Multiplicity distributions and correlations of secondary charged particles produced in 60, 200A GeV/c ^{16}O-nucleus interactions.

M. Mohsin Khan[1],* Shakeel Ahmad[2], N. Ahmad[2], M. D. Azmi[2], Kushal Das[2], M. Irfan[2]
[1]*Department of Applied Physics, Aligarh Muslim University, Aligarh - 202002, INDIA*
[2]*Deptartment of Physics, Aligarh Muslim University, Aligarh - 202002, INDIA*
*khanmohsinin@gmail.com

Introduction

Charged particle multiplicity in high energy hadron-hadron(h-h), hadron-nucleus(h-A) and nucleus-nucleus (A-A) collisions are only global measure of the characterstics of the final state produced in these collisions[1,2]. It is of vital importance to explain the mechanism of multiparticle production. From such studies it is a well established fact that the independent emission of single particle leads to poisson type of multiplicity distribution and a deviation from this shape may, therefore, reveals correlations and the underlying dynamics [2]. Study of such aspects, particularly in relativistic and ultrarelativistic heavy-ion collisions[1,2] are envisaged to provide useful information about the phase transition of the hot and dense nuclear matter into hadrons and also provide a unique opportunity to understand the possibility of quark-gluon plasma formation in these collisions. Several models have been proposed to explain the exotic phenomenon of multiparticle production in A-A collisions at high energies[2]. Relativistic A-A collisions are considered to be very messy because their geometry is very difficult and they involve many participating nucleons. Not withstanding these inherent difficulties, characteristics of relativistic nuclear collisions can be instigated by a thorough study of the global observables such as deposition of energy, momentum spectra and distributions of multiplicities of secondary charged particles.

Pseudorapidity variable, η, is also considered as one of the most important kinematical variables. Its distribution is envisaged to yield very useful information about the mechanism of multiparticle production. A study of pseudorapidity gap, Δη, between the produced particles in the η-space is considered of vital importance to look for the existence of correlations and cluster formation[2].

The Data

Two sets of data on the interactions of 60 and 200 A GeV/c ^{16}O-ions with AgBr from emulsion experiments performed by EMU01 collaboration[3] are used in the present study. The number of events are 422 and 223 respectively. The other details of the data, criteria for selecting events and tracks, etc., can be found elsewhere[4]. For comparing the results presented in this study with the model predictions, matching number of events have been generated using AMPT[5].

Results and Discussion

When a large number of particles are produced by smashing heavy-ions at a high energy, a very natural and interesting quantity to study theoretically and experimentally is the mean value of multiplicity. The mean multiplicities of relativistic charged particles,$\langle n_s \rangle$, produced in ^{16}O-AgBr collisions at 60 and 200A GeV/c have been determined and listed in Table 1.

Energy per nucleon (GeV)	Data	$\langle n_s \rangle$
60	Experimental AMPT	73.22±2.19 72.78±2.60
200	Experimental AMPT	136.73±4.61 143.32±4.65

Table 1: Mean multiplicities of relativistic charged particles

As expected, $\langle n_s \rangle$ is higher at 200A GeV/c as compared to those at 60A GeV/. It is interesting to note that AMPT and experimental values are in reasonable agreement. Shown in Fig.1 are the multiplicity distributions of the relativistic hadrons produced in the collisions of ^{16}O-ion with the AgBr group of nuclei at the two energies. It is clear from the figure that the distributions for the experimental data are reproduced nicely by AMPT at both the energies. It is worth mentioning that both the multiplicity distributions at 60A GeV/c apparently look like poissonian distribution. However, the distributions at 200A GeV/c significantly deviates from possonian. Fig. 2 shows the η distributions of the relativistic charged particles which look like a Gaussian. Fig. 3 depicts two-particle correlations. This plot basically comprises of the distributions of the pseudorapidity gaps between two consecutive particles produced in the collisions. A peak at lower values of Δη is considered as an indication for the presence of two-particle correlations or short range correlations. It is clear from Fig. 3 that two-particle correlations occurs only in the experimental data at

60 and 200A GeV/c and in the AMPT simulated data.

Conclusions

From the results obtained in the present study the following interesting conclusions may be arrived at:

1. There are clear indications for independent emission as well as correlated production of particles in relativistic nuclear collisions.

2. AMPT does not completely explain the characteristics of relativistic nuclear collisions.

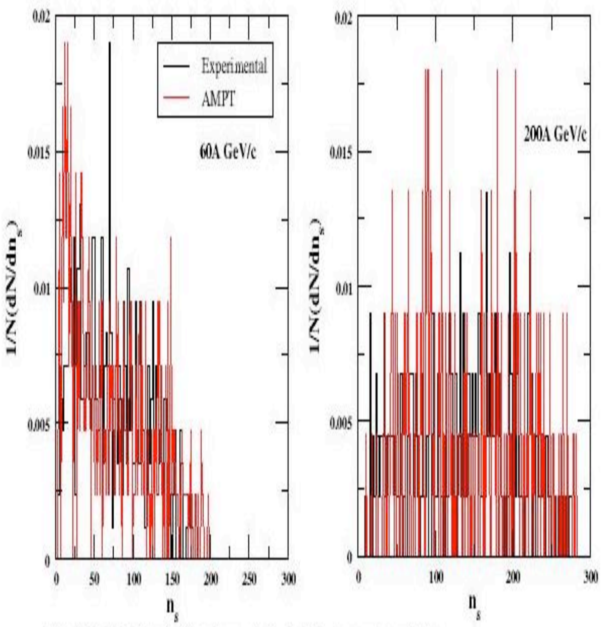

Fig.1 Multiplicity distributions of relativistic charged particles.

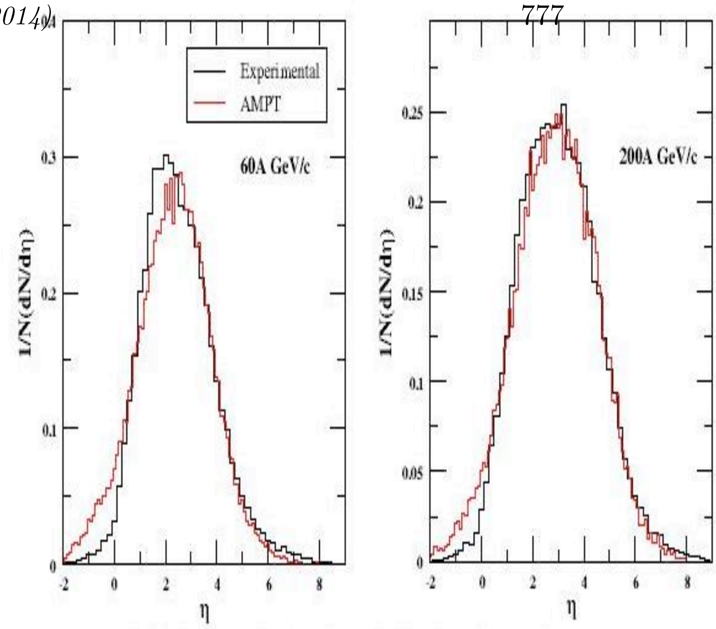

Fig.2 Pseudorapidity,η, distributions of relativistic charged particles.

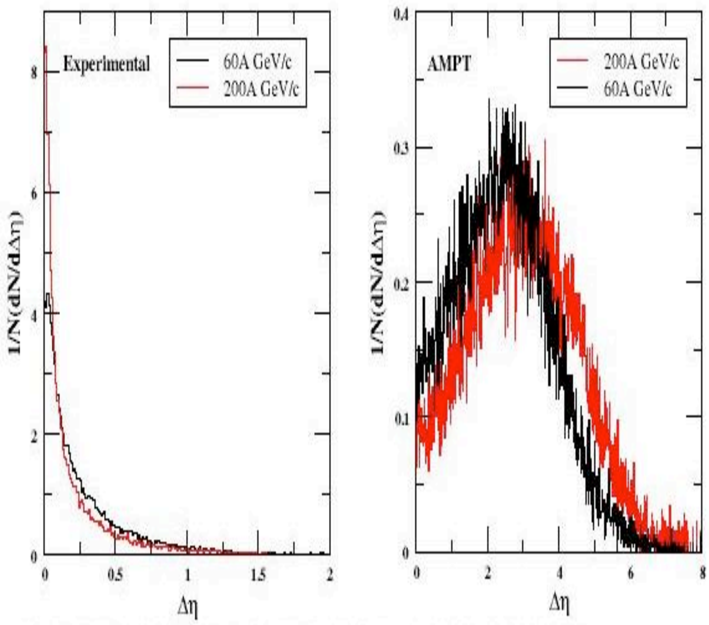

Fig.3 Pseudorapidity gap,Δη, distributions of relativistic charged particles.

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