

Isospin dependence of fragmentation

S. N. Soisson, A. S. Botvina, B. C. Stein, G. A. Souliotis, D. V. Shetty, S. Galanopoulos,
S. Wuenschel, Z. Kohley, L. W. May, and S. J. Yennello

In nuclear reactions there is a strong interplay between many nucleons that can lead to fast equilibration of a nuclear system. Multifragmentation reactions provide valuable information about hot nuclei surrounded by other nucleons and nuclei, which provides an environment similar to that of supernova interior as they are highly excited and equilibration properties can be constrained [1]. Understanding how the equation of state behaves in supernova matter is important in constructing the abundances of chemical elements in the universe however current models have used only “average” nuclei as the starting point of the models [2] or only take into consideration long-lived nuclei where neutron rich nuclei are in cold or slightly excited states [3]. Neither of these methods is truly sufficient for the accurate treatment of supernova processes as they distort the true statistical ensemble in many cases.

Using the Forward Array Using Silicon Technology, FAUST, a beam of ^{32}S was reacted with $^{112,124}\text{Sn}$, $^{\text{nat}}\text{Au}$ at 45 MeV/nucleon to probe the isospin dependence of nuclear fragmentation from multi-

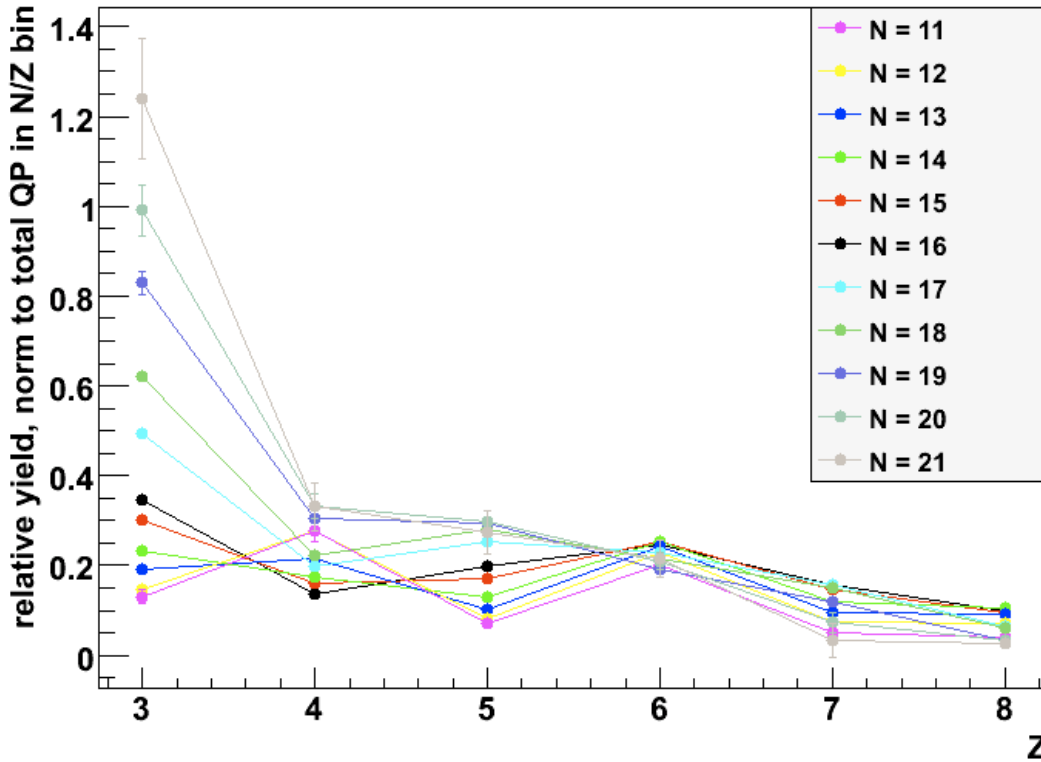


FIG. 1. Charge distribution of fragment for reconstructed quasiprojectile sources with $\sum Z=16$ and $\sum N= 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21$. The yield of each element is normalized to number of quasiprojectiles in a given source.

fragmentation processes [4,5]. FAUST consists of 68 Si-CsI(Tl) telescopes arranged in 5 concentric rings which span from approximately 1.6 to 45 degrees. The arrangement along with the asymmetry in the size of the projectile and target allows for complete reconstruction of the projectile from the resulting fragments. A reconstructed quasi-projectile is generated for each event by summing the charge and mass collected. Free neutrons are neglected in this process as FAUST does not have the capability to detect free neutrons. Focusing only on the reaction $^{32}\text{S} + ^{112}\text{Sn}$, the isospin dependence of the fragmentation is currently being studied. Fig. 1 shows the change in the charge distribution as a function of neutron

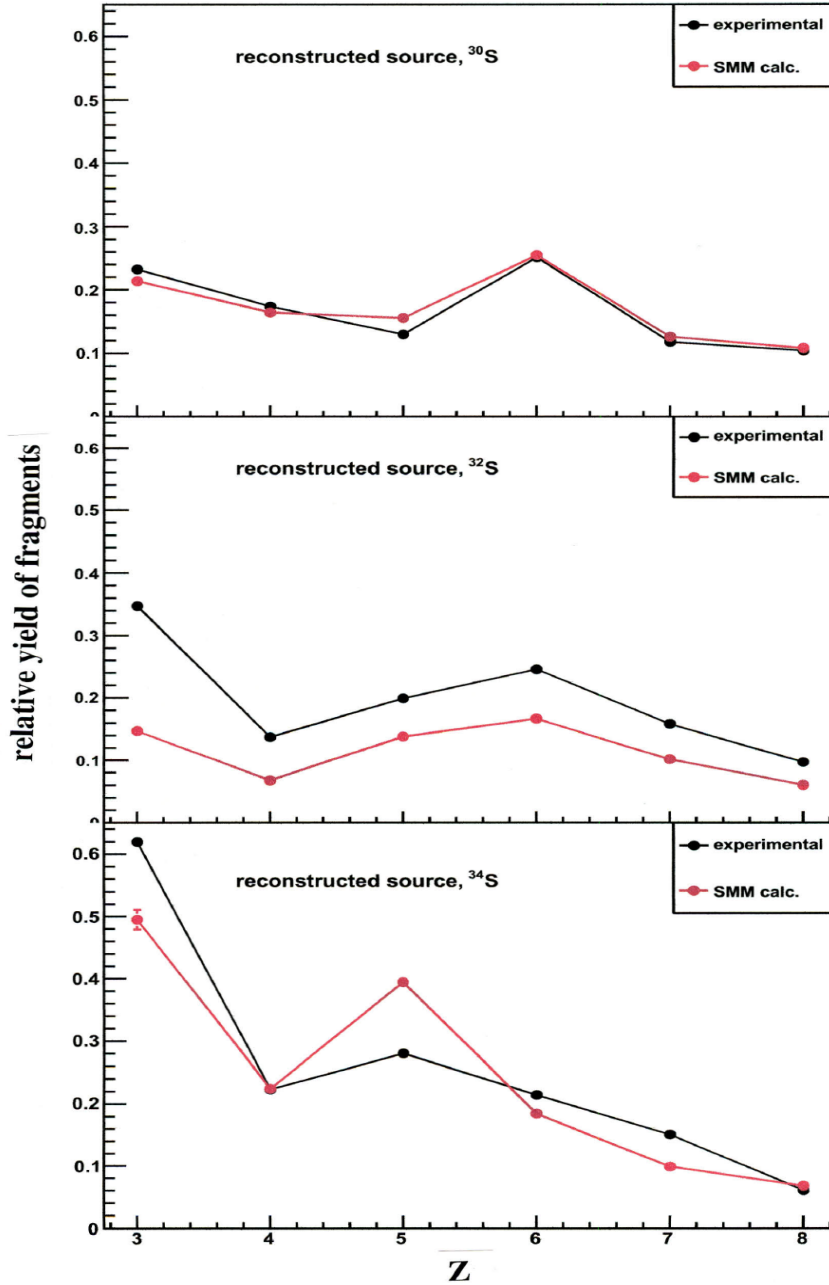


FIG. 2. Charge distributions of fragments from reconstructed quasiprojectile sources 30S (top), 32S (middle), and 34S (bottom) from the experimental data (black) and SMM (red).

content of quasi-projectiles whose charge is that of the beam, 16. The yield of each element is normalized to the number of quasi-projectiles in a given source. For the most neutron poor quasi-projectiles (ex. $N = 11$) one can see that there is a prominent “zig-zag” behavior which occurs in the range of $Z = 3$ to 8. As the neutron content increases the “zig-zag” behavior dampens and the resulting shape of the charge distribution becomes more power law like (ex. $N = 21$). SMM, the Statistical Multifragmentation Model [6], has been used to attempt to model this behavior. The results are presented in Fig. 2 for the quasi-projectiles ^{30}S , ^{32}S and ^{34}S . As one can see, the SMM does a reasonable job at predicting the shape of the charge distribution. For ^{30}S , the shape has a prominent “zig-zag” pattern, ^{32}S the “zig-zag” pattern dampens but the SMM predicts the normalized yield to be lower. In contrast, the ^{34}S has a very different shape to the charge distribution in comparison to the previous examples and the SMM is able to predict that shape reasonably well. From this observation we are beginning to look at the underlying properties of these experimental signatures and constrain the EOS for supernova processes through a better experimental definition of the populated statistical ensemble.

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