Angular characteristics of particles produced in pion-nucleus interactions

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Introduction

The investigation of particle-nucleus collisions is fundamental for studying the nature of interaction process and the particles produced in such interactions. The present study is based on the multiparticle production using nuclear emulsion technique. Nuclear emulsion is a material which memorizes the tracks of charged particles. Emulsion consists of various elements like hydrogen, carbon, nitrogen, oxygen, silver and bromine. When a beam of high energy particles interacts with the emulsion nuclei, a large number of particles are produced. These secondary particles are categorized as shower, grey and black particles. Shower particles are relativistic pions emitted in the most forward cone. The results presented in this paper are based on such particles only.

In high energy multiparticle production most of the work done is for inclusive interactions that is for all impact parameters, but less attempt has been made to study collisions with less impact parameters. Keeping this fact in mind we chose to study those events which are other than the normal events. Therefore we analyzed the events which are beyond 2 standard deviations (σ) from average value. In the case of inclusive data, the value of σ is 6.48 ± 0.54 and the mean value of relativistic charged particles, $\langle N_s \rangle$, is 14.18 ± 0.08. Thus the events with $N_s \geq \langle N_s \rangle + 2\sigma$, that is $N_s \geq 28$, have been considered for the present study. We can say that these events are high multiplicity events. We cannot say firmly that these are exactly central collision events but may be considered as pseudo central collision events.

In this report, angular characteristics have been studied in terms of pseudorapidity. Two, three and four particle rapidity-gap correlations have also been investigated.

Experimental Procedure

The data was collected using a stack of emulsion exposed to a negative pion beam of momentum 340 GeV/c. To make sure that data sample does not include any secondary interaction, the primaries of all the events were followed back to the edge of the plates and only those events whose primary remained parallel to the main beam direction and which did not show any significant change in their ionization were finally picked up as genuine primary events. The events/interactions were picked up after leaving three millimeters from the leading edges of the emulsion plates. The number of shower, grey and black tracks observed in an event has been denoted by N_s, N_g and N_b respectively. When grey and black tracks are taken together then it is called as heavily ionizing tracks denoted by N_h ($=N_g + N_b$). The detailed discussion about the experimental techniques can be found in our earlier publications [1 – 3]

Results and Discussion

The angular characteristics of relativistic charged shower particles have been studied in terms of pseudorapidity variable, η, defined as $\eta = -\ln \tan\theta/2$ where θ is the space angle with respect to the primary beam. The normalized single particle pseudorapidity distribution of charged secondaries is shown in Fig. 1 for the events $N_s \geq 28$. For comparison the data for $N_h \geq 0$ and $N_h = 0, 1$ are also given in the same figure. No bimodal structure in the distribution is observed. We [4, 5] and Babecki et al have reported similar results for $N_h \geq 0$ data.

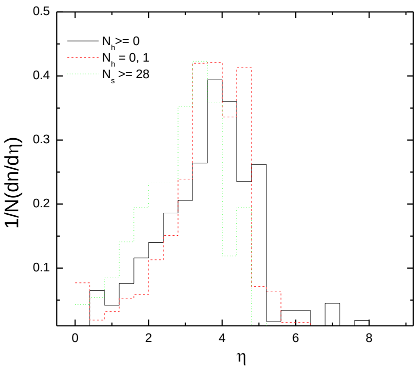

Fig. 1: Pseudorapidity distribution of relativistic charged particles

The method of rapidity gap has been used to study cluster formation that is the particles are supposed to be produced in the form of clusters. For such a study, the pseudorapidity of all the tracks in an event are arranged in increasing order i. e. $\eta_1 < \eta_2 < \eta_3 \ldots\ldots < \eta_n$. The difference between the neighbouring values is calculated for each event, we call this as two particle rapidity gap, the distribution of which is shown in Fig. 2. The excess of events and observation of sharp peaks at the smaller values of gaps is attributed to the existence of short range correlations among secondary particles which is taken as an indication for the formation of clusters.

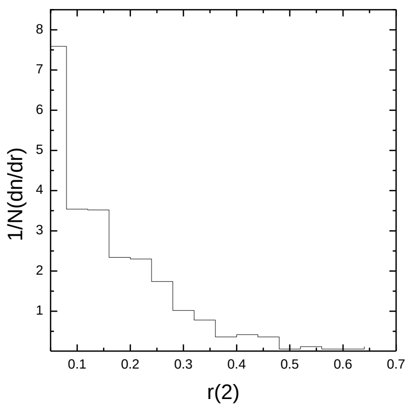

Fig. 2: Two particle rapidity gap distribution for the events $N_s \geq 28$.

Three and four particle rapidity correlations are shown in Fig. 3. No sharp peaks occur at smaller values of rapidity gaps and hence we conclude that higher order correlation do not exist in these interactions.

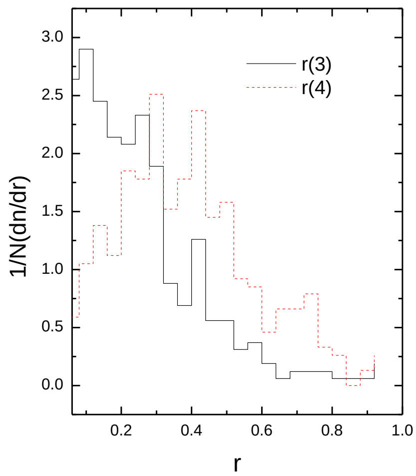

Fig. 3: Three and four particle rapidity gap distribution for the events $N_s \geq 28$.

References

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