Study of Clusters Produced in 4.5 A GeV ^{12}C-Nucleus Interactions

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1. Introduction

The phenomenon of clusterization of secondary charged particles produced in high energy hadron - nucleus collisions has been extensively investigated. [1-4]. However, less attention has been paid to study the characteristics of clusters produced in nucleus - nucleus reactions at relativistic energies [5, 6]. Such studies may provide some interesting information about the mechanism of hadronization of final state charged particles produced in heavy ion reactions. Thus, some interesting results on characteristics of clusters produced in 4.5 A GeV 12C-nucleus interactions are obtained by analyzing the experimental data in terms of pseudo rapidity variable, η[= -ln tan (θ/2)], where θ is the angle of emission of secondary charged particles with respect to mean beam direction in the lab frame.

2. Experimental details

In the present work an emulsion stack comprising of several pellicles of NIKF1- BR-2 nuclear emulsion of standard composition has been used. The pellicles were tangentially irradiated with 4.5 A GeV carban beam at the synchrophyasatron of the Joint Institute for Nuclear Research, Dubna. Russia. The size of each pellicle is 18.7 cm x 9.7 cm x 0.06 cm.All other informations regarding the measurement of angle of emitted relativistic charged particles etc are given in our earlier publications [7, 8].

In order to investigate the cluster characteristics of relativistic charged particles, a random sample of 681 disintegrations caused by 4.5 A GeV carbon nuclei in nuclear emulsion is analyzed. The tracks having relative velocity,β>0.7 are termed as relativistic charged particles which are generally pions.The number of pions produced in an event is denoted by Ns.

3. Experimental results

In order to study some salient features of clusters produced in 12C-nucleus interactions, the values of pseudo rapidity, η are estimated and are arranged in decreasing order for each event. The two-, three-, and four-particle rapidity gap are determined by calculating: η_{i+1}-η_1, η_{i+2}-η_1 and η_{i+3}-η_1, where i=1, 2, 3….respectively.

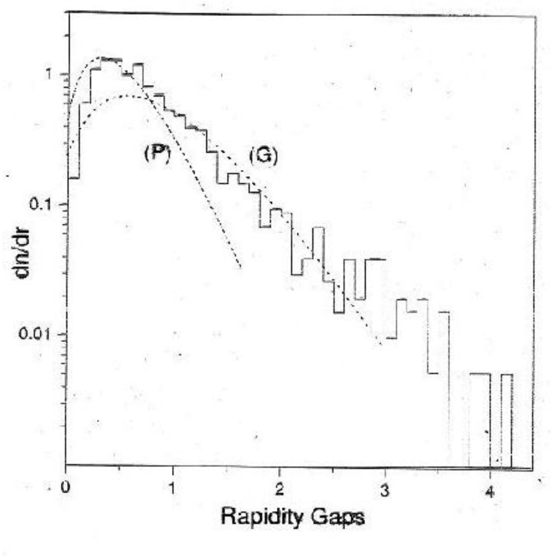
It is observed that the two- and three-particles rapidity gap distributions can be reproduced quite well from the two channel generalization of the Chew-Pignotti model [9] of the form

$$dn/dr=A \exp(-Br)+C \exp(-Dr) \quad (1)$$

Which is expected on the basis of the multiperipheral model Here A and C are the normalization factor. The parameters B and D represent the slop in two parts of the rapidity gap distribution. The parameter B is a measure of the strength of the correlation, while the parameter D is regarded as the cluster density. It is reported that the maximum number of charged particles constituting a cluster is four and the cluster size does not depend on the nature and energy of the projectile[10].

Four- particle rapidity gap distribution is plotted in the figure.It is observed in the figure that sharp peak at relatively smaller values of the rapidity gap does not appear. It may, therefore, be considered that the four- particle rapidity gap correlation does not occur in 4.5 AGeV 12C-nucleus interactions.

In order to examine the behavior of uncorrelated production, the four- particle rapidity gap distribution is compared with Poission distribution. It is evidently clear from the figure that the four-particle rapidity gap distribution does not agree with the Poission distribution. We have also compared the four-



particle rapidity gap distribution with the Wigner distribution [11] of the form

P(x) = (Π/2) xexp (-Πx²/4) (2)

Where x = r/<r>, r and <r> represent the rapidity gap and mean rapidity gap between the nth nearest neighbours respectively, for the entire event considered in the present study. It is seen in the figure that the curve corresponding to Wigner distribution, which is regarded as the nearest neighbor of Gaussian Orthonormal Ensembles (GOE) type distribution, is a nice fit to the four- particle rapidity gap distributions.

4. Conclusion

On the basis of the present investigation we may conclude that the four- particle rapidity gap distribution is GOE like distribution, indicating that two different types of mechanisms are operating for production of final state relativistic charged particles (pions).On comparing the findings of the present work with those obtained in hadron-nucleus collisions in the energy range ~ (24-400) GeV [2],it may be concluded that the mechanism of hadronization of final state charged particles in both hadron-nucleus and nucleus-nucleus is perhaps the same.

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