Study of limiting fragmentation in nucleus - nucleus interactions at 14.6 A GeV

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Introduction

Heavy ion collider experiments provide us a unique opportunity to study the unusual phenomena happening in nucleus - nucleus interactions at relativistic high energies. Among these phenomena, limiting fragmentation retain it's own unique significance from the very begining since it was first proposed by J. Benecke et al. [1] in 1969. This hypothesis has been confirmed experimentally in a wide range of processes such as proton - proton interactions, proton - nucleus and nucleus - nucleus interactions [2–5] at different energies. In present paper, we discuss our extensive analysis on the limiting fragmentation behaviour of projectile helium fragments in nucleus - nucleus interactions at 14.6 A GeV energy. For this purpose, we have made a detailed study of the projected angular distribution and transverse momentum distributions of projectile helium fragments in individual helium channels.

Experimental Details

A stack of Fuji emulsion pellicles exposed horizontally with a ^{28}Si beam at 14.6 A GeV at BNL AGS, was used to obtain the present data for our analysis. To locate the minimum bias ^{28}Si-emulsion interaction events, conventional along-the-track scanning technique was used.The emulsion pellicles were scanned by using an OLYMPUS BH2 microscope with a 100 × oil immersion objective under a total magnification of 2250. Each primary beam track in emulsion pellicles was carefully followed up to a distance of 4 cm from the entrance edge. Total 855 inelastic events were taken into account for our investigation purposes. Charged secondary particles emitted in each interactions were divided according to their ionization, range and velocity into black (b), grey (g), shower (s) and projectile fragments (PF_s). PF_s are having charge $Z \geq 2$ and are emitted in a narrow forward cone. For Z = 2 case, we denote the PF_s as helium fragments. Helium fragments are identified from their grain density solely, which is about 4 g_{min}.

Results and discussions

In Fig.1, the projected angular distibution of projectile helium fragments in each individual helium reaction channels is fitted with a Gaussian function of the form $N(\theta_P) = A\exp(-\theta_P^2/2\sigma^2)$. Projected angular distribution for each individual helium reaction channel is displayed with their respective standard deviation width σ. Here different reaction channels deals with collision events ranging from the interactions at small impact parameters to the interactions at large impact parameters. From Fig.1, we can observe that standard deviation width of the projected angular distributions for 2He, 3He and 4,5,6He channel (i.e. for quasi - central to extreme peripheral interaction events) are comparable to each other within experimental errors. Whereas the value of σ for 1He channel (i.e. for non peripheral interactions) events shows a considerable deviation which is not comparable to the value of σ for the peripheral collision events. Extending our discussion on the limiting fragmentation scenario, we have shown transverse momentum distributions of projectile helium frag-

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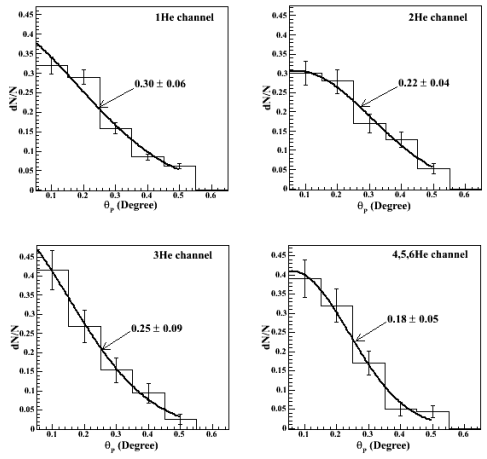

FIG. 1: Projected angular distribution for projectile helium (Z=2) fragments in individual helium reaction channels. Solid curve is a Gaussian fit to the data points.

ments in individual helium reaction channels in Fig. 2, which will consolidate our observations in more convincing fashion. In Fig. 2, the standard deviation width σ of transverse momentum distribution of projectile helium fragments in 2He, 3He and 4,5,6He channel are found to be comparable to each other with a little high value of σ in the case of 3He channel which may be due the large contribution of helium fragments at small transverse momentum value for 3He channel. While, in the case of 1He channel, the standard deviation width σ of transverse momentum distribution is quite massive which shows a large inconsistency from the values of σ for other higher helium reaction channels (i.e. quasi - central and peripheral collision events). Thus, the projected angular distribution and transverse momentum distribution of projectile helium fragments suggests that hypothesis of limiting fragmentation for projectile helium fragments holds good qualitatively for quasi-central and peripheral collision events in nucleus - nucleus interactions at 14.6 A GeV energy.

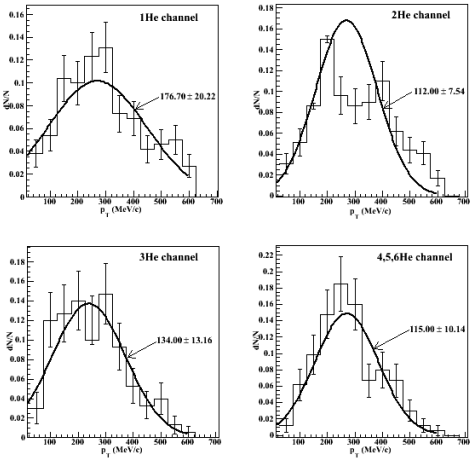

FIG. 2: Transverse momentum distribution of projectile helium (Z = 2) fragments in individual helium reaction channels. Solid curve is Gaussian fit of the data points.

Acknowledgments

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