Multiplicity Characteristics of Target Fragments at Relativistic Energy

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Introduction

Nuclear fragmentation is an important experimental phenomenon in nucleus – nucleus collisions at relativistic high energy [1]. According to the Participant – Spectator (PS) Model [2], the interacting system can be divided in three parts: a target spectator, a participant, and a projectile spectator. The overlapping part of two colliding nuclei is called the participant and the other parts are called the target spectator and the projectile spectator, respectively. The velocity of the participant has a wide distribution from zero to the projectile velocity. The velocity of the target spectator in the laboratory reference frame is almost zero, while the projectile spectator has almost the same velocity as projectile. It is known that violent collision happens in the participant region, and weak excitation and cascade collision happens in the spectator region. The participant produces many mesons, nucleons, photons, and lepton pairs, etc., and the spectator fragments into many nucleons and nuclei [3]. The investigation of target fragments through nucleon – nucleus or nucleus – nucleus interactions has been a field of active research. The difference between projectile and target fragments is easy due to wide difference in their velocities. The projectile fragments corresponding to the spectator part are distinguished in forward narrow cone of $\leq 10^0$, while the produced particles and scattered protons have a much broader distribution. The target fragments are observed as highly ionizing particles, distributed isotropically. They can be black, which are essentially evaporation fragments from the target, or grey particles which are knockout protons or slow mesons [4]. The nuclear emulsion detector having very high position and angular resolution and its composition is acting as target for the projectile to interact, so it is widely used in the investigation of nuclear fragmentation [5].

The aim of the present research is to perform a systematic analysis of target fragmentation in ^{84}Kr with emulsion interaction at around 1 A GeV and compare our result with different energy of same projectile and study the behavior of multiplicity distribution of target fragments with same projectile having different energy.

Experimental Detail

The data were collected by the scanning of NIKFI BR-2 stacks of nuclear emulsion plates having volume 9.8 x 9.8 x 0.06 cm. The plates were irradiated horizontally to around 1.0 A GeV ^{84}Kr beam at GSI, Darmstadt in Germany. Both, line and volume scanning methods were adopted for collection of inelastic interactions with the help of the Olympus BH-2, transmitted light-binocular microscope under 100X oil emersion objectives and 15X eyepieces. The beam tracks were picked up at a distance of 4 mm from the edge of the plate and carefully followed until they either interacted with emulsion nuclei or escaped through any one surface of the emulsion or stopped in the plate [6]. In the measured interactions, all charged secondary particles have been classified according to the range in the emulsion and the relative ionization. Classification of all charge particles has been explained in Ref. [6].

Result and Discussion

The Multiplicity distribution of the Secondary Charged Particles is a useful Parameter to understand the mechanism of Multiparticle particle production in high energy interactions [6]. The Normalized Multiplicity distribution of the target fragments are shown in figure, 1, 2, 3 and 4 for Black, Grey, Heavily Ionizing Particles and Shower particles emitted in ^{84}Kr-Em Interaction at deferent energies, respectively. From figure 1(top) we conclude that the number of event enhanced having $N_b = 0$ and

1 at higher energy. And at low energy, there is an increased population of events having $N_b > 4$.

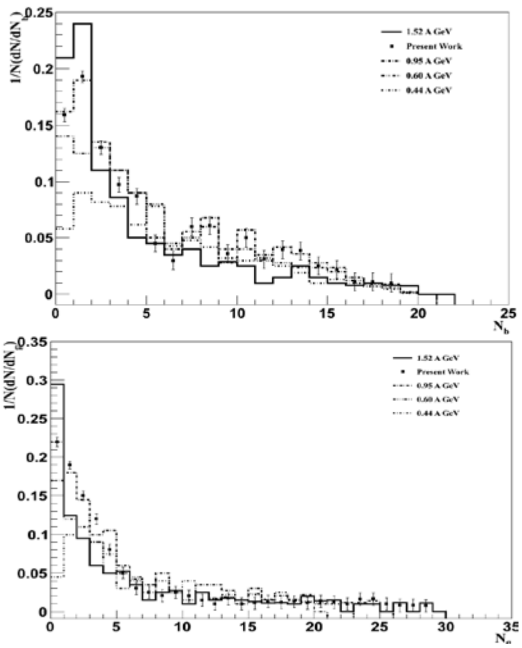

Fig. 1: The normalized multiplicity distribution of the (top) black and (bot) grey particles Produced in ^{84}Kr-Em interactions at different incident energies.

Therefore we can say that the target fragmentation is more effective at low energy. The maximum number of blacks in an event is nearly same in an all the energy interval. The normalized multiplicity distribution of grey particle (figure 1bot) shows that the number of events having $N_g = 0$ increases with increasing beam energy. At high energy, the population of events in the interval $N_g = 0 - 5$ is enhanced, while at low energy the region Ng = 0 – 10 is highly populated. The maximum number of the grey particles in an event increases with increasing beam energy. From figure 2(top), we can observe that the peaks of the distributions shift toward the larger N_h values as we move from high to low energy side. There is a larger population of events at higher value of N_h as the beam energy goes down. The normalized multiplicity distribution of the shower particles (figure 2bot.) shows that the tail of the distributions extends further at higher beam energy. At low energy, the magnitude of the peak is small and the distribution takes an almost uniform shape.

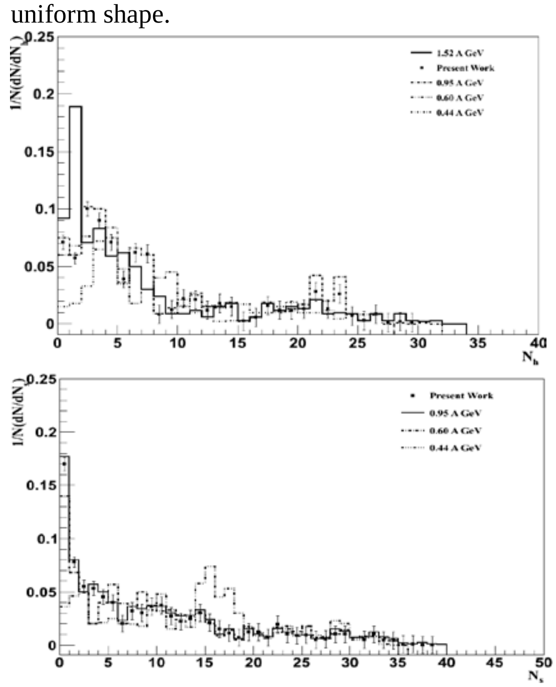

Fig. 2: The normalized multiplicity distribution of the (top) heavily ionizing charged particle and (bot) shower particles.

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