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The InKiIsSY experiment at LNS: A study of size vs. isospin effects with ^{124}Xe+^{64}Zn and ^{124,112}Sn+^{64,58}Ni reactions

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Abstract

The systems ^{124}Sn+^{64}Ni and ^{112}Sn+^{58}Ni at 35 AMeV were analyzed in previous experiments, by using the 4π multi-detector CHIMERA in order to investigate the time-scale and mechanisms of fragments formation. By comparing the two systems, effects that have been correlated to Isospin transport in reaction dynamics and symmetry energy term of nuclear equation of state at sub-saturation density were found. Recently, in order to disentangle the Isospin effects from size effects the ^{124}Xe+^{64}Ni reaction was investigated at the same beam energy of 35 AMeV.

1 Physical motivations

The study of isospin degree of freedom in nuclear reactions induced by stable and radioactive beams is suited to probe the nuclear equation of state of asymmetric nuclear matter. In recent years several experiments have been undertaken with the CHIMERA 4π detector in order to investigate the mechanisms of the primary processes which are responsible for fragments formation and to pin down the effects on the reaction dynamics of the Isospin degree of freedom by comparing neutron rich and neutron poor systems. In particular we have investigated the time-scale of fragments formation from dynamical and pre-equilibrium emission to statistical decay of excited systems at equilibrium. It has been shown that the lighter fragments ($Z\leq 9$) in the midrapidity region are likely to be emitted in fast fragmentation of the neck connecting PLFs (Projectile-like Fragments) and TLFs (Target-like Fragments) within 40-80 fm/c from the beginning of re-separation [1]. Conversely, emission of heavier IMF (Intermediate Mass Fragments), with $Z\geq 9$, has been shown to happen at the last stage of the neck expansion process and has been associated with the "Dynamical Fission" mechanism [2,3]. The Dynamical Fission occurs in a late stage of the re-separation of TLF-PLF binary system (time$\geq$ 120 fm/c), but before the PLF and TLF have achieved full equilibration, as suggested by anisotropy observed in the angular distribution of the IMF [4]. An interesting effect has been observed in the IMF production cross-section; in fact, Fig. 1 shows the production cross-section for statistical and dynamical break-up of PLF as a function of the charge of the IMF. It has been observed that dynamical fission probability is enhanced up to a factor 2 in the neutron rich system expecially for heaviest IMF ($Z\geq 9$); in constrast cross-section associated to the statistical emission shows no differences between the two systems [5]. In ref. [4] it has been suggested that the origin of the enhancement of the dy-

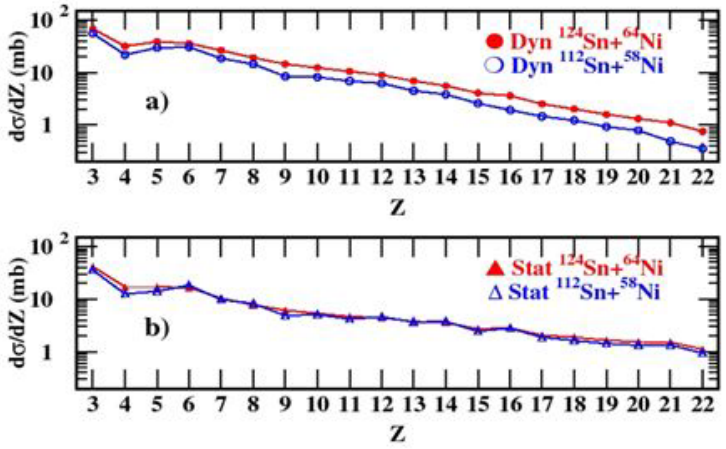

Figure 1: Cross section associated to dynamical (upper panel) and statistical (lower panel) emission mechanism for neutron rich system (full symbols) and neutron poor one (empty symbols).

namical fission component is due to the very different N/Z ratio of the two systems studied. Indeed, neither the 7% geometrical cross-section difference nor the 10% available energy difference between the two systems can explain the observed enhancement. However, calculations with the CoMD-II model [6, 7] have suggested that the origin of the observed difference could be related to the entrance channel mass difference of the two systems.

2 The InKiIsSy experiment

In order to disentangle the effects related to isospin from the ones related to the different size of entrance channels, in the InKiIsSy (Inverse Kinematic Isobaric System) experiment we have studied the system ^{124}Xe+^{64}Zn, having the mass of the neutron rich Sn+Ni system and an isospin near to the neutron poor one, at the bombarding energy of 35 AMeV. These measurements were performed in April 2013 at INFN-LNS in Catania with 4π CHIMERA multi-detector. For the first time CHIMERA was coupled to a prototype of FARCOS array. FARCOS (Femtoscope Array for COrrelation and Spectroscopy) [8, 9] is a new generation correlator under construction aimed to measure P-P-and fragment-fragment correlation functions with high energy and angular resolution for nuclear dynamics and spectroscopy. Using Farcos in coincidence with detectors of large angular coverage like CHIMERA assures an accurate event characterization that is an important requirement

for both dynamics and spectroscopy. In particular, in this experiment, in order to test the new apparatus we used four prototypes of FARCOS telescopes in a 2x2 configuration, placed at 25 cm from the target and covering an angular region ($\Delta\theta_{lab} \sim 15^o \div 45^o$, $\Delta\phi_{lab} \sim 75^o$), to detect LCP (Light Charged Particles) and IMF with high angular resolution. In addition, we tried to test feasibility of measuring with high momentum resolution the p-p and fragment-fragment correlations, with an accurate event characterization based on fragments detected in coincidence by CHIMERA. This kind of studies are also important for the forthcoming availability of low energy radioactive beams at SPES; so providing interesting perspectives to extend our knowledge about the isospin dependence of dynamical asymmetric break up of the projectile/target in a domain of larger Isospin asymmetries and lower energies, where other aspects, such as large deformations or Coulomb proximity effects of the target and projectile play a crucial role in the fission process [10]. Data analysis of the Inkiissy experiment is in progress.

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