Distribution of Isospin During Fragmentation of Excited Quasiprojectiles in the Reactions of ^{28}Si + ^{112}Sn and ^{124}Sn at 30 and 50 MeV/nucleon.

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Early work by Lamb [1] laid the foundations for treating the nucleus as a two component system although the results were not connected to multifragmentation. Statistical calculations describing multifragment disassembly predicted that much of the neutron excess would be observed as free neutrons [2]. Thermodynamic calculations by Müller and Serot [3] lead us to the idea that, for the very neutron rich systems, there may exist a distribution of the excited nuclear matter into a neutron rich gas and a more symmetric liquid. The difference of the mean N/Z ratio of the light charged particles (LCP) and of the intermediate mass fragments (IMF) may be a possible experimental signature of a separation into a gas (resulting mostly in emitted LCPs) and a liquid (IMFs). In our recent work [4] we presented the characteristics of the quasiprojectiles with $Z = 12 - 15$, reconstructed from fully isotopically resolved fragments with $Z_f \leq 5$, detected in the forward angles. The data were obtained using FAUST multidetector array [5] at Cyclotron Institute of Texas A&M University in the reaction of ^{28}Si beam with ^{112,124}Sn targets at projectile energies 30 and 50 MeV/nucleon. For this data we demonstrate that, in a well defined system that has isotopic identification of all charged fragments, the mean value of N/Z ratio of LCPs is more sensitive to N/Z of quasiprojectile than mean N/Z ratio of IMFs. The more proton rich the system is the stronger it will favor breaking up into still more proton rich light fragments while the N/Z ratio of heavier fragments remains relatively insensitive.

Since the experimental setup does not detect free neutrons it is important to see if this might bias the data. The effect of including

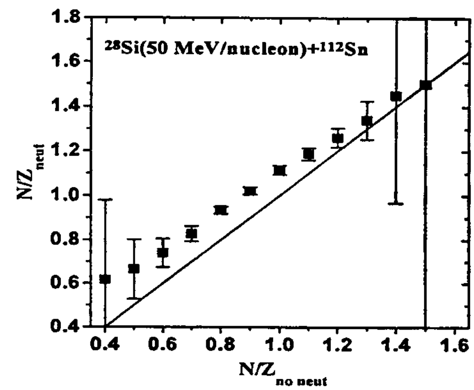

Figure 1: Average neutron to proton ratio of all particles emitted from the quasiprojectile versus those bound in charged fragments for reaction ^{28}Si(50MeV/nucleon)+^{112}Sn. Symbols represent the hybrid DIT/SMM calculation. Solid line indicates the case $N/Z_{neut} = N/Z_{noneut}$.

emitted neutrons in the calculation of N/Z_{QP} was simulated using hybrid simulation combining the model on deep inelastic transfer and statistical model of multifragmentation with the FAUST software replica. The N/Z ratio of quasiprojectile with and without including emitted neutrons tracks very well together as may be seen in figure 1.

In figure 2a we show the multiplicity of charged particles versus N/Z_{QP} for the reaction ^{28}Si+^{112}Sn at 50 MeV/nucleon. The squares represent the multiplicity of all charged particles. The multiplicity of charged particles increases as N/Z_{QP} decreases. This is then broken down into the multiplicity of light charged particles (circles) and the multiplicity of intermediate mass fragments (triangles). Here we can see that the multiplicity of LCPs increases with decreasing N/Z_{QP}. Meanwhile the multiplicity of IMFs increases as N/Z_{QP} increases. The results of hy-

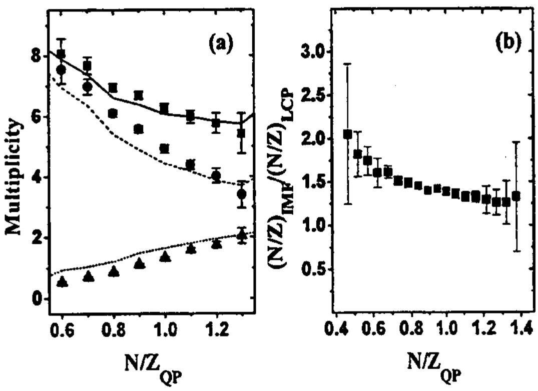

Figure 2: (a) - Multiplicity of all charged particles (squares), light charged particles (circles) and intermediate mass fragments (triangles) versus N/Z_{QP}. Corresponding lines represent the hybrid calculation. (b) - Experimental ratio of mean values of N/Z ratios of light charged particles and intermediate mass fragments versus N/Z_{QP}. Data are given for reaction ^{28}Si(50MeV/nucleon)+^{112}Sn.

brid calculation (lines) are consistent to the experiment. In figure 2b we show the ratio $(N/Z)_{IMF}/(N/Z)_{LCP}$ as a function of N/Z_{QP}. The ratio increases with decreasing N/Z_{QP}. As there are less neutrons available the excess protons go into the smaller fragments rather than the larger fragments. The least neutron rich quasiprojectiles with $N/Z_{QP} \approx 0.5$ prefer to breakup into very neutron deficient LCPs and much more neutron rich IMFs. This inhomogeneous isospin distribution washes out rapidly as N/Z_{QP} approaches region of β-stability. Such a behavior may be understood when taking into account that N/Z range of detected LCPs is much wider than N/Z range of IMFs where usually only few stable and nearly stable isotopes are produced. The observed inhomogeneous isospin distribution is likely caused by more favorable energy balance of the deposition of proton excess into LCPs, either free protons or light proton rich clusters. Based on data presented here, there is a question if an phase transition analogous that one described in [3] may be expected for very proton rich fragmenting systems. Our data may be considered as an argument in favor of such a scenario.

References

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