Nuclear Structure Studies with EXOGAM at NFS

Understanding and predicting the evolution of nuclear structure and the novel phenomena in nuclei has long been a pursuit of scientific curiosity. Conventional methods such as charged particle probes, beta-decay, coulomb-excitation, and heavy-ion fusion evaporation reactions have been employed so far in the phase space of shell structure, magic numbers, angular momentum, and excitation energy. However, the horizon of possibilities expands when we delve into the uncharted territories of fast-neutron probes. The (n,xn) reactions are a long-standing reaction mechanism used in the cross-section data evaluation, but rarely used in the framework of nuclear structure.

This might unveil a treasure trove of reactions, particularly the (n,xn) reactions with high production thresholds, which, until now, have not been looked at from the eye of nuclear structures. As a result, we know very little about their reaction mechanisms.

The internship project presents a chance to understand the neutron analysis techniques along with the high-resolution gamma spectroscopy analysis with clover type HPGe detector. The experiment was performed with Ni and Pb targets, studying pure neutron channels is the main interest alongside isotopes that are produced from (n,p/d/t) reaction. The ^{56}Ni de-excitation was observed and a large number of gamma-gamma coincidences were sorted. To manage the complexity of the gamma-ray data, new analysis tools have been developed, and ongoing work aims to further enhance these capabilities. The project provides a comprehensive experience encompassing both experimental data analysis and simulation.

This experiment represents pioneering work in nuclear structure research using a large gamma detector array in combination with fast neutrons. Currently, such studies are uniquely possible at the NFS GANIL–SPIRAL2 facility. The program opens a new door for nuclear structure studies. We are looking for a highly motivated student with a strong interest in experimental nuclear physics to join this project.

References:
 X. Ledoux et al., EPJ Web of Conferences 146, 03003 (2017)
DOI: 10.1051/epjconf/201714603003

In-beam γ-ray spectroscopy with fast neutron probes at NFS (2025)
DOI: 10.1016/j.nuclphysa.2025.123135

Skills required:
Python, ROOT, C++

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