Effect of Nucleon Exchange on Projectile Multifragmentation in the Reactions of ^{28}Si + ^{112}Sn and ^{124}Sn at 30 and 50 MeV/nucleon

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We use the projectile multifragmentation events reconstructed using isotopically identified fragments for the study of the nucleon exchange between the projectile and target. The experiment was done with a beam of ^{28}Si impinging on ~1 mg/cm^2 self supporting ^{112,124}Sn targets. The beam was delivered at 30 and 50 MeV/nucleon by the K500 superconducting cyclotron. The detector array FAUST [1] was composed of an arrangement of 68 silicon - CsI(Tl) telescopes covering polar angles from 2.3° to 33.6° in the laboratory system. The total charge of quasiprojectiles used in analysis is restricted to the values near to the charge of the projectile $Z_{tot} = 12 - 15$. For the events with $Z_{tot} = 14$ we define the principal neutron exchange observable as the mass change by subtracting the sum of the neutrons bound in the detected fragments from the neutron number of the beam

$$\Delta A = N_{proj} - \sum_f N_f \qquad (1)$$

where N_{proj} =14 for ^{28}Si beam. The apparent charged particle excitation of the quasiprojectile is reconstructed for every projectile fragmentation event using the formula

$$E^*_{app} = \sum_f (T_f^{QP} + \Delta m_f) - \Delta m_{QP} \qquad (2)$$

where T_f^{QP} is the kinetic energy of the fragment in the reference frame of the quasiprojectile and Δm_f and Δm_{QP} are the mass excesses of the fragment and quasiprojectile.

We carried out a comparison of the experimental observables to the results of the simulations. For a description of the production

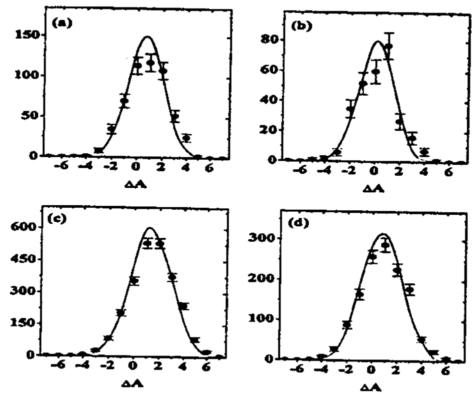

Figure 1: Experimental (circles) and simulated (lines) distributions of the mass change for fully isotopically resolved quasiprojectiles with $Z_{tot} = 14$, (a) - 30 MeV/u, ^{112}Sn, (b) - 30 MeV/u, ^{124}Sn, (c) - 50 MeV/u, ^{112}Sn, (d) - 50 MeV/u, ^{124}Sn.

of excited quasiprojectiles we used the Monte Carlo code of Tassan-Got et al. [2]. This code implements a version of the model of deep inelastic transfer suitable for simulations using a Monte Carlo technique. We simulated the deexcitation of highly excited quasiprojectile using the statistical model of multifragmentation (SMM) [3]. The target deexcitation was not taken into account as a contributing source of the charged particles at the forward angles. The simulated events were filtered by the FAUST software replica.

The results of the simulation are shown in Figs. 1,2. Simulated distributions of the mass change for fully isotopically resolved events with Z_{tot} = 14 (lines) are plotted in Fig. 1 (circles represent experimental data). In Fig. 2 are shown simulated distributions of the apparent quasiprojectile excitation energy for both $Z_{tot} = 14$ and $Z_{tot} = 12 - 15$ (histograms labeled as A and B) along with experimental data (circles

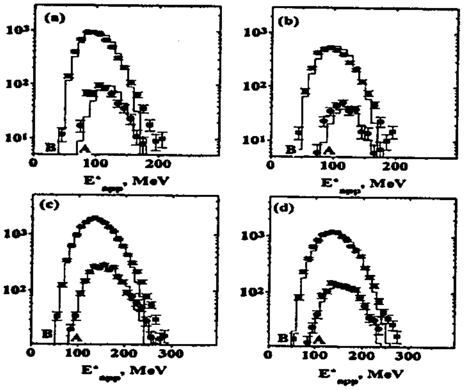

Figure 2: Distributions of reconstructed apparent excitation energies of the quasiprojectiles. Symbols mean experimental distributions of the isotopically resolved quasiprojectiles with $Z_{tot} = 14$ (solid circles) and $Z_{tot} = 12 - 15$ (solid squares). Solid histograms labeled as A and B mean simulated distributions for $Z_{tot} = 14$ and $Z_{tot} = 12 - 15$, (a) - (d) as in Fig. 1.

and squares). The simulated data have been normalized to the sum of experimental events with $Z_{tot} = 12 - 15$. The agreement of the experimental and simulated distributions of the mass change and apparent excitation energy is good for all cases.

Using a backtracing procedure we estimated the ranges of contributing angular momenta in the simulated data. The mean values are 186 and 203 $\hbar$ for ^{112}Sn and ^{124}Sn targets at 30 MeV/nucleon and 243 and 263 $\hbar$ at 50 MeV/nucleon, respectively. Corresponding widths of distributions are 20 $\hbar$ at 30 MeV/nucleon and 29 $\hbar$ at 50 MeV/nucleon. Obtained range of contributing angular momenta means that the projectile and target nuclei overlap only partially and the collisions are peripheral. This conclusion is consistent with the model assumptions of used model of deep inelastic transfer where only slow radial relative motion of the projectile and target is assumed. Using the backtracing procedure we further estimated the mean multiplicity of emitted neutrons. Mean values of the multiplicity of emitted neutrons are 0.9 and 1.2 for ^{112}Sn and ^{124}Sn targets at 30 MeV/nucleon and 1.4 and 1.7 for ^{112}Sn and ^{124}Sn targets at 50 MeV/nucleon. Such multiplicities of emitted neutrons imply that the N/Z ratio of the reconstructed quasiprojectiles gives realistic estimate of true isospin of the fragmenting system.

References

[1] F. Gimeno-Nogues *et al.*, Nucl. Inst. and Meth. In Phys. Res. A **399**, 94 (1997).

[2] L. Tassan-Got, C. Stéfan, Nucl. Phys A **524**, 121 (1991).

[3] J. P. Bondorf *et al.*, Phys. Rep. **257**, 133 (1995).