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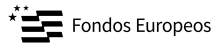
25 → * 1999
2024

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

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USC-IGFAE, LPC-Caen and FRIB

Zakopane 2024 Conference



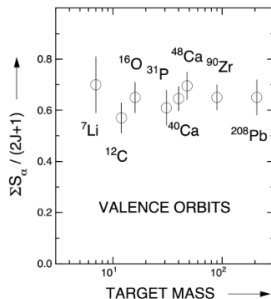
A recap on spectroscopic factors

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

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

Experimentally:
Reduction of $\sim 65\%$!

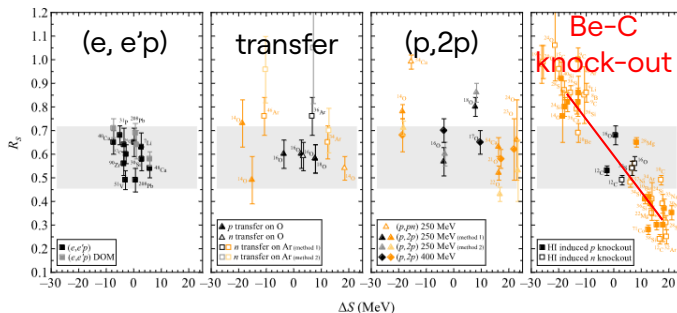
- **Short-range** correlations: tensor forces,...
- **Long-range**: vibrations, giant resonances,...



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!**

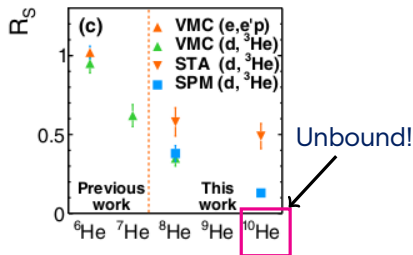
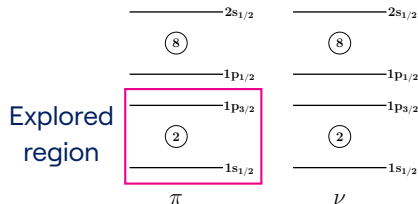


T. Aumann et al. Prog. Part. Nucl. Phys. 118 (2021)

⇒ 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, ^3He) reactions:



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

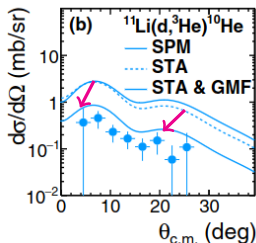
Several challenges in this region:

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

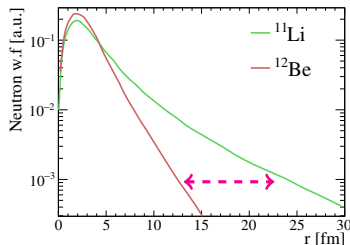
2 Impact of core excitations (completar algo +)

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 $^{10,12}\text{Be}(d, ^3\text{He})$ reactions to:

Overlaps:

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

————— $1p_{1/2}$

● ● ————— $1p_{3/2}$

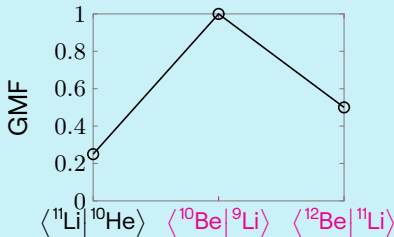
② This strength

● ————— $1s_{1/2}$

π

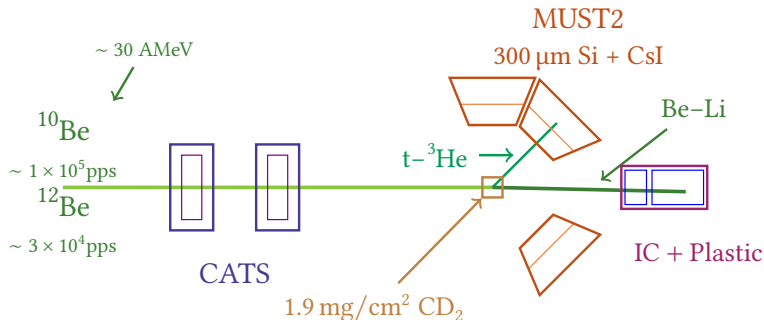
Explore effects of GMF:

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



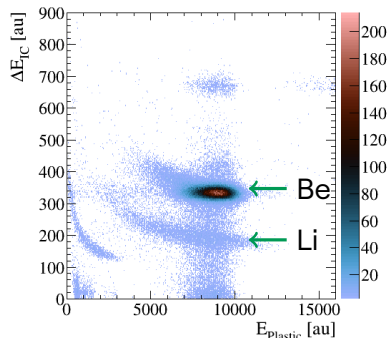
Experimental setup

Traditional solid target experiment @ LISE

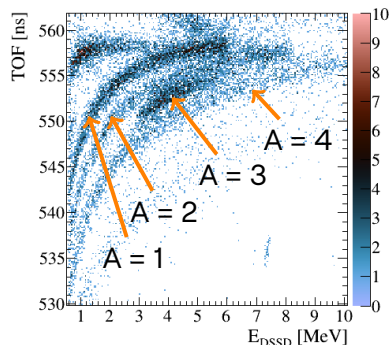


A glance at the analysis

1 Heavy ID at 0°



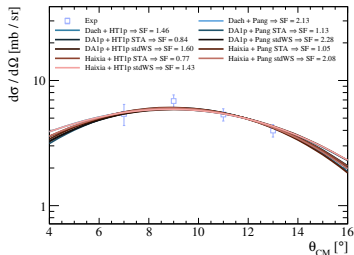
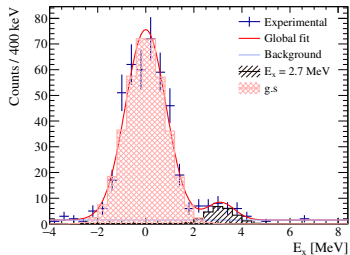
2 Light PID in DSSD



3 E_x from missing mass technique

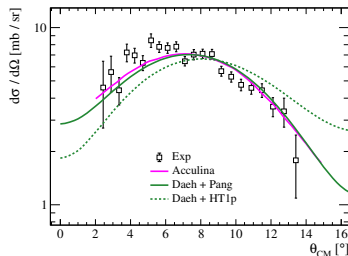
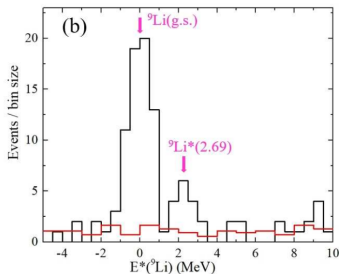
$$E_{beam} + (E, \theta)_{Lab} \rightarrow E_x$$

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



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

Recent experiment @ Acculina by *E. Yu. Nikolskii et al.*, *NIM B 541* (2023). Different beam energy of 40 AMeV

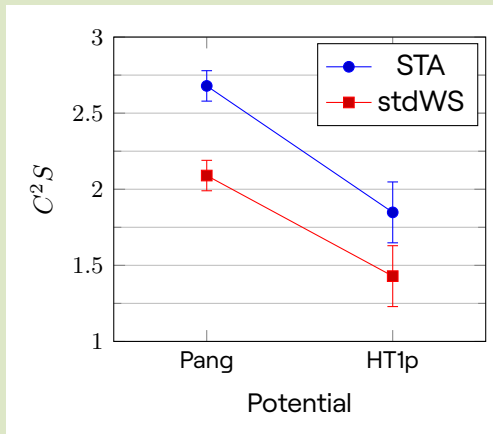


Their analysis:
 $C^2S = 1.74$

Our C^2S :

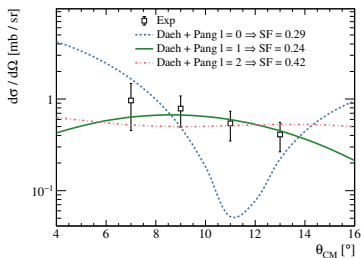
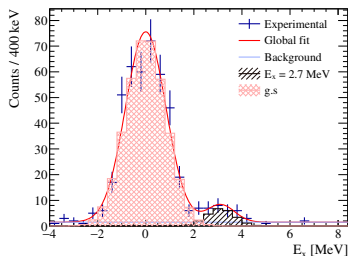
- Pang: 2.679(48)
- HT1p: 1.848(33)

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



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

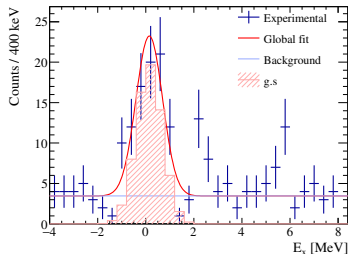
The **first** excited state $1/2^-$ is also accessible.



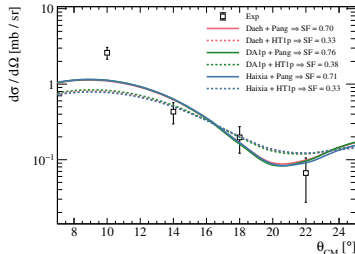
First direct measurement:
 $C^2S = 0.237(46)$

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

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



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



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

Conclusions

Ola
A ver
Que
Poñemos
Aqui

Acknowledgments

The E748 collaboration:

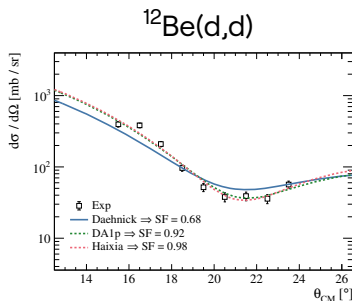
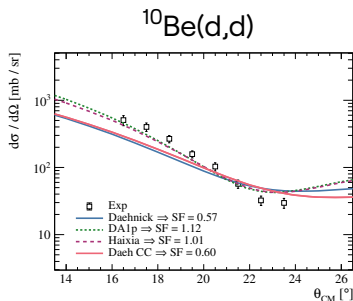
- Santiago:
B. Fernández
- LPC-Caen:
A. Matta
F. Delaunay
N. L. Achouri
F. Flavigny
J. Gibelin
M. Marques
N. Orr
- IJCLab:
D. Beaumel
M. Assié
Y. Blumenfeld
S. Franchoo
A. Georgiadou
V. Girard-Alcindor
F. Hammache
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I. Stefan
- GANIL:
B. Jacquot
O. Kamalou
A. Lemasson
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

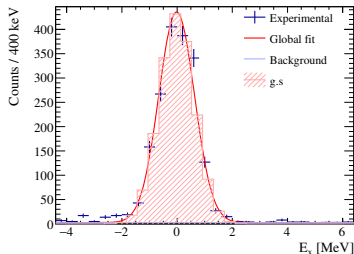
Elastic cross sections

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

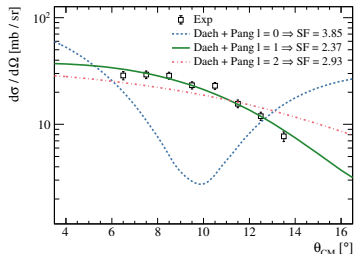


Best OMP: new ones DA1p and Haixia!

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



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



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

Kinematical lines

