Improved intermittency analysis of charged particle density fluctuations in Pb+Pb collisions at $\sqrt{s_{NN}}$= 2.76 TeV

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Introduction

Recent results from ALICE Collaboration on correlations and fluctuations of the global observables for the Pb-Pb collisions[1, 2] at LHC energies have given a new insight to understand the underlying dynamics of multiparticle production and to appreciate the importance of such studies to understand the physics of the phase transition and quark-gluon plasma (QGP) formation. The results so far are very encouraging regarding formation of a novel phase of matter,QGP, predicted by the quantum chromodynamics (QCD)[3]. It is interesting to note that high energy density regime of the QCD is believed to be very sensitive to non-linear dynamics and non-perturbative effects, including parton saturation, onset of color deconfinement and chiral symmetry restoration[2]. However, the existence of QCD critical point is a controversial issue, which is expected to clarified in the high energy heavy-ion collisions at the LHC. It has been argued[4, 5] that in the vicinity of the critical point, according to recent theoretical investigations, the chiral condensate should exhibit critical fluctuations (self-similar and scale-invariance). These fluctuations are believed to be present in the pseudorapidity and tranverse momentum distributions of charged particles produced in the relativistic nuclear collisions [5].
In the present study, the second order factorial moment in the pseudorapidity ,η and transverse momentum, p_t spaces has been calculated for the AMPT[6] simulated data corresponding to LHC Pb+Pb collisions at $\sqrt{s_{NN}}$= 2.76 TeV.

Detail of the Data

A data set comprising of 50k events of Pb+Pb interactions at $\sqrt{s_{NN}}$= 2.76 TeV are generated using AMPT model.

Method of analysis

If a pure critical system is produced in ultra-relativistic nuclear collisions then the presence of multiplicity fluctuations in small bins of η, ϕ and p_t may be revealed by the dependence of the second order scaled factorial moments, F_2, of charged particle tracks as a function of bin size. In order to do this, a chosen region of η and p_t space is partitioned into M×M equal-size bins and the F_2 is calculated using following expression:

$$F_2(M) = \frac{< \frac{1}{M^2} \sum_{i=1}^{M^2} n_i(n_i-1) >}{< \frac{1}{M^2} \sum_{i=1}^{M^2} n_i >^2} \quad (1)$$

where (< .... >) shows the averaging over bins and events, n_i is the number of tracks in the i^{th} bin and M^2 is the total number of bins. If the system of produced hadrons tends to exhibit critical fluctuations, $F_2(M)$ is expected to scale with M according to the following power law behaviour which is termed as intermittency:

$$F_2(M) \propto M^{2\phi_2} \quad (2)$$

where ϕ_2 is known as the intermittency index and is said to denote the strength of intermittency. If the freeze out occurs at the

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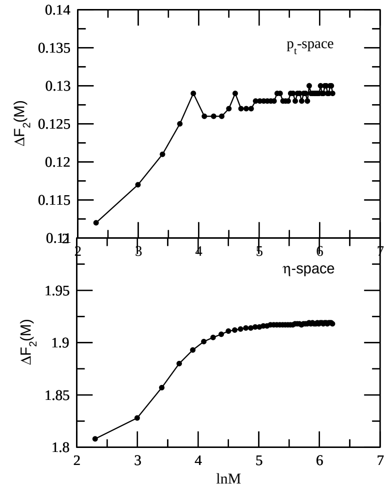

Fig.1 Variation of $\Delta F_2(M)$ with natural logarith of number of bins, M for AMPT simulated Pb+Pb collisions at 2.76 TeV per nucleon pair energy.

critical point[7] then $\phi_2 = \phi_{2,cr}^{B} = \frac{5}{6}$. In order to overcome uncorrelated tracks to clearly observe the intermittent behaviour an artificial set of mixed events has been constructed. This mixed data set is created by merging tracks from different AMPT generated original events into new events having same (mean) multiplicities. In this way mixed events are necessarily contain uncorrelated tracks. Using the AMPT generated and mixed data sets, the correlator, $\Delta F_2(M) = F_2^{AMPT}(M) - F_2^{mixed}(M)$, is calculated and is said to reveal the critical behaviour[6]. The $\Delta F_2(M)$ is expected to show the same power law behaviour with the number of bins as shown by the pure critical system given by Eq.2. i.e. $\Delta F_2(M) \propto M^{2\phi_2}$.

Results and Discussions

Fig.1 depicts the variations of $\Delta F_2(M)$ with M in η and p_t spaces. In the final presentation we will also show the calculation of errors and the variations $\Delta F_2(M)$ with M^2. A power law behaviour is discernible in Fig 1 for within some limited range of M and not for the entire η and p_t spaces selected for the present study. It is also observed from the figure that the power law behaviour is much stronger in η space.

Acknowledgments

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