On fluctuations and phase transition in experimental and AMPT simulated ^{16}O-Agbr interactions at 200A GeV/c.

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Introduction

The study of correlations and fluctuations of global and local observables have always been the most important tool for understanding the phenomenon of multiparticle production in relativistic nuclear and hadronic interactions. Various methods and theoretical models have been proposed and studied experimental by many reserachers working in the field of high energy physics. A. Bialas[1] and Peschanski, R. C. Hwa[2] and F. Takagi[3] have successfully established the role of multiplicity and pseudorapidity density fluctuations in understanding phase transition of produced hot and dense nuclear matter to the final state hadrons. These methods have 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. This method of DFA 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 analyze the long range correlation of global variables characterizing the collisions.

Data

In the present study the data is obtained from the emulsions experiment performed by EMU01 collaboration[7] for the interactions of ^{16}O- ions with AgBr target at 200A GeV/c. The data sample is comprised of 432 events. To compare the experimental results with the simulation, a similar data has been generated using AMPT model. The other details of these data can be obtained elsewhere[8].

Results and discussion

Present study is an attempt to use the method described in the work[4,5,6,9] for studying the bin multiplicity fluctuations and long-range correlations . The first approach is to measure the extent of cross-correlation in the azimuthal-space Φ and pseudo-rapidity-space η as described. Using this approach the DXA-exponents between η and Φ of the tracks in an event are calculated. The degree of cross-correlation, Y_j is then calculated. In the present study the azimuthal space has been chosen as the reference space and for each chosen pseudo-rapidity interval around η_0 the Φ values are taken and arranged in increasing order. Corresponding to these arranged values of Φ, η values are calculated and the MF-DFA coefficients are calculated.

To carry out the analysis presented in this analysis, the available experimental and simulated data sets are divided into seven sets with different pseudo-rapidity intervals, $\Delta\eta$ around the central rapidity η_c regions and the degrees of correlations is determined for all $\Delta\eta$-intervals. In order to measure the degree of cross-correlation, the values of Y_j 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 for the experimental and simulated data. It is observed from the Fig.1 that the crossed correlation is more evident in the small mid rapidity region and becomes weaker as the pseudorapidity interval increases. It is interesting to note that the values of Υ_j for the experimental and simulated data are different(Table 1) but the trend of their variations for the AMPT simulated data.

Conclusions

On the basis of the results obtained in the present study it may be pointed out that the bin multiplicity fluctuations and the long range correlations is present to some extent in the ^{16}O-AgBr interactions at 200A GeV/c. However to be more conclusive about the presence of these aspects during the hadronization of produced nuclear matter the study should be carried out for more statistics and for the data at further higher energies. Authors are trying to carry out this analysis on LHC data.

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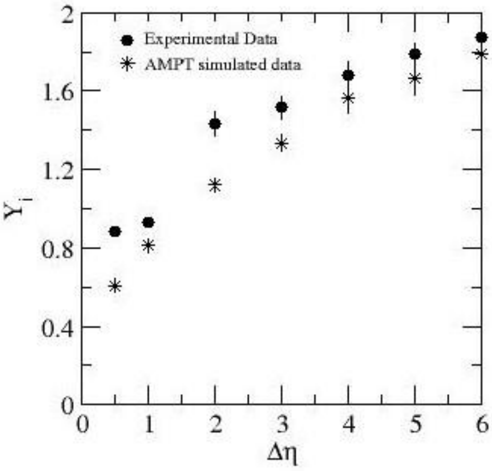

Fig.1 Variations of Υ_i with $\Delta\eta$ for the experimental and AMPT simulated data on ^{16}O-AgBr interactions at 200A GeV/c

Table 1: Values of multifractal cross-correlation coefficients Υ_j for ^{16}O-AgBr interactions at 200A GeV/c.

$\Delta\eta$	Υ_j(Experimental)	Υ_j(AMPT)
0.5	0.881±0.016	0.608±0.020
1.0	0.927±0.022	0.813±0.022
2.0	1.432±0.061	1.121±0.031
3.0	1.515±0.055	1.335±0.042
4.0	1.679±0.071	1.566±0.076
5.0	1.787±0.055	1.664±0.081
6.0	1.874±0.0711	1.788±0.080

References

[1] A. Bialas, R Pischanski, Nucl. Phys. B 273 703(1986)
[2] R. C. Hwa, Phys. Rev. D 41 1456 (1990)
[3] F. Takagi, Phys. Rev. Lett. 72 32(1994)
[4] S.B.C.K. Peng, S. Havlin, M. Simons, H. Stanley, A. Goldberger, Phys. Rev. E49 1685(1994).
[5] B. Podoblink, H.E. Stanley, Phys. Rev. Lett. 100, 084102(2008).
[6] J. W. Kantelhardt et al., Physica A 02, 01383(2002)
[7] S. Ahmad et al., Adv. High Energy Phys., 2013, 01(2013)
[8] S. Ahmad et al., AHEP, ID 6914627(2018).
[9] Sushmita Bhaduri, Anirban Bhaduri, Dipak Ghosh, Europ. Phys. Journal A 53, 135(2017).