Coupling Effects and Reaction Mechanisms in Weakly-Bound Nuclear Systems

Leandro Gasques

Universidade de São Paulo













very useful for probing the nuclear interaction!!!

Besides the elastic scattering, other processes may occur ...



## Weakly-bound nuclei - Cluster structure



https://www.nndc.bnl.gov/nudat3/

#### Weakly-bound nucleus = larger probability to breakup







#### Breakup followed by transfer

## LAFNA - IF - USP



30B beamline





Image from Juicing
Vegetables

<sup>10</sup>B + <sup>120</sup>Sn @ 40 MeV



#### 2018





16 pseudo-telescopes



<sup>10</sup>B + <sup>120</sup>Sn @ 40 MeV



### **Coupled-channel calculations**





## Weakly-bound nuclei - Cluster structure



## **Coupled-channel calculations**







$\mathbf{Q}$	$\mathbf{Q}$	
2016	2023	
Inclusive measurements	Exclusive measurements	
<sup>6,7</sup> Li + <sup>120</sup> Sn	<sup>6,7</sup> Li + <sup>196</sup> Pt	
<sup>6,7</sup> Li + <sup>124</sup> Sn	<sup>6,7</sup> Li + <sup>119</sup> Sn	
<sup>10,11</sup> B + <sup>120</sup> Sn	<sup>10,11</sup> B + <sup>119</sup> Sn	
<sup>10</sup> B + <sup>197</sup> Au	<sup>12,13</sup> C + <sup>64</sup> Zn	

<sup>12,13</sup>C + <sup>119,120</sup>Sn



#### **Basic requirements:**

- Large granularity
- Large geometric efficiency

### **Exclusive measurements**

- <sup>6,7</sup>Li + <sup>196</sup>Pt
- <sup>6,7</sup>Li + <sup>119</sup>Sn
- <sup>10,11</sup>B + <sup>119</sup>Sn

- $^{12,13}C + {}^{64}Zn$ 
  - <sup>12,13</sup>C + <sup>119,120</sup>Sn

#### 2023





### Large area 16 strips telescopes (1000 + 300 + 20 microns)





### 256 pseudo-telescopes



## <sup>7</sup>Li+<sup>119</sup>Sn @ 24 MeV



### <sup>10</sup>B+<sup>119</sup>Sn @ 40 MeV



## Sum of all 256 pixels <sup>10</sup>B+<sup>119</sup>Sn @ 40 MeV





## Sum of all pixels <sup>10</sup>B+<sup>119</sup>Sn @ 40 MeV





# Sum of all 256 pixels <sup>10</sup>B+<sup>119</sup>Sn @ 40 MeV



# <sup>11</sup>B+<sup>119</sup>Sn @ 40 MeV

Experimental campaign 17-28 of April 2023



# Sum of all 256 pixels <sup>11</sup>B+<sup>119</sup>Sn @ 40 MeV





# Sum of all 256 pixels <sup>11</sup>B+<sup>119</sup>Sn @ 40 MeV





### March 2025



FIG. 4.  $(\Delta E_{\rm red}, E_T)$  spectrum taken with STAR at  $\theta_{\rm lab} = 120^{\circ}$  for the  $^{12}C+^{119}Sn$  measured at  $E_{\rm Lab} = 46.9$  MeV. Panel (a) shows the yields observed in a single pixel, while panel (b) shows the yields accumulated in an entire vertical strip of  $\Delta E$ .

# Forthcoming



# Forthcoming

**OSCAR** (hOdoscope of Silicons for Correlations and Analysis of Reactions)

D. Dell'Aquila et. al., NIM A877, 227 (2018)



#### Si PIN photodiodes



### INFN - USP collaboration (MOU)

### Building 2 pieces



- Several reactions have been investigated at LAFNA
- The simultaneous description of many reaction processes are a good benchmark for nuclear potential models
- All in all, coupled-channel calculations provide a reasonable description of the data

- Several reactions have been investigated at LAFNA
- The simultaneous description of many reaction processes are a good benchmark for nuclear potential models
- All in all, coupled-channel calculations provide a reasonable description of the data

The development of instrumentation is extremely important

Students are very welcome for joining our research group!





### GRIPe

Grupo de Reações entre Íons Pesados





