

LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS



Elastic scattering of radioactive nuclei at relativistic energies

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ELASTIC NUCLEAR SCATTERING

In an elastic scattering process, the system's kinetic energy and the total linear momentum (|p|) are conserved.



Fig.1 Scattering of an incident beam of particles. The incoming beam arrives in the z direction and is scattered to the solid angle $d\Omega$. θ is the angle between the scattered beam and the z-axis; ϕ is the angle on the xOy plane.



Fig.2 Differential angular cross section at small angles for protons from ²⁰⁸Pb with 1050 MeV.

STUDYING RADIOACTIVE NUCLEI

Inverse kinematics enable the **study of radioactive isotopes. Using this** and of all the products of the reaction. **Radioactive beams** are produced by **In-flight separation**. A primary stable beam hits a light target and the fragments of the reaction are released in the same direction, creating a **beam with a diversity of different isotopes**.



Fig.3 Comparison between direct kinematics and inverse kinematics.

Fig.4 Scheme of the production of radioactive beams using the In-flight separation method.

EXPERIMENTAL SET UP R3B



Fig.5 Schematic view of the LAND/R3B setup for the S393 campaign. In blue the group of detectors before the target, in red the ones surrounding the target and in brown the detectors after the target.

DETECTORS: BEFORE THE TARGET





Fig.6 Correlation between incoming charge (Z) and mass-to-charge ratio (A/Z) values. Each reagion represents a different isotope.

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DETECTORS: ARROUND THE TARGET

When **radiation** (energy) hits the Silicon Strip Tracker (SST) information about its **position and energy** can be acquired.

S-side (x)

K-side (y)



6



ROLU

Fig.8 Energy loss measurements on each SST (1,2,3,4) for the incoming beam.



Fig.9 Energy loss measurements in consecutive SST in each direction for the incoming beam. SST2 vs. SST1 for K-side (top left) and S-side (top right) and for SST4 vs. SST3 for K-side (bottom left) and S-side (bottom right).

DETECTORS: AFTER THE TARGET





Target

PSP ROLU POS

Beam from FRS

Fig.10 Mass (A) (left) and charge (Z) (right) measured at TFW for the incoming beam.

veto LAND

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STAR OF THE ANALYSIS



Fig.11 Correlation between incoming charge (Z) and mass-to-charge ratio (A/Z).

ENERGY ANALYSIS





Fig.12 Energy loss measurements on each SST (1,2,3,4) for 8 Li (Z = 3) before and after energy conditions.

ENERGY ANALYSIS





Fig.12 Energy loss measurements on each SST (1,2,3,4) for 8 Li (Z = 3) before and after energy conditions.







Fig.13 Scattered θ values for ⁸Li at 490 MeV/u.



Fig.14 Scattered θ values for ¹¹Be (left) and ¹⁷C (right) at 490 MeV/u.



SCATTERING ANALYSIS FOR ¹³B ¹⁴B AND ¹⁵B



Fig.15 Scattered θ values for ¹³B ¹⁴B and ¹⁵B (left to right) at 490 MeV/u.









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ELASTIC NUCLEAR SCATTERING

In an **elastic scattering** process, the system's **kinetic energy** and the total linear momentum (|p|) are **conserved**.



Fig.1 Scattering of an incident beam of particles, where s is the impact parameter and θ is the angle between the scattered and incident directions.

Fig.2 Scattering of an incident beam of particles. The incoming beam arrives in the z direction and is scattered to the solid angle d Ω . θ is the angle between the scattered beam and the z-axis; ϕ is the angle on the xOy plane.



Fig.14 Scattered θ values for ¹¹Be (left) and ¹⁷C (right) at 490 MeV/u.

dΩ





