Charge Effect on projectile fragments dispersion for different colliding systems

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Introduction

Multi-particle production and multi-fragment emission are crucial phenomena in high energy heavy ion interactions. Availability of beams of heavy ions with relativistic energies has made it possible to use nuclear collisions to study properties of nuclear matter of finite temperature and high densities. The detail studies on dependence of the emission angle of projectile fragments at various experimental and colliding system parameters helps us in understanding the reaction mechanism and provide informations about the fragmentation properties. The participant-spectator model is the base line model for the study of the high energy nucleus-nucleus collisions. One of the models extensively used for studying nuclear collisions is the hydrodynamical model which predicts collective effects on hydrodynamical compression of the nuclear matter [1]. Collective effects may be exhibited in various forms depending on the collision conditions. In near relativistic heavy-ion projectile fragmentation case the width of the angular dispersion distribution depends on the charge number of the fragment. The greater the charge number, the smaller is the width of the distribution [2].

In the present paper we report on the emission angle dependence of projectile fragments on the charge of the fragments as well as on the different target groups of the detector.

Experimental Detail

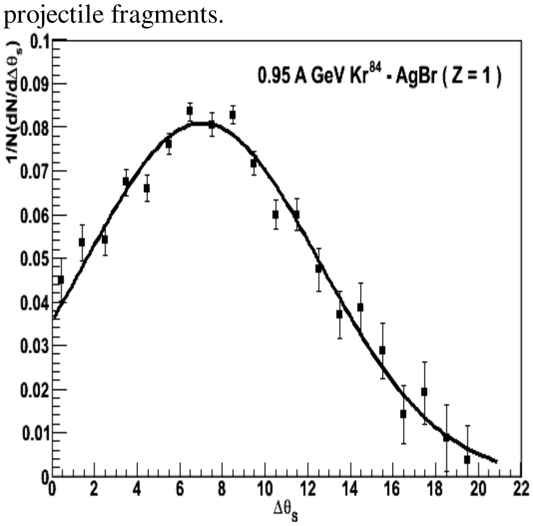
Nuclear emulsions provide a very good angle resolution hence to see the effects of fragment emission direction can be considered reasonably accurate. This kind of detectors has been widely used in the investigations of nuclear fragmentation [3]. In the present paper, we report on the emission of projectile fragments depends on the charge of the fragments as well as type of the target. In this experiment we collected high statistics of around 1 A GeV ^{84}Kr-Em inelastic interactions. Since nuclear emulsion is a composite target, thus the incident ^{84}Kr projectile will interact with either one of the following components: the free hydrogen, the light CNO and heavy Ag(Br) nuclei. The target separation has been done on the basis of target breakup. Projectile fragments are classified in three main classes such as single, double and multiple charge fragments based on the grain, blob and hole density measurement methods [4].

All Projectile fragment emission angles of minimum bias events have been determined from the vector directions of the incident projectile and emitted fragment tracks obtained by measuring of the x, y and z coordinates at three closest points from the interaction vertex separated by 50 µm each along the projectile and along the each fragments using Olympus BH-2 optical binocular microscope having 2250X magnification and 0.5^o least count [4]. The emission (space) angles is calculated as θ_s=Cos^{-1} (Cos θ_p* Cos θ_d), where θ_p and θ_d are projected and dip angles and are calculated as follows θ_p= Tan^{-1} ($\Delta y/\Delta x$) and θ_d = Tan^{-1}(Δz *S)/ $(\Delta x^2+\Delta y^2)^{1/2}$, where Δz is change in z Co-ordinate in a distance x and y in the (x-y) plane and S is the shrinkage factor. The calculated value of shrinkage factor is 3.3.

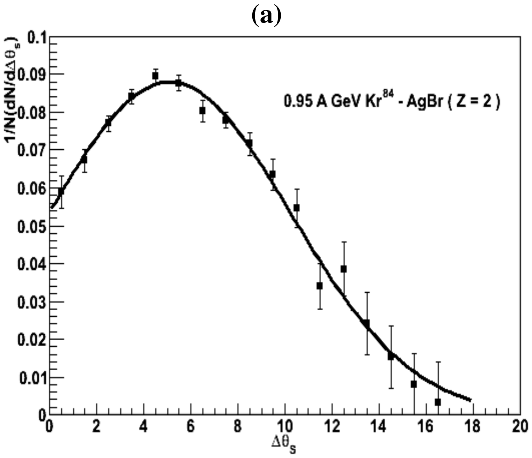
Results

The Fermi motion is considered to have influence on the angular distribution of emitted particles. Therefore it is important to understand the angular distribution of projectile fragments in interactions. The normalized emission angle distribution of all the identified projectile fragments groups, such as single, double and multiple charge (z), shown in figure 1 (a, b & c) for Ag(Br) target group. Solid line is the Gaussian fit to the data is also shown in the figure.

It can be seen from the figure 1c that almost all heavier (z>2) projectile fragments are confined to a narrow forward cone peaking at $1.78^0 \pm 0.34^0$, showing small dispersion from the direction of the (^{84}Kr) projectile. From figures 1a&b, it can be seen that as charge of the projectile fragments decreasing their dispersion from the projectile direction are increasing, as shown by the mean value of the Gaussian fitting for z=2 and 1 as $5.10^0 \pm 0.12^0$ and $7.05^0 \pm 0.13^0$, respectively. Almost 80 percent alphas projectile fragments are concentrated in the 5^0 forward cones. From figure it is clear that the Coulomb force is acting differently for different charge projectile fragments.



(a)



(b)

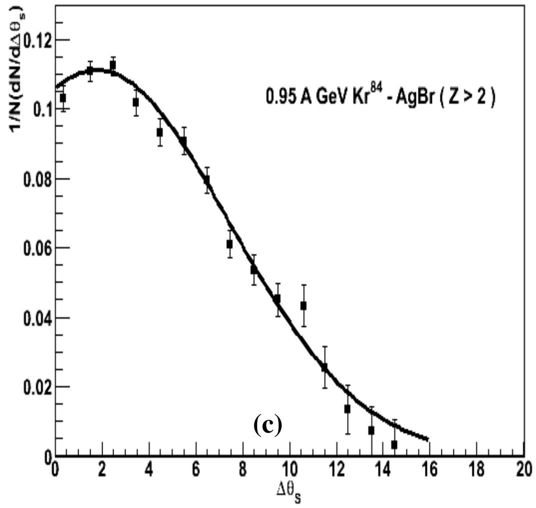


Fig. 1: Normalized distribution of angular separation between **(a)** single (z =1) **(b)** double (z = 2) **(c)** multiple (z>2) with other (z>1) charged projectile fragments in case of Ag (Br) target.

We will present similar study for other target groups such as H, CNO and compare our results with others. To check the collective effect of nuclear matter, event-by-event angular dispersion of quasi-central events will also be present [5-8].

References

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