Recent results from RIBRAS (Radioactive Ion Beams in Brasil) facility

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An overview of the recent experiments performed at RIBRAS facility are presented. Experiments has been performed at RIBRAS by using light exotic projectiles on different light and medium mass targets, in order to study the elastic scattering and breakup reactions. We also present the results from the study of the ^{120}Sn(^{6}He,α) reaction around the coulomb barrier.

1. Introduction

The study of nuclear reactions induced by radioactive ion beams is one of the current interesting topics in nuclear physics, due to the observation of cluster like structure and weak binding energies, when compared with the stable projectiles [1]. Recently with the improvement of the radio-active ion beam facilities, the study of nuclei far from the line of stability has been improved considerably [2, 3]. The elastic scattering and transfer reactions induced by low-energy neutron-rich and proton-rich projectiles on several targets have been studied over the recent years and a large total reaction cross sections has been reported [2–4]. Further these results are compared with the reactions with stable beams. An important step in the study of reactions with radio active ion beams, is to identify the reaction channels responsible for the increase of the total reaction cross sections, such as breakup and transfer. Light nuclei away from the line of stability usually present a pronounced cluster structure formed by a core surrounded by one or more weakly bound nucleons (^{6}He, ^{7}Be, ^{8}B, ^{10}Be, ^{12}B etc). Due to the small breakup energies and the low angular momentum of the valence nucleons, the wave functions extend to large distances from the core, forming a kind of low density halo nuclei [5]. As a result, reactions such as projectile breakup and nucleon transfers may be strongly favored in the interaction of these projectiles, which enhances the total reaction cross sections.

In this context, we have performed several experiments in order to study the elastic scattering and effect of break up on light and medium mass targets with different radio active ion beams (^{6}He, ^{7}Be, ^{8}Li, ^{8}B, ^{10}Be and ^{12}B etc) using RIBRAS facility. Here we present the results for the reaction ^{120}Sn(^{6}He,α) reaction along with several other elastic scattering experiments.

RIBRAS System and Recent Experiments

RIBRAS is a large acceptance double solenoid system which is used to produce radio active ion beams installed at the laboratory of nuclear physics in the Institute of Physics, University of São Paulo [2, 3]. The secondary radio active ion beams are produced in-flight, by nucleon transfer reactions between the primary beam delivered by 8UD-Pelletron accelerator and the primary targets such as ^{9}Be, ^{3}He and LiF. Nucleon transfer and fusion-evaporation reactions produce the secondary beams with intensities ranging from 10^4 - 10^6 pps, for primary beam intensities around 300 - 500 enA. The low production cross sections due to the low primary beam energies is compensated by the large acceptance angle of the first solenoid (30 msr), which allows to collect most of the secondary beam particles produced at forward angles. The secondary particles produced from the transfer reaction are selected by the first solenoid and focused in the scattering chamber located just after the first solenoid. RIBRAS can be operated by using the two solenoids or only one solenoid.

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Usually the secondary beam after the first solenoid is contaminated with p,d,t,α and degraded primary beam particles. A degrader foil can be placed in the scattering chamber after the first solenoid in order to provide differential energy loss and subsequent purification of the secondary beam by the second solenoid. In this way, a secondary beam with purity better than 90% can be achieved after the second solenoid. The secondary beam production rates are maximized in the beginning of the experiment by varying the solenoid currents and monitoring the elastic scattering on a ^{197}Au target. The elastic scattering and break-up/transfer measurements are usually carried out by using E-ΔE silicon detector telescopes mounted on a rotating plate inside the secondary chambers after the first and second solenoids.

Recently several elastic scattering experiments were performed in RIBRAS facility on light and medium mass targets with ^{6}He, ^{7}Be, ^{8}B, ^{8}Li and ^{10}Be projectiles. These experiments were performed by using only the first solenoid. It is well known that, the elastic scattering angular distributions provide information about the nuclear potential as well as of the total reaction cross section. At low energies below the coulomb barrier the elastic angular distributions are affected by both the long range Coulomb and the short range nuclear interactions and the measurement of elastic scattering angular distributions on different mass targets allows the study of the interplay between Coulomb and nuclear interactions [6]. The ^{8}Li elastic scattering has been measured on ^{9}Be, ^{58}Ni and ^{120}Sn targets by using the transfer reaction ^{9}Be(^{7}Li,^{8}Li)^{8}Be. The ^{7}Be, ^{10}Be elastic scattering was studied on ^{9}Be by using the transfer reactions ^{9}Be(^{7}Li,^{7}Be)^{6}He and ^{9}Be(^{11}B,^{10}Be)^{10}B. The elastic scattering of ^{12}B on ^{58}Ni was studied by using the transfer reaction ^{9}Be(^{11}B,^{12}B)^{8}Be. Further, we have also studied ^{120}Sn(^{6}He,α) reaction around the coulomb barrier using the two solenoids in order to study the two neutron transfer.

α-particle energy distributions were measured at different beam energies around the Coulomb barrier. The α-production data was analyzed as a function of the Q-value for the ^{120}Sn(^{6}He,α)^{122}Sn* reaction. It is observed that the centroid of the Q-value distribution decreases from slightly positive values up to negative values, as the incident beam energy increases [7]. Since the Q_{gs} for this reaction is highly positive ($\sim +14.01$ MeV), the residual nucleus ^{122}Sn must be formed in a highly excited state around $E^{*} \approx 14$ MeV and above. At these high excitation energies, the 2n-transfer reaction populates states in the continuum of ^{122}Sn, well above the one-neutron emission threshold at $E^{*} = 8.81$ MeV. Further using Brinks formula for Q-optimum transfer, we tried to interpret the decrease in the reaction Q-value to a corresponding increase in the transferred angular momentum. Results will be discussed in the conference.

Summary

A summary of the several experiments performed in RIBRAS are presented. Elastic scattering and reactions involving light exotic projectiles such as ^{6}He, ^{7}Be, ^{8}B, ^{8}Li, ^{11}Li, ^{10}Be on several light and medium mass targets are discussed.

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