On Multiparticle Correlations in Relativistic Heavy-ion Collisions

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Introduction

Extensive experimental data from relativistic nuclear collisions has been used to study the multiparticle correlations as a signature of the collective phenomenon. It has recently been shown [1-4] that the collective signatures observed in hadron-hadron, hadron-nucleus and nucleus-nucleus collisions at relativistic and ultra-relativistic collisions can be understood by studying multi-particle correlations. At RHIC and LHC such studies are proven to be very significant because a hot and dense system is created which in turn helps studying and understanding the production of quark-gluon plasma (QGP). At these collider multiparticle correlations studies have been found useful for understanding important signatures of hydrodynamically flowing medium .

This manuscript presents the measurements of multiparticle correlations in the experimental and AMPT simulated data on 60A GeV and 200A GeV ^{16}O-nucleus collisions

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The Data

Two samples of data on the interactions of 60 and 200 A GeV/c ^{16}O-ions with AgBr from emulsion experiments performed by EMU01collaboration 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[5]. For comparing the results presented in this study with the model predictions, matching umber of events have been generated using AMPT[6].

Analysis

The multiplicity of relativistic charged particles produced in 60 and 200 A GeV/c ^{16}O-ions collisions with AgBr and their azimuthal angles,ϕ, are measured. Two-, Four-, and Six-particle correlators are calculated using the expressions 1,2,3 given below. The azimuthal distribution of particles produced in a collisions can be described[1] by a Fourier series with coefficients v_n, where n is the harmonic number.

$$<2> = <\cos(n(\phi_1 - \phi_2))> = \left\langle v_n^2 \right\rangle \quad (1)$$

$$<4> = <\cos(n(\phi_{1+} \phi_2 - \phi_3 - \phi_4))> = \left\langle v_n^4 \right\rangle \quad (2)$$

$$<6> = <\cos(n(\phi_{1+} \phi_2 + \phi_3 - \phi_4 - \phi 5 - \phi_6))> = \left\langle v_n^6 \right\rangle \quad (3)$$

where $\phi_{1,2,3,4,5,6}$ denote the azimuthal angles of four different particles in an event of the considered data sample. As mentioned[1], any m-particle correlators will have contributions from lower-order correlations, and m-particle cumulants $c_n\{m\}$ are constructed to remove these. For two particle cumulant the relation is simply{1}

$$c_n\{2\} = <<2>> \quad (4)$$

where the double bracket indicates first an average over particles in a single event and then an average over number of events in the data sample. For four- and six- particle cumulant, the relations are

$$c_n\{4\} = <<4>> - 2<<2>>^2 \quad (5)$$

and

$$c_n\{6\} = <<6>> - 9<<4>><<2>> + 12<<2>>^3 \quad (6)$$

where it can be noted by construction that the lower order correlations are removed. The harmonic coefficients are found to be connected to the cumulants[1].

In the present study we have studied above parameters for n= 2.

Results and discussion

In the present study the available experimental and simulated data sets is considered with the entire azimuthal range and the gaps are calculated for two and four particles to obtain the values of 2- and 4- particle correlators and cumulants. In Tab. 1, the values of $c_2(2)$
And $c_2(4)$ are listed for the experimental and AMPT simulated data.

Table 1: Values along with statistical errors of 2- and 4-particle cumulants for the experimental and simulated data.

Interaction	$c_2(2)$ Exp.	$c_2(2)$ AMPT	$c_2(4)$ Exp.	$c_2(4)$ AMPT.
60AGeV/c ^{16}O-AgBr	0.258 ±0.009	0.331 ±0.014	0.143 ±0.004	0.180 ±0.018
200AGeV/c ^{16}O-AgBr	0.315 ±0.011	0.291 ±0.016	0.247 ±0.019	0.282 ±0.014

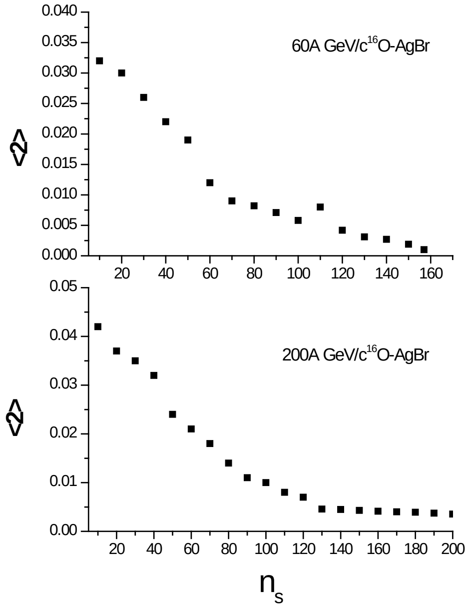

Fig.1.*Variations of 2-particle correlators with n_s for the experimental data.*

Shown in Fig.1 are the variations of 2-particle correlator,<2>, with the relativistic charged particle multiplicity, n_s for the experimental data at 60A and 200A GeV/c. The other results on the experimental and AMPT simulated data will be presented.

Conclusions

The results obtained in the present analysis hint towards the existence of 2- and multi-particle correlations of the produced hadrons in the relativistic nuclear collisions. AMPT simulation seems to support the results obtained for the experimental data. More conclusive results may be obtained if the analysis would be carried out for a higher statistics and a minimum bias data.

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