PhD position in experimental nuclear physics

Shedding new light on the structure of ^{56}Ni using (n,3n) reaction at NFS

The project proposes to re-investigate the nuclear structure of the doubly magic nuclei ^{56}Ni using the (n,3n) reaction from ^{58}Ni. The nuclei near ^{56}Ni are of particular interest as they are amenable to different microscopic theoretical treatments while studying the competition between single-particle and collective excitations. The collective states in ^{56}Ni involve multiparticle multi-hole excitations across the N=Z=28 shell gap from the 1f7/2 shell to the 2p3/2, 1f5/2, and 2p1/2 orbits. Excitations to the higher lying 1g9/2 orbit are necessary to explain the observed rotational bands in Cu and Zn. At high excitation energies, reaction studies have revealed evidence for hyper-deformed resonances in the ^{56}Ni compound.

While the structure of ^{56}Ni has been intensively investigated using charged particle or heavy ions collisions, the pure neutron probe was never used. The (n,xn) reactions are a long standing reaction mechanism used in the nuclear data evaluation but never used in the framework of nuclear structure. For the first time, using the unprecedented neutron flux at ~ 30MeV of the NFS facility of GANIL-Spiral2, ^{56}Ni can be populated from ^{58}Ni in a (n,3n) reaction opening a new probe and possibly new aspect of the nuclear structure of this doubly magic nucleus.

In this project, we propose to perform a prompt gamma spectroscopy of ^{56}Ni using the EXOGAM array at NFS using the (n,3n) reaction. Such new spectroscopic information is also relevant for nuclear reaction mechanism formalism (like TALYS) and nuclear data evaluation. For nuclear structure, the main motivation is the search for low spin (J=2 or 4) states from 3 to 10 MeV excitation energy possibly populating the 0+ states at 3956 keV, 6654 keV and 7903 keV observed only in ^{58}Ni(p,t)^{56}Ni reactions. The experiment (E838_21) was approved at the December 2021 GANIL PAC and should be schedule at the facility in autumn 2023.

This experiment is a pioneering work in the study of the nuclear structure studies using large gamma-array and fast neutron and is only possible at GANIL-Spiral2 today. If successful, this program will open new opportunity at the NFS facility.

Another aspect that will be developed in this thesis is the FAIR approach for the data (https://www.panosc.eu/data/fair-principles/). The nuclear community is going toward the OPEN Science framework and this approach requires the fundamental change of how the big data are recorded and analysed. This aspect will be included in the PhD work using the data collected at NFS as the first example of its kind at GANIL.

Expected skills:

C++ programming, nuclear physics master diploma, working in collaboration, instrumental skills.

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