INSTITUTO GALEGO
DE FÍSICA
DE ALTAS ENERXÍAS
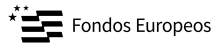
IGFAE

25

1999
2024

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

M. Lozano-González, A. Matta, B. Fernández-Domínguez,
F. Delaunay, J. Lois-Fuentes
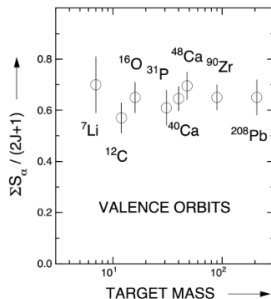
USC-IGFAE, LPC-Caen and FRIB

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:
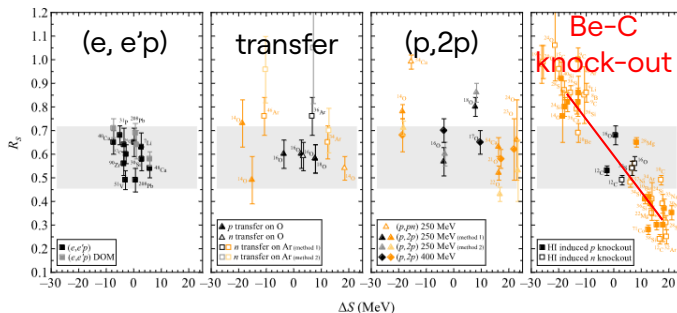Reduction of $\sim 65\%$!

- **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**!
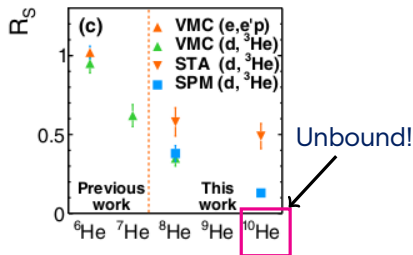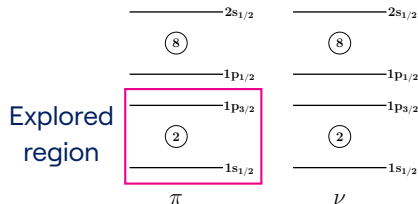

T. Aumann et al. Prog. Part. Nucl. Phys. 118 (2021)

$\Rightarrow$ 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:
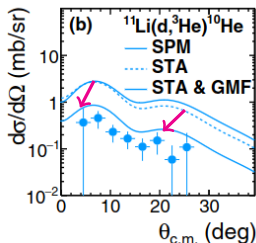

A. Matta et al., Phys. Rev. C 92 (2015)

Several challenges in this region:

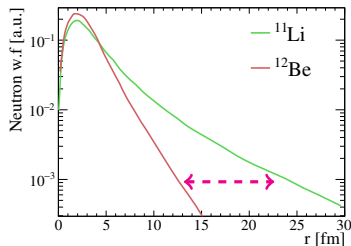**1** Dealing with **unbound** nuclei (^{10}He)

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)

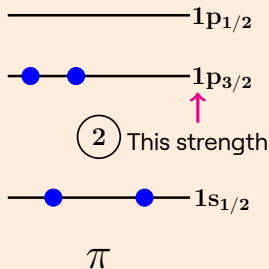
N. K. Timofeyuk, private communication (in E748 proposal)

$\Rightarrow$ Need to establish more systematics for this parameter

Physics case of E748

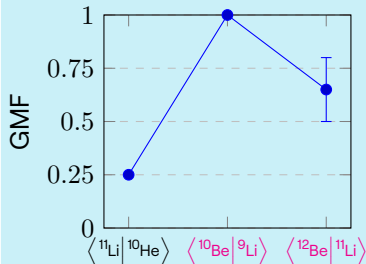E748 @ GANIL back in 2017. Using $^{10,12}\text{Be}(d,^3\text{He})$ reactions to:

Overlaps:

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

$1p_{1/2}$

$1p_{3/2}$

$\textcircled{2}$ This strength

$1s_{1/2}$

π

Explore effects of GMF:

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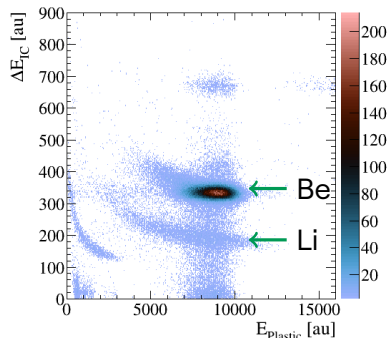- $\left\langle ^{12}\text{Be}\middle|^{11}\text{Li}\right\rangle, \text{GMF} \sim 0.5?$

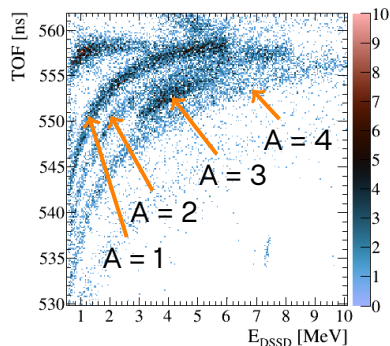# Experimental setup

Tradional solid target experiment @ LISE
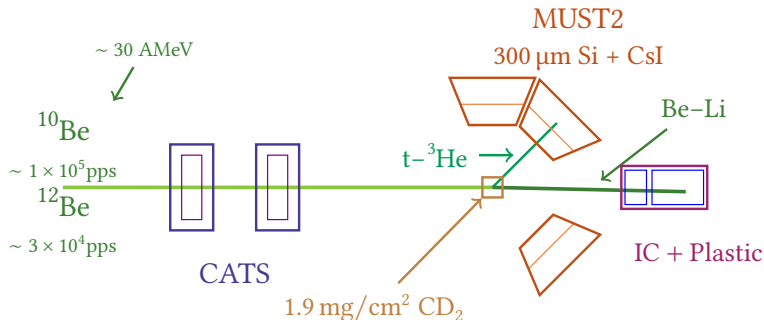
A glance at the analysis

1 **Heavy** ID at $0°$
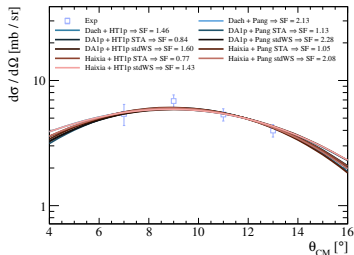
2 **Light** PID in DSSD

3 E_x from **missing mass technique**
$$E_{\text{beam}} + (E, \theta)_{\text{Lab}} \rightarrow E_x$$

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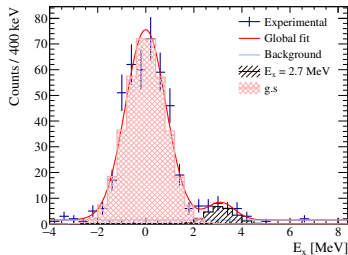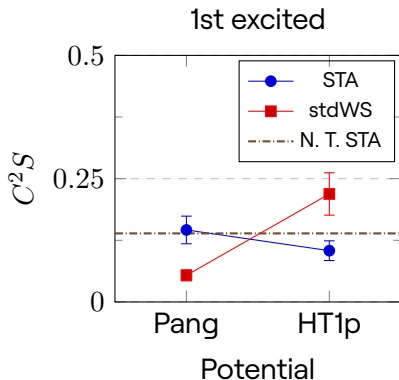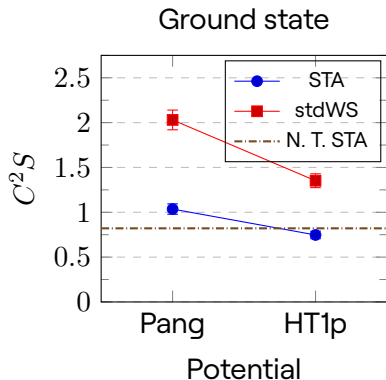
Results: ^{10}Be(d,^{3}He)^{9}Li

The **first** excited state $1/2^-$ is also accessible.
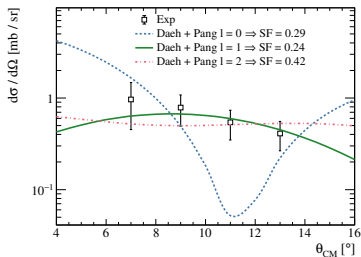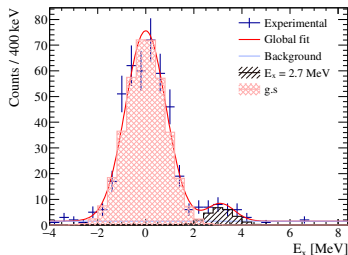
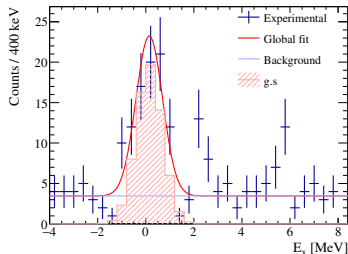**First** direct measurement:
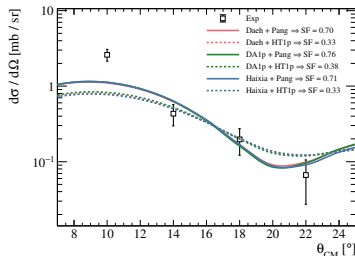$C^2S = 0.237(46)$

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

Results: ^{10}Be(d,^{3}He)^{9}Li
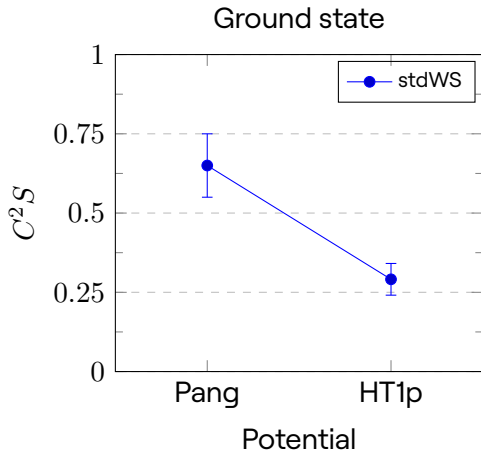
Results: ^{12}Be(d,^{3}He)^{11}Li

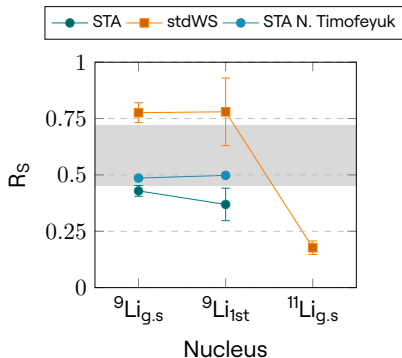1. $C^2S = 0.33$ with Haixia + HT1p
2. Need to solve puzzle with different OMPs

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

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

Conclusions

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

And now what?

Acknowledgments

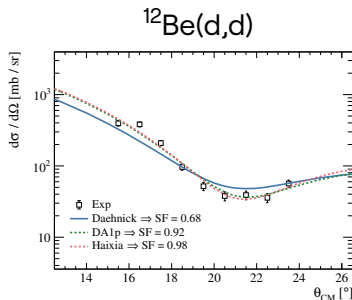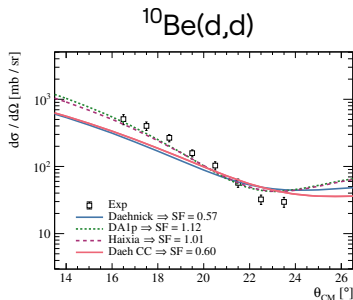The E748 collaboration:

- 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
  N. de Séreville
  A. Meyer
  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
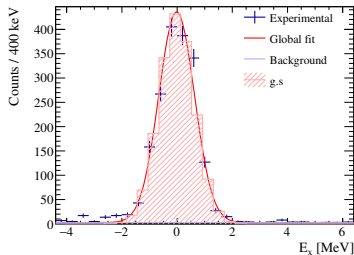
- Surrey:
  N. Timofeyuk

Backup

Elastic cross sections

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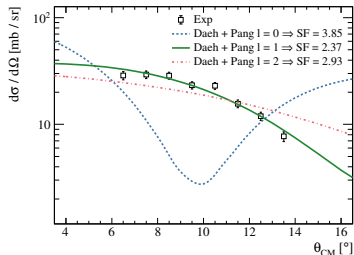

^{10}Be(d,d)

$d\sigma / d\Omega$ [mb / sr]

- □ Exp
- Daehnick ⇒ SF = 0.57
- DA1p ⇒ SF = 1.12
- Haixia ⇒ SF = 1.01
- Daeh CC ⇒ SF = 0.60

θ_{CM} [°]

^{12}Be(d,d)

$d\sigma / d\Omega$ [mb / sr]

- □ Exp
- Daehnick ⇒ SF = 0.68
- DA1p ⇒ SF = 0.92
- Haixia ⇒ SF = 0.98

θ_{CM} [°]

Best OMP: new ones DA1p and Haixia!
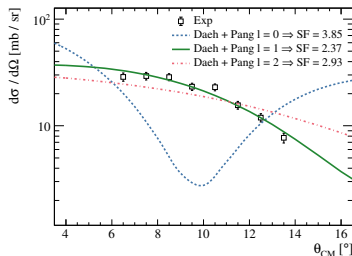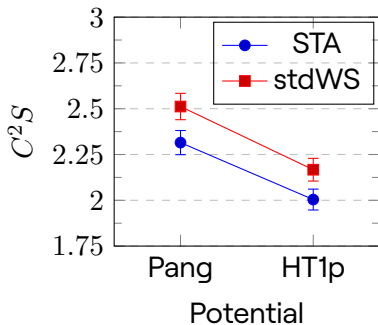
Crosscheck: ^{10}Be(d,t)^{9}Be

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 $\ell = 1$
$C^2S = 2.370(69)$

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

Kinematical lines

^{10}Be

^{12}Be