Internship in experimental nuclear physics

Study of cluster production

Collisions of heavy ions at intermediate energies are a unique tool to lead nuclear matter to extreme conditions of density, pressure, temperature, and neutron-proton asymmetry. The initially compressed nuclear system expands towards low densities where several intermediate mass fragments are produced. Nucleons and light clusters such as deuterons, tritons and alpha particles are also emitted during this fragmentation process as well as products of evaporation by excited primary fragments. Selecting reactions from peripheral to central collisions (e. g. by means of the geometric impact parameter), it is possible to study the phenomena that depend on isospin transport (N/Z) and thus extract information on the density dependence of symmetry energy. This term of the nuclear equation of state plays an important role both in studying the structure of exotic nuclei and astrophysical phenomena.
This internship project consists in determining the properties of the clusters produced during the evolution of the system. At low density, uniform nuclear material becomes unstable with respect to clustering. Indeed, at densities lower than the saturation density, the inter-nucleon separation becomes comparable to the NN interaction, so that it becomes energetically favorable for the system to fragment into neutron-rich clusters. Clustering significantly increases symmetry energy at very low densities, which could be useful for modelling the explosion of Core Collapse Supernovae Type II. The project will focus on the detailed measurement of these clusters (energy spectra, angular distributions, multiplicities and their correlations) and compare them with the predictions of transport models.
The student will be involved in the following activities:
- energy calibration of light charged particles measured in previous experiments;
- analysis of the clusters produced in experiments already measured with INDRA; determination of their properties, as function of impact parameter/excitation energy.

Expected skills:
Nuclear physics, experimental profile, C++, ability to work in team

This work can be pursued by the PhD-thesis entitled Study of the density dependence of the symmetry energy and cluster production.

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