Extended Glauber Model and Nuclear Fragmentation Characteristics of $^{84}Kr_{36}$ Projectile

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Introduction

Investigation of nuclear fragmentation and its possible connection with a critical phenomenon in nucleon-nucleus or nucleus-nucleus interactions of relativistic heavy nuclei have been the subject of active research in experimental as well as theoratical physics. These studies reveals the information about fragmentation mechanism of nucleus-nucleus interactions at relativistic energy. According to the P-S Model (Participant-Spectator Model) [1], the overlapping region of nuclear volumes of two colliding nuclei is called the participant part where multiple production of new particles occur. The remaining parts of nuclei that do not participate in the interactions are called the spectator regions of projectile and target nuclei. In participant region during production process, a fraction of available energy is transferred to the spectator parts of colliding nuclei, leaving those nuclear remnants in an excited state [1]. After this stage, the deexcitation of the nuclear remnants takes place. The latter process, called nuclear fragmentation, particularly the fragmentation of the relativistic projectile nucleus [1].

The aim of the present article is to investigate the breakup of relativistic $^{84}Kr_{36}$ nuclei during interactions with the different target nuclei in nuclear emulsion at 1 GeV per nucleon.

Experimental detail

Nuclear emulsion detector is composed of silver halide crystals immersed in a gelatin matrix consisting mostly of hydrogen, carbon, nitrogen, oxygen, silver and bromine while a small percentage of sulfur and iodine are also present. In the present experiment, we have employed a stack of high sensitive NIKFI BR-2 nuclear emulsion pellicles of dimensions 9.8x9.8x0.06 cm^3, exposed horizontally to $^{84}Kr_{36}$ ion at kinetic energy of around 1 GeV per nucleon. The exposure has been performed at Gesellschaft fur Schwerionenforschung (GSI) Darmstadt, Germany. Interactions were found by along-the-track scanning technique well described in Ref.[1]. A total of 700 inelastic events produced in $^{84}Kr_{36}$-emulsion interactions were located. In the present analysis, out of 700 there are 570 events having fulfilled the required criteria of further investigation [1].

All charge secondary emitted or produced in an interaction are classified in accordance with their ionization, range and velocity into the following categorie:

(a) Shower tracks (N_s): These are freshly created charged particles with normalized grain density $g^* < 1.4$ and relative velocity $\beta > 0.7$. They are mostly fast pions with a small admixture of Kaons and released protons from the projectile which have undergone an interaction.

(b) Grey tracks (N_g): Particles having ionization in the interval $1.4 < g^* < 6.0$ and range L > 3 mm are defined as greys. This particle has relative velocity (β) in between $0.3 < \beta < 0.7$.

(c) Black tracks (N_b): Particles having range L > 3 mm from interaction vertex from which they originated and $g^* > 6.0$. This particle has relative velocity $\beta < 0.3$.

The number of heavily ionizing charged particles ($N_h = N_b + N_g$) depends upon the target

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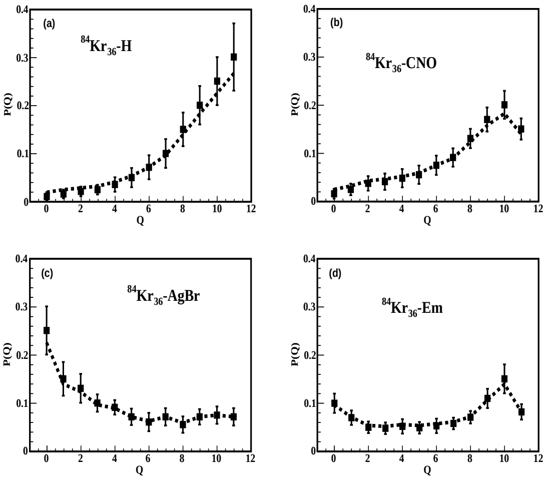

FIG. 1: (a)-(d) The experimental (points with error bars) and calculated (curves) total charge distributions of nuclear fragments in the interactions of $^{84}Kr_{36}$ projectile with: (a) H target events, (b) CNO target events (c) AgBr target events (d) Em target events.

breakup. Therefore we used such distribution to fix criteria for target separation [1].
(I)Ag / Br target events: $N_h \geq 8$ and at least one track with R < 10 μm is present in an event.
(II)CNO target events: $1 < N_h < 8$ and no tracks with R < 10 μm are present in an event.
(III)H target events: $N_h \leq 1$ and no tracks with R < 10 μm are present in an event.
In each event, Z_{max} is the maximum possible charge of a given projectile fragment. The total stripped charge of the projectile fragments Q is defined as Q = $\Sigma n_i Z_i$, where n_i is the number of projectile fragments with charge $Z_i \geq 1$ and the summation is carried out over all such fragments in an event.

Result and Discussion

Figures 1(a)-1(d) exhibit the comparison of calculated total charge distributions of nuclear fragments P(Q) with those experimentally measured in interactions of the $^{84}Kr_{36}$ projectile with different components of emulsion nuclei at around 1 GeV per nucleon. The curves are calculated according to the Glauber extended model [2]. The Figures 1(a)-1(d) reveals the good agreement between the experimental and calculated distributions. The shapes of the distributions are very different. The total charge Q of the spectator fragments also showing the dependence on the impact parameter (indicated by n_h) i.e., these distributions strongly depends on the mass of the target nuclei. For the collisions with quasi-nucleon target ($^{84}Kr_{36}$-H events) the Q distribution is peaked close to the charge Z_p of the primary, and essentially does not extend below $Z_p/2$ while in the collisions with heavier targets ($^{84}Kr_{36}$-AgBr events) the distribution is almost flat over the entire Q range. This behavior results in the decrease of $< Q >$ with the increase of the target mass [2]. Thus we can conclude that the total charge distributions of nuclear fragments are well described by the predictions of the extended Glauber model [2].

References

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