CHARGE-PICKUP IN 1 A GeV Pb COLLISIONS WITH DIFFERENT TARGETS

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TWO MECHANISMS:

- Quasi-elastic (direct) reaction.
- $\Delta$-resonance formation (example: $n \rightarrow \Delta^0 \rightarrow p + \pi^-$).

WHY?

- Important test for any microscopic model on nucleon-nucleon interactions.
- These data: Po production in Pb-Bi spallation target for ADS.

BUT:

- Few data, mostly restricted to total charge-pickup cross sections.
TARGETS:
- (87.3 ± 2.2) mg/cm² liquid hydrogen.
- (206 ± 6) mg/cm² liquid deuteron.
- ‘Titanium’ ⇔ empty target container.

T. Enqvist et al., NPA 686 (2001) 481.
RESULTS: TOTAL AND PARTIAL CHARGE-PICKUP CROSS SECTIONS

<table>
<thead>
<tr>
<th></th>
<th>$^{208}$Pb+p</th>
<th>$^{208}$Pb+d</th>
<th>$^{208}$Pb+Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_{tot}$ [mb]</td>
<td>28 ± 6</td>
<td>30 ± 7</td>
<td>50 ± 9</td>
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</tbody>
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Cross section [mb]

- $^{83}$Bi
- Pb + p
- Pb + d
- Pb + Ti
TWO STAGE PROCESS:

1. INTRA-NUCLEAR CASCADE
2. EVAPORATION / FISSION

\[ \sigma_{\text{tot}} [\text{mb}] \]

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\(83\text{Bi}\) partial cross sections:

\[ \text{Cross section [mb]} \]

\[ \text{MASS} \]
INFLUENCE OF PROJECTILE ENERGY

\[ \text{197}^{\text{Au}} (0.8 \text{ A GeV}) + p \rightarrow \text{80}^{\text{Hg}}, \]
\[ \text{F. Rejmund et al., NPA 683 (2001) 540.} \]

\[ \text{208}^{\text{Pb}} (1 \text{ A GeV}) + p \rightarrow \text{83}^{\text{Bi}} \]
\[{}^{209}\text{Bi} + p \rightarrow {}^{208}\text{Po} \ (T_{1/2} = 2.898 \text{ y}, E_\alpha = 5.12 \text{ MeV}), \quad {}^{209}\text{Po} \ (T_{1/2} = 102 \text{ y}, E_\alpha = 4.88 \text{ MeV})\]

No data in the energy range of interest!

Calculations → differences between 35 % and 70 %.

Estimation → from measured production cross sections for \(^{207}\text{Bi}\) and \(^{208}\text{Bi}\) in \(^{208}\text{Pb} + p\) at 1 A GeV.

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<tr>
<th>(\sigma_{\text{ISABEL}}) [mb]</th>
<th>(\sigma_{\text{INCL4}}) [mb]</th>
<th>(\sigma_{\text{estim}}) [mb]</th>
</tr>
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<td>(^{208}\text{Po})</td>
<td>2.70</td>
<td>3.64</td>
</tr>
<tr>
<td>(^{209}\text{Po})</td>
<td>0.97</td>
<td>3.53</td>
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SUMMARY AND OUTLOOK

Isotopically resolved charge-pickup cross sections of relativistic $^{208}$Pb projectiles in the interactions with different targets give new insight in the physics involved.

Problems with describing experimental results in the case of proton and deuteron induced charge-pickup reactions.

Consequence on the target-activity calculations for accelerator driven systems.

Need for model improvement and more data.