ LISE

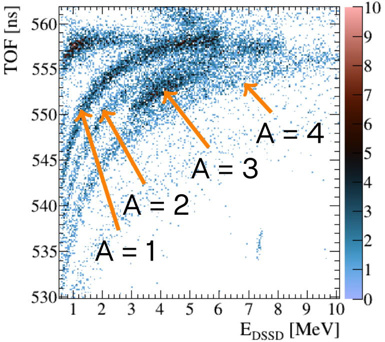


A glance at the analysis

1 **Heavy** ID at 0°



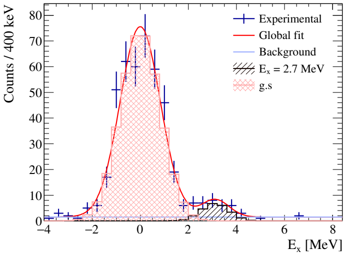
2 **Light** PID in DSSD

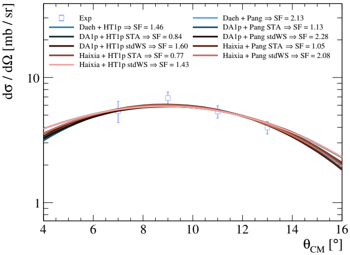


3 E_x from **missing mass technique**

$$E_{\text{beam}} + (E, \theta)_{\text{Lab}} \to E_x$$

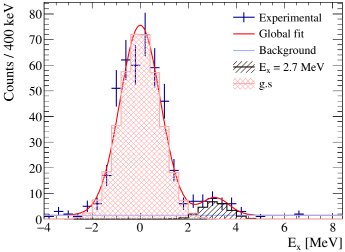
Results: $^{10}Be(d,{}^{3}He)^{9}Li$

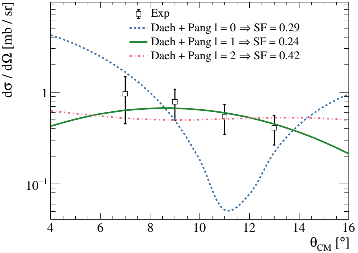




Results: $^{10}Be(d,^{3}He)^{9}Li$

The **first** excited state $1/2^-$ is also accessible.

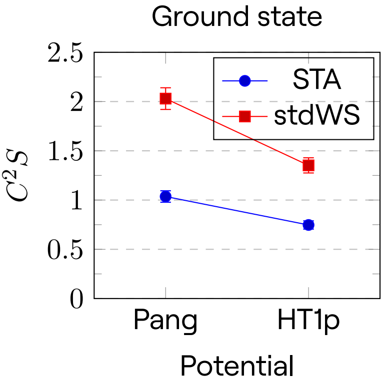


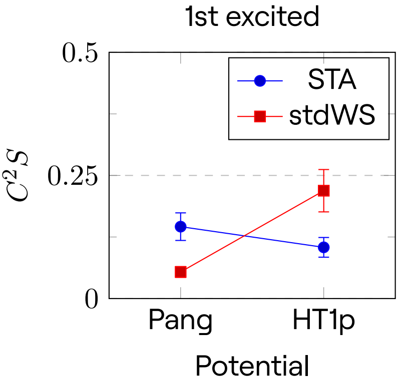


First direct measurement:
$C^2S = 0.237(46)$

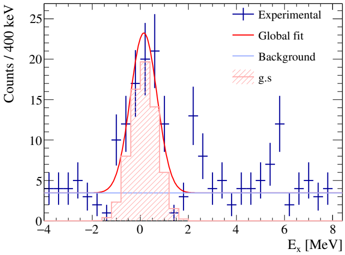
SM calculation by Acculina:
$C^2S = 0.207$

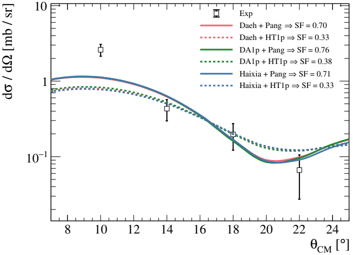
Results: ^{10}Be(d,^{3}He)^{9}Li





Results: ^{12}Be(d,^{3}He)^{11}Li



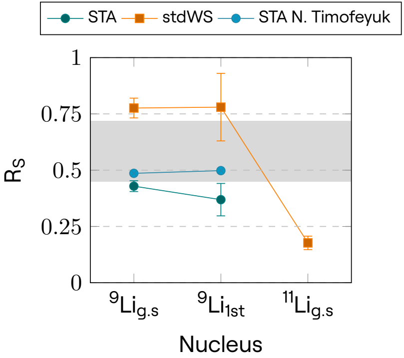


1. $C^2S = 0.33$ with Haixia + HT1p
2. Need to solve puzzle with different OMPs

Fulfils expectation of:
$0.65(\text{quenching}) \cdot 0.5(\text{GMF})$
This is true with Pang but not with HT1p...

Conclusions

The reduction factor R_S is computed using SM C^2S from the SFO–tls interaction.



And now what?

Acknowledgments

The E748 collaboration:

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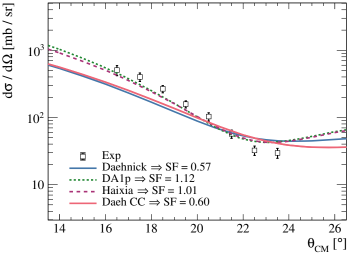
  M. Rejmund
  T. Roger
  O. Sorlin
  J.C. Thomas
  M. Vandebrouck
  B. Bastin
  F. de Oliveira
  C. Stodel
- RIKEN:
  S. Koyama
  D. Suzuki
- Surrey:
  N. Timofeyuk

Backup

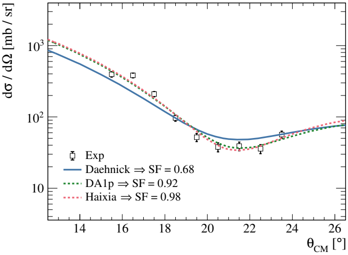
Elastic cross sections

Normalization of all cross-sections was obtained from fits to the elastic data using the Haixa potential.

^{10}Be(d,d)

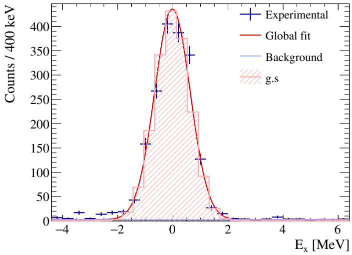


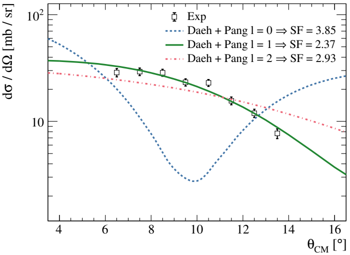
^{12}Be(d,d)



Best OMP: new ones DA1p and Haixia!

Crosscheck: $^{10}Be(d,t)^{9}Be$

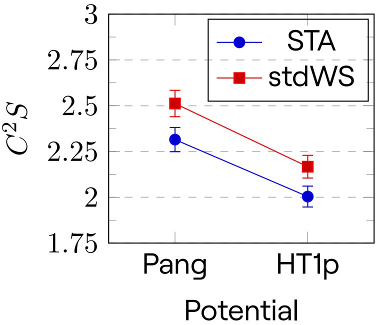


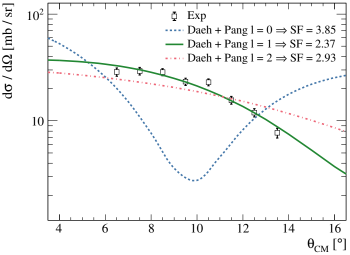


Best fit is a $\ell = 1$
$C^2S = 2.370(69)$

In accordance with $\sim 60\,\%$ quenching of SFs

Crosscheck: ^{10}Be(d,t)^{9}Be





Best fit is a $\ell = 1$
$C^2S = 2.370(69)$

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Kinematical lines