High-Precision Momentum Measurements of Projectile Fragments in ^{112,124}Sn+^{112,124}Sn Collisions at 1 *A* GeV*

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The longitudinal re-acceleration phenomenon of the fragmentation residues, was observed originally in the projectile fragmentation of uranium [1,2] at the Fragment Separator (FRS), GSI Darmstadt. According to transport calculations [3], this phenomenon is related to the participants blast, and the longitudinal momenta of the surviving residues can give a direct access to the momentum-dependent properties of the nuclear mean field (MF), little affected by the uncertainties in nuclear incompressibility [3]. After this first experimental observation, a set of experiments was carried out at the FRS. The aim was to explore the dependence of the reacceleration on the initial beam energy, on the system size, as well as the importance of the isospin effects on the evolution and strength of the participants' blast. The dependence on the initial beam energy and on the size of the system was pursued by studying the reactions ^{197}Au+^{197}Au and ^{197}Au+Al at 500 and 1000 *A* MeV [4] at the FRS, GSI.

This work is devoted to study the importance of the isospin effects. To this purpose the fragmentation of two systems, ^{112}Sn+^{112}Sn and ^{124}Sn+^{124}Sn at 1000 *A* MeV, whose *N/Z* ratio is 1.24 and 1.48 respectively, was studied. If there are sensible effects of the momentum dependence of the symmetry MF (as it is expected in this energy regime [5]) one could expect sensible differences [3] for the momentum transfer to the spectators, that would be detectable in the mean longitudinal velocity of fragments from systems with different isospin content.

The experiment was performed using the high-resolution magnetic spectrometer, the FRS, at GSI. The 1 *A* GeV ^{112}Sn and ^{124}Sn beams impinged on two thin targets of ^{112}Sn and ^{124}Sn, respectively. The magnetic rigidity of each projectile-residue could be measured with high precision by determining the deflection in a magnetic dipole field. This gave a measure of the longitudinal momentum, and hence on the longitudinal velocity, with a statistical relative uncertainty of $\pm 5 \cdot 10^{-4}$, once the product is identified in mass and atomic number. Details of the experimental set-up and the detector equipment, as well as a description of the analysis method can be found in ref. [1,2,4,6].

To give an idea of the precision of the method, in figure 1, as an example of longitudinal velocity distribution, we present the measured spectra of two fragments, ^{65}Zn and ^{82}Sr. The velocity is given in the frame where the beam is at rest. The mean values of the velocity distributions of fragmentation residues as a function of their mass number are shown in figure 2. Statistical uncertainties are not shown in order not to overload the figure. They correspond to the fluctuations of the points. The absolute uncertainty amounts to less than 0.03 cm/ns for each system, independently.

With increasing mass loss, the velocities first decrease as expected from previously established systematics [6], described bye the dashed line, then level off, and finally increase again, the same tendency as observed in ref. [1,2,4]. Contrary to the heavier system studied in ref. [1,2,4] here no net re-acceleration is found. The discussion on the physical results and the comparison of the experimental results with theoretical predictions is still in progress.

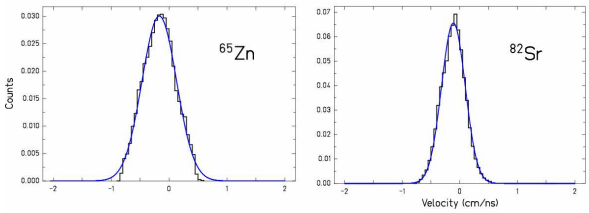

Figure 1: Example of longitudinal velocity spectra for two final fragments: ^{65}Zn and ^{82}Sr.

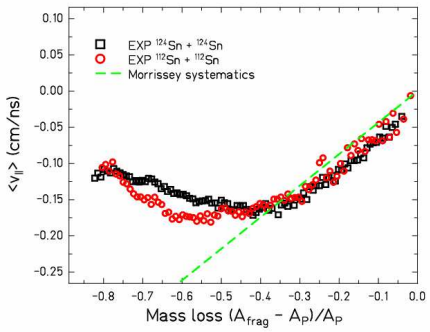

Figure 2: Measured mean value of the longitudinal velocity as a function of the mass of the fragments produced in the reactions ^{112,124}Sn+^{112,124}Sn at 1 *A* GeV. The dashed line gives the prediction of the Morrissey's systematic [7].

References

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