Emission characteristics of the single charged projectile fragments emitted in ^{84}Kr$_{36}$ + Em interaction at 1 GeV per nucleon

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1. Introduction

Collisions at relativistic energy are linked to nuclei as well as elementary particles, cosmic rays, astronomy, and other fields. The nuclear emulsion detector is one of the earliest detectors, having been used from the beginning of experimental nuclear and astroparticle physics [1,2]. The multiplicity distribution study of projectile fragments help to understand the process of nucleus-nucleus collisions and reveals information on particle production mechanisms. The multiplicity of single charged projectile fragments produced in ^{84}Kr + Emulsion interaction at 1 A GeV are reported in the present article.

2. Experimentl Details

The exposure of the nuclear emulsion detector has been performed at Gesellschaft fur Schwerionenforschung (GSI) Darmstadt, Germany. Nuclear emulsion detector is a mixed target detector, it contains the sum of H, C, N, O, Ag, Br with small percentage of I and S. ^{84}Kr nuclei used as a projectile with incident kinetic energy of ∼1 GeV per nucleon, containing around 98 to 95 % of ^{84}Kr with 2 to 5 % of impurity. The dimension of nuclear emulsion plates used in this analysis was 9.8 × 9.8 × 0.06 cm^3[1,2]. The event of interest recorded in nuclear emulsion plates was scanned for further physics analysis using Olympus BH-2 binocular microscope. We have used two different scanning methods. One is volume scanning, and second is line scanning. In the present analysis we have used 700 events outof 750 events. The projectile fragments are produced from the projectile spectator segments, which have a charge of $Z \geq 1$. These components of projectiles are further divided into three main groups. Single charge projectile fragments (N$_{z=1}$), double charge projectile fragments (N$_{z=2}$), and multicharge projectile fragments (N$_{z>2}$) [1,2]. The target fragments are divided into three main groups on the basis of relative range (L), normalized grain density (g*), and relative velocity (β). Grey Particles: These particles have L > 3mm, $1.4 < g^* < 6.8$, and $0.3 \leq \beta < 0.7$. Black Particles: These particles have $L \leq 3mm$, g$^* \geq 6.8$, and $\beta < 0.3$. Heavily ionizing charged particles are the sum of black and grey particles and denoted by N$_h$. On the basis on N$_h$ value the emulsion detector is basically divided into three target groups. H-target group having N$_h$ value less than or equal to 1. CNO target group having N$_h$ value in the range of 2 to 8. AgBr target group with N$_h$ value greater than 8 [1,2].

3. Result and Discussion

The multiplicity distribution of the single charged projectile fragments emitted from the interaction of the projectiles ^{84}Kr (1 A GeV) [Present work], ^{28}Si (3.7 A GeV) [3], ^{22}Ne (3.7 A GeV) [3], ^{16}O (3.7 A GeV) [3], ^{12}C (3.7 A GeV) [3] with H-target, CNO-target and AgBr-target of the nuclear emulsion are shown in figure 1,2&3 respectively. Figure 1 and figure 2 show that the first value of the ^{28}Si is very low in both case of the events emitted from interaction with H-target and CNO-target of the emulsion, while after first value it again follow the same emission feature as like

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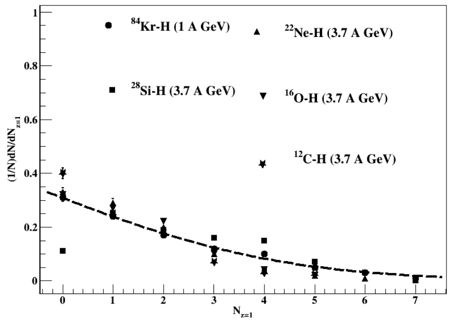

FIG. 1: Multiplicity distribution of the single-charged projectile fragments emitted from the interaction of the different projectiles with H target of the nuclear emulsion.

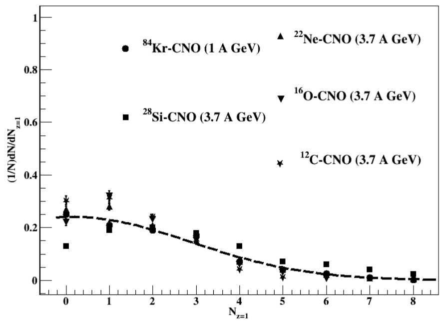

FIG. 2: Multiplicity distribution of the single-charged projectile fragments emitted from the interaction of the different projectiles with CNO target of the nuclear emulsion.

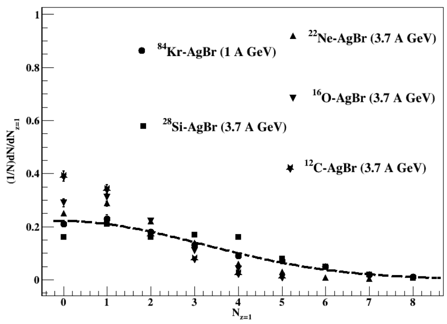

FIG. 3: Multiplicity distribution of the single-charged projectile fragments emitted from the interaction of the different projectiles with AgBr target of the nuclear emulsion.

other projectiles. Figure 3 show that the first value of ^{12}C projectile fragments is higher as compared to other projectiles. Even after this small fluctuations in values, we can see from figure 1,2&3 that the emission feature of the single charged projectile fragments are showing same nature of the distribution and also independency on the interaction with different target group of the nuclear emulsion for all the projectiles fragments even projectiles having different incident kinetic energy. This reveals that the emission of single charged projectile fragments not depending on the interaction with different target group of the emulsion [4].

4. Conclusion

The present analysis show that the emission characteristics of the single charged projectile fragments are showing independency on the interaction of projectile with different target groups of the nuclear emulsion even the projectiles having different mass and incident kinetic energy. Due to the unique feature of this detector technology, presently it is in use of searching for rare events in various experimental collaboration, worldwide, such as OPERA, SHiP-CERN etc.

5. Acknowledgments

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