STUDY OF CLUSTER STRUCTURE OF EXOTIC 13B NUCLEI PRODUCED AT FRIBS FACILITY OF LNS – CATANIA

The study of the nuclear clustering is one of the oldest and important subject in the field of the nuclear physics, since it reveals much about the nature of the force through which the nucleons interact and the resulting symmetries. The α-particle is one of the most highly bound cluster nuclei, but also heavier nuclei tend to optimize their own binding energy by generating internal clusters. This can lead to clustering in alpha shape as well in other possible exotic configurations, particularly favoured in light neutron rich systems, producing strongly deformed and easy to break up nuclei.
In this framework we are going to study the break-up of the Boron isotope ^{13}B, measuring the ccompetition between the different decay channels, related to different cluster states. Experiment will be realized at LNS with a beam of ^{13}B produced by the on line fragmentation system FRIBS and impinging on the hydrogen of a plastic (CH_2) target. Decay products of the ^{13}B will be measured with CHIMERA and FARCOS multi detector devices. Activity will concern experiment preparation and realization at LNS as well as following data analysis carried out also at the Dipartimento di Fisica e Astronomia.

MEASUREMENT OF NUCLEAR DENSITY IN HEAVY ION REACTION AT FERMI ENERGIES

The research work aims at studying the nuclear reaction mechanisms in Heavy Ions collisions at Fermi energies. An important role in these studies is played by the gradient of the nuclear density affecting the isospin asymmetry of the reaction products. Experimental determination of the value of the nuclear density in the early phase of the collision between two heavy nuclei is a crucial step towards the understanding of the underlying mechanism responsible for the production of nuclear clusters of intermediate atomic number ($Z< 10$), that is still an unsolved problem. The experimental method consists in constructing kinetic energy correlations of couple of clusters and its comparisons with the most advanced nuclear transport theories.

STUDY OF PYGMY RESONANCE IN RADIOACTIVE BEAMS EXCITED WITH BOTH ISOSCALAR AND ISOVECTOR PROBES

The NEWCHIM group of LNS is involved in the construction and use of the FARCOS correlator (Femtoscopy ARray For Correlation measurements and Spectroscopy). This array will consist in its final configuration of 20 triple telescopes of silicon strip and CsI, 12 of which will be already available in the second semester of 2019. This array will be used with fragmentation beams at LNS performing measurements on the excitation of Pygmy Dipole Resonance (PDR) on ^{68}Ni by isoscalar and isovector probes (Carbon and Gold targets). Gamma rays from PDR will be detected in the CsI(tl) detectors of the CHIMERA array, while ^{68}Ni scattered will be detected and identified around zero degree with some FARCOS telescopes. The student will participate at LNS to this experiment and eventually to other experiments performed in the same experimental campaign. He will then perform part of the data analysis of the experiment in order to complete its master thesis. It will be involved also in the mounting and test of FARCOS telescopes. He can learn how to use the full digital electronics of the array and the use of ASIC preamplifiers developed for FARCOS. The student will also learn modern methods of production of radioactive beams, with the setting of the tagging systems for event by event identification of the fragmentation beam. Techniques for the synchronization of acquisition systems will be also used. If the student is also interested to theoretical aspect of the population and decay of Pygmy Resonances he will be able to collaborate with the theory group of the Catania, Padova and Valencia Universities, also involved in the project.

RESEARCH AND DEVELOPMENT OF A NEW MODULAR DEVICE FOR CHARGED PARTICLE AND NEUTRON DETECTION WITH HIGH ANGULAR RESOLUTION

The NEWCHIM group of LNS has been working from some years to the development of a new modular device for the simultaneous detection of light charged particles and neutron with high energy and angular resolution. Several test on a new scintillating plastic material have been done in order to study its characteristics in term of pulse shape identification of neutron gamma and charged particles, using a digitalization of the light signal. Several simulations and experimental tests are still to be done in order to define the good light sensor between photodiode and SiPM, and to choose the precise geometry in term of dimensions, number and assembly of the single detection cell of the final array. The student will thus be involved in simulation concerning neutron detection with single and multiple cells in a particular surrounding environment. Moreover he will carry on several tests for the choice of the ideal light sensor to be coupled to the plastic scintillator, and to test its performance in term of light yield, timing response and pulse shape identification capabilities. The use of a dedicated front end electronics coupled to a fully digital electronics for signal acquisition is foreseen, and the student will be engaged in the development and test of all these systems. The work will be carried on between the LNS and the Dipartimento di Fisica e Astronomia, profiting of all the experience of the NEWCHIM in the field of detector and associated electronics development.

DYNAMICAL PROCESSES IN PROJECTILE BREAK-UP AND INTERMEDIATE MASS FRAGMENTS PRODUCTION AT 20 A.MEV BEAM INCIDENT ENERGY STUDIED WITH THE CHIMERA AND FARCOS DEVICES AT LNS-CATANIA

The NEWCHIM group is going to carry out an experiment, on Dynamical processes in projectile break-up and Intermediate Mass Fragments production at 20 A.MeV beam incident energy studied with the CHIMERA and FARCOS devices at LNS-CATANIA (CHIFAR). The group in the past measured the Intermediate Mass Fragments (IMF) production in the collisions of 124/112Sn + 64/58Ni and 124Xe + 64Zn at the bombarding energy of 35 A. MeV. Following a carefully method to study the IMFs emission mechanism, it has been observed a competition between dynamic and statistical emission with the former one being favored in neutron rich system. This studies are of fundament importance in order to explore the influence of the isospin in the reaction mechanism. The CHIFAR experiment aims is to extend such measurements toward lower energies where fragmentation scenario is partially overlapping with deep inelastic collisions. A new generation Correlation FARCOS array (Femtoscopy ARray For Correlation measurements and Spectroscopy) will be used for the first time in its full configuration. This array will consist in a configuration of 10 triple telescopes of silicon strip (300 and 1500 um) and CsI(Tl) crystals. Thanks to its high angular and energy resolution, it will be possible to study different correlations among light particles (femtoscopy) and light fragments.

EFFECTIVE INTERACTION AND DYNAMICS OF EQUILIBRATION PHENOMENA IN THE SYSTEM ^{48}CA+^{27}AL AT 40 MEV/NUCLEON

The proposed thesis work starts with the analysis of the data collected for the 48Ca+27 Al at 40 MeV/nucleon collision recently performed in Catania at the LNS by using the 4π multi-detector CHIMERA.The aim of this study is to investigate on isospin equilibration processes in different reaction mechanisms. The charge, mass, velocity and multiplicity measurements of the produced fragments and the comparison with molecular dynamics approaches will allows to get information about the effective interaction describing the iso-vectorial force and at what extent it affects the spontaneous clustering process. By working on the collected data the student will have the opportunity to work on the most important and modern identification techniques associated to the charged particle detection (E-DE technique, time of flight, pulse-shaping analysis and related software) together with the fundamental criteria for the analysis of complex-multi-particles events.
Finally, the theoretical interpretation of the experimental results will allow the knowledge of one of the most sophisticated semi-classical approaches to the nuclear many-body problem.