A study to observe fluctuation and long-range correlations in experimental and AMPT simulated ^{16}O-AgBr interactions at 60A GeV/c.

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Introduction

In order to study the behavior of matter produced in relativistic nuclear collisions the study of correlations and fluctuations have played an important role. In this attempt, the method of F_q-moments by Bialas[1] and Peschanski, method of G_q-moments by Chiu and Hwa[2] and the method of Tq-moments by Takagi[3] have successfully established the role of multiplicity fluctuations in understanding the phenomenon of multiparticle production and the transition of produced hot and dense nuclear matter to hadrons. These methods kept producing important results despite their own merits and demerits. Then an important method, Detrended Fluctuation Analysis (DFA), was introduced[4] for understanding the fluctuations, chaos and long-range correlations in multiparticle production in high energy nucleus-nucleus collisions. DFA method was then extended to the multifractal-DFA (MF-DFA) method, for analyzing multifractal time series[5] and to Detrended Cross Correlation Analysis (DXA)[6] to analyse the long range correlation.

Data

The data used is the present study is obtained from the emulsions experiment for the interactions of ^{16}O-ions with AgBr target at 60A GeV/c. The data sample is comprised of 422 events. To compare the experimental result wth the simulation, a similar data has been generated using AMPT model. The other details of these data can be obtained elsewhere[7]

Method of the analysis

In the present study the method described in the references[4-6,8] have been used. The first approach is to measure the extent of cross-correlation in the azimuthal-space Φ and pseudorapidity-space η as described[4-6]. Using this approach the DXA-exponents between η and Φ of the tracks in an event are calculated. The degree of cross-correlation, Υ_j is then calculated.

In the present study the azimuthal space has been chosen as the reference space and for each chosen pseudorapidity interval around η_0 the Φ values are taken and arranged in increasing order. Corresponding to these arranged values values of Φ, η values are calculated and the MF-DFA coefficients are calculated.

Results and discussion

In this study the available experimental and simulated data sets is divided into six sets with different pseudorapidity intervals, $\Delta\eta$ around the central rapidity η_c regions and the degrees of correlations is determined for all $\Delta\eta$-intervals. To measure the degree of cross-correlation, the method described in the reference 5 is used. These values are calculated for the experimental and AMPT simulated data sets. These values are listed in Table 1 and the variation of Υ_j with $\Delta\eta$ is shown in Fig.1.

It is observed from Fig.1 that the crossed correlation is very prominent in the narrow mid rapidity region and becomes weak as the pseudorapidity interval increases. It is interesting to note that a similar trend is seen for the AMPT simulated data.

Table 1: Values of multifractal cross-correlation coefficients Υ_j for ^{16}O-AgBr interactions at 60A GeV/c.

$\Delta\eta$	Υ_j(Experimental)	Υ_j(AMPT)
0.5	0.742±0.031	0.516±0.020
1.0	0.827±0.042	0.656±0.022
2.0	0.914±0.044	0.711±0.031
3.0	1.112±0.048	0.836±0.042
4.0	1.162±0.051	0.971±0.055
5.0	1.189±0.055	1.038±0.061

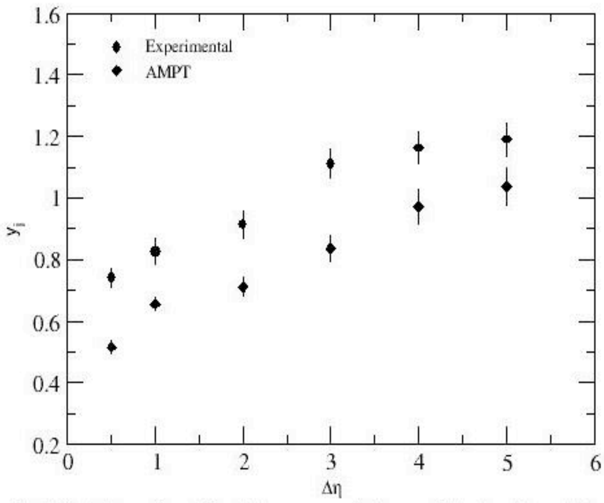

Fig.1 Variations of multifractal cross-correlation coeficients with rapidity gaps for experimental and AMPT simulated data on ^{16}O-AgBr interactions at 60A GeV/c.

Conclusions

The results obtained in the present study hints towards the presence of bin multiplicity fluctuations and long range correlations in the multiparticle production in high nergy nuclear collisions. To draw more clear conclusions the study should be carried out for more statistics and for the data at further higher energies (RHIC and LHC).

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