Study of shell evolution around the doubly magic $^{208}\text{Pb}$, via a multinucleon transfer reaction at MINIBALL

A. Illana Sison
On behalf of the IS572 collaboration
OUTLINE

• Physics motivation
• Multinucleon Transfer (MNT) technique
• Experimental Setup
• Preliminary results
• Outlook and future perspectives
PHYSICS MOTIVATION

The region around $^{208}\text{Pb}$ has been very difficult to populate experimentally due to its large $A$ and $Z$. We would like to study the nuclear structure evolution beyond $N = 126$. 
Why the neutron-rich Pb region?

Where is above the 8+ isomer? and the negative states?

PHYSICS MOTIVATION

And why the neutron-rich Po region?

Where is above the 8+ isomer? and the negative states?

PHYSICS MOTIVATION

The region around $^{208}\text{Pb}$ has been very difficult to populate experimentally due to its large $A$ and $Z$. We would like to study the nuclear structure evolution beyond $N = 126$. 

How can we study this region? Fragmentation, Transfer reaction, Multinucleon transfer with stable beams or ISOL beams.
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MULTINUCLEON TRANSFER

• It is possible to transfer several nucleons and large angular momentum between the projectile and the target.

• It has been proved as a fantastic mechanism with stable beams.

MULTINUCLEON TRANSFER

With stable beams:

$^82\text{Se}$ onto $^{198}\text{Pt}$

BLF measured in P

Yield (beads)

In-beam gamma coincidence with recoils $\rightarrow$ Gamma spectrometer (AGATA) + magnetic spectrometer (PRISMA/VAMOS)

Up to ~20 nucleons transfer

Courtesy of J.J. Valiente-Dobon
proton pick-up and neutron stripping channels lead to neutron rich heavy mass nuclei

proton stripping and neutron pick-up channels lead to neutron rich medium mass nuclei

MULTINUCLEON TRANSFER

GRAZING calculations

With this technique is possible to do:

- In-beam spectroscopy of several nuclei at the same time.
- We can investigate isomers between 25 ns and 5 μs.

Courtesy of S. Szilner
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EXPERIMENTAL SETUP

To be consider:
- High beam intensity into a thick target: High $\gamma$-rate and contamination.
- High instantaneous beam intensity.

First MNT experiment with RIB.
- Beam Intensity required $1.5 \times 10^7$ pps.
- First Exp. @ HIEISOLDE with:
  - All cavities used (6.2 MeV/u)
  - The RF pulse length of 1.6 ms.
EXPERIMENTAL SETUP

Solutions:
- Very slow extraction.
- CD + Absorbers for particle detection.
- New trigger for MINIBALL.
- Target size must be optimized.

<table>
<thead>
<tr>
<th>Target</th>
<th>Thickness [mg/cm²]</th>
<th>Intensity [pps]</th>
<th>Total hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>²⁰⁸Pb</td>
<td>1.0</td>
<td>~ 1.0 x 10⁶</td>
<td>~ 15</td>
</tr>
<tr>
<td>²⁰⁸Pb</td>
<td>13.0</td>
<td>~ 1.0 x 10⁶</td>
<td>~ 120</td>
</tr>
</tbody>
</table>

Different trigger modes (γ-γ, γ-p, γ-γ-γ, γ-γ-p, ...) have been implemented in the DAQ.
Problems during the run:

- Radiation problems in ISOHALL. Test at 2.0 μA → the highest value registered was 146 μSv/h!!!!
- We couldn’t run with high proton beam intensity. Some actions were carried out without any success.
- Proton Beam intensity limited.
- Therefore we had a very Low beam intensity (> factor 10).

What will we be able to extract from this run?
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PRELIMINARY RESULTS

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Gate in 799 keV \( (^{210}\text{Pb} : 2^+ \rightarrow 0^+) \)

298 keV \( (^{210}\text{Pb} : 4^+ \rightarrow 2^+) \)

\[ \text{Pb lines} \]

\[ \text{Rb + Rb-like} \]

\[ \text{Pb?} \]
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OUTLOOK AND FUTURE PERSP.

- The experiment was successful despises of the Radiation problem inside ISOLDE-HALL.
- Cross-sections for MNT using the thin target will be extracted. Theory Vs Experiment.
- In-beam $\gamma$ spectroscopy will be performed with the thick target:
  - To identify all the nuclei produced, like 210Pb, …
  - Isomer spectroscopy (with lifetimes between 25 ns to 5 $\mu$s).

Multinucleon transfer technique with Radioactive Ions Beams has been proved. New opportunities!
COLLABORATION

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THANKS FOR YOUR ATTENTION
MNT WITH STABLE BEAMS

Direct kinematics, binary reaction:
BLF lighter (enough energy for identification)
TLF heavier (physics goal but not enough energy)