Internship in experimental nuclear physics

Study of isospin equilibration in quasiprojectile breakup reactions at Fermi energies with the INDRA-FAZIA setup

Heavy-ion collisions in the Fermi energy regime have been widely employed to probe the properties of nuclear matter far from equilibrium conditions: they allow to investigate various phenomena (e.g. isospin transport [1]) that can be interpreted in the framework of the nuclear Equation of State (NEoS), describing the properties of nuclear matter in terms of thermodynamic variables. The INDRA-FAZIA apparatus [2], operating in GANIL, is particularly well suited to investigate such topics [3]: the excellent isotopic separation of FAZIA at forward angles and the large angular coverage provided by INDRA allow to access the details of reaction mechanisms as well as a rather complete view of the global event features.
An experiment using the INDRA-FAZIA detection array, approved for June 2025, aims to investigate isospin transport in quasiprojectile (QP) breakup events, a fission-like process which has been linked to a dynamical origin, with short characteristic timescales [4]: quite recently, the study of the mechanisms of isospin drift and diffusion in this reaction channel from a previous INDRA-FAZIA experiment has led to interesting results [5], whose interpretation, however, still presents some issues [6,7]. In the experimental analysis we will focus on the isospin equilibration taking place inside the excited, deformed QP* prior to its breakup by relating the isospin content of the two daughter nuclei with their emission configuration, in view of clarifying contrasting results found in the literature [8].

The intern will be involved in:

- Assisting in the experimental setup preparation for the June 2025 experiment.
- Participating in data acquisition and reduction during the experiment.
- Performing preliminary analysis of the collected data, focusing on the mass-charge identification of the detected nuclear fragments.
- Analyzing transport model simulations of the measured reactions to gain familiarity with the reaction mechanisms involved.
- Engaging in collaborative discussions with the research team to refine the experimental strategy.

Through this internship, the candidate will gain familiarity with state-of-the-art nuclear physics experimental techniques and data analysis tools, as well as a deeper understanding of the physics topics related to the nuclear Equation of State and isospin transport.

[1] V. Baran et al., Phys. Rev. C, 72, 064620 (2005)
[2] G. Casini and N. Le Neindre, Nucl. Phys. News 32, 24 (2022)
[3] C. Ciampi et al., Phys. Rev. C 106, 024603 (2022)
[4] A. A. Stefanini et al., Z. Phys. A 351, 167 (1995)
[5] C. Ciampi et al., Phys. Rev. C 108, 054611 (2023)
[6] S. Piantelli et al., Phys. Rev. C 101, 034613 (2020),
[7] A. Jedele et al., Phys. Rev. Lett. 118, 062501 (2017)
[8] K. Brown et al., Phys. Rev. C 87, 061601(R) (2013)

Expected skills:

- General knowledge of nuclear physics and charged particle detection techniques
- Interest in experimental techniques for nuclear physics
- Basic programming skills and familiarity with C++. Prior knowledge of the ROOT framework would be a bonus, but introductory training in both C++ and ROOT can be provided by the team.
- Good communication skills and proficiency in English

Contact:
Caterina Ciampi
Phone: +33 (0)2 31 45 45 43
mail: caterina.ciampi@ganil.fr