Proximity effect in multifragmentation events

Lauren Heilborn, G. Souliotis, S. Soisson, P. Cammarata, P. Marini, L.W. May, A. McIntosh, A. Raphelt, B. Stein, and S.J. Yennello

The relationship between the N/Z of the fragmenting source and the nature of its subsequent fragmentation was studied in the reaction of ^{32}S on ^{112}Sn at 45 MeV/nucleon. Isotopically resolved light charged particles (LCP) and intermediate mass fragments (IMF) were measured with the Forward Array Using Silicon Technology (FAUST) [1]. The velocity distribution of ^{7}Li was observed to be asymmetric and backward peaked in the frame of the moving quasiprojectile (QP) [2]. The QP consisted of all detected charged particles in a given event. The shape of the velocity distributions seemed inconsistent with dynamic effects, so a simple numerical ratio was determined between the number of particles emitted in the "forward" direction and the "backward" direction, in the frame of the QP. In this ratio, a value greater than 1 means there are more particles of a particular type emitted forward than back in multifragmentation events. The experimental data, shown in Fig. 1, demonstrates that lower neutron-content particles, as well as larger Z fragments, are emitted in a more forward direction, while lower Z and more neutron-rich fragments favored backward emission.

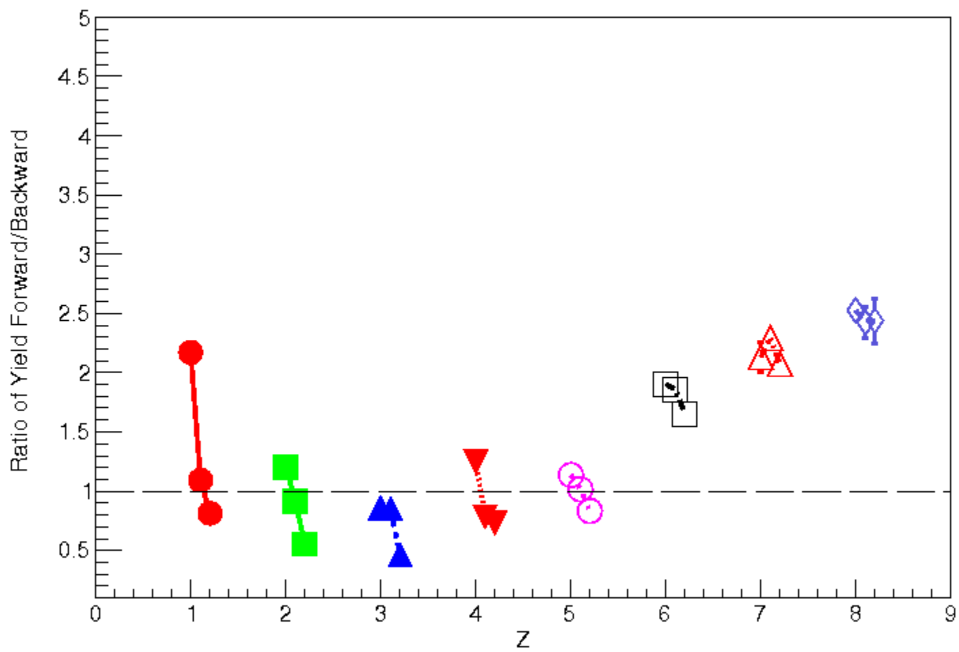

FIG. 1. Ratio of the number of low-Z particles emitted forward of the QP vs. the number emitted backward. Symbols represent fragments of the same Z, and within an element. For example, the circles represent, from left to right, protons, deuterons, and tritons.

In order to investigate the velocity distributions of the emitted fragments in the beam direction of the center-of-mass of the QP, and an effect caused by the Coulomb field of the quasitarget (QT). The Deep-Inelastic Transfer/Statistical Multifragmentation Model (DIT/SMM) code was run for this system at different distances between the QP and the QT at the time of breakup. The DIT creates an excited QP [3]. The SMM simulates the breakup of this excited QP [4]. The unfiltered DIT/SMM longitudinal velocity distribution was approximately Gaussian in shape, and the ratios for all fragments were centered about 1.

The proximity of the QP to the QT at the time of breakup in SMM does affect the distribution of fragments in the QP frame. When the QT is more than 60 fm/c from the QP at the time of the breakup, the ratios of forward to backward emitted particles remain centered at 1. When this SMM data is run through a software "filter," for the purpose of emulating real collisions which are detected by the FAUST array, the ratios shift to higher values, as more of the forward particles may be geometrically accepted. As the QT is moved to a closer proximity, the SMM data matches the experimental data qualitatively more closely. Fig. 2 shows the ratios of particles emitted forwards vs. backwards in the frame of the QP, plotted as the experimental data in Fig. 1. Similar trends are observed in both; however, the SMM data does not match numerically. Below a distance of 20 fm/c in time, the ratios do not differ much, as the QP and QT may not have completely separated at the time of multifragmentation.

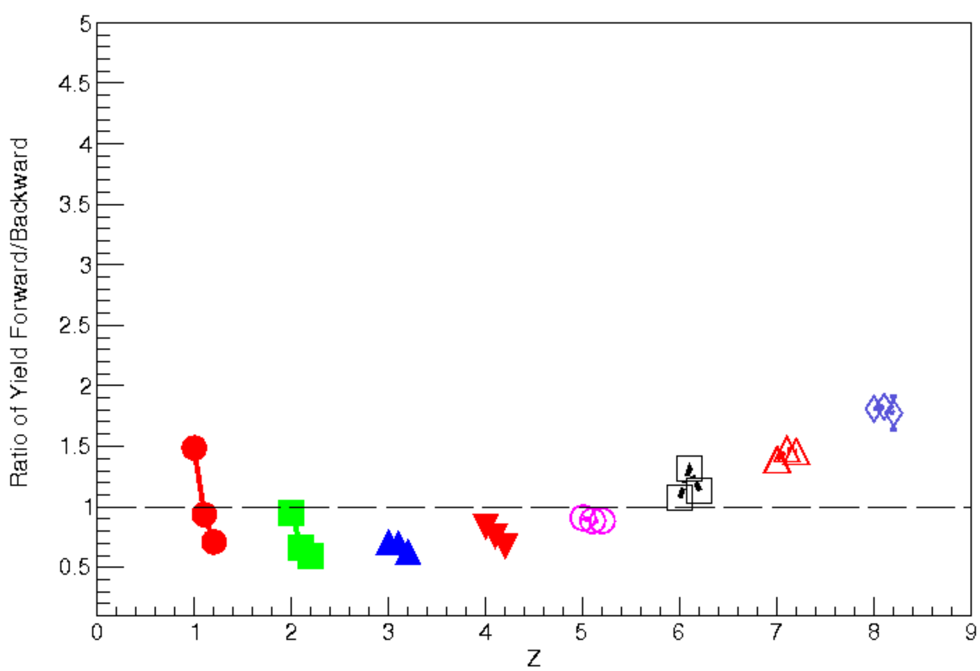

FIG. 2. Shows the same ratio and visualization scheme as used in Figure 1. These ratios were calculated for data from DIT+SMM simulation, with 20 fm/c between the QP and the QT, after the simulated data had been geometrically and energetically "filtered" to emulate actual data through the FAUST detector.

The effect is diminished when the experimental filter is applied. None of the proximity options shown scaled to the shapes of the originally observed distributions of ^{7}Li and other LCPs from the experimental data. Investigation of the source of the asymmetric velocity distributions of fragments is ongoing, and includes data from other systems of reactions.

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