Scaling Properties of charged particles generated in Xe-Xe collision at $\sqrt{s_{NN}} = 5.44$ TeV using AMPT Model

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MOTIVATION

The exploration of the QCD phase diagram and the critical end point search is one of the main goals in the relativistic heavy-ion collisions.

Near critical temperature

Tension between the collective interactions and thermal randomization leads to clusters of all sizes.

↓

Large density fluctuations in multiplicity distribution

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To understand the dynamics of the particle production and phase changes, one of the proposed measures is to study the fluctuations in spatial patterns of produced particles [1].

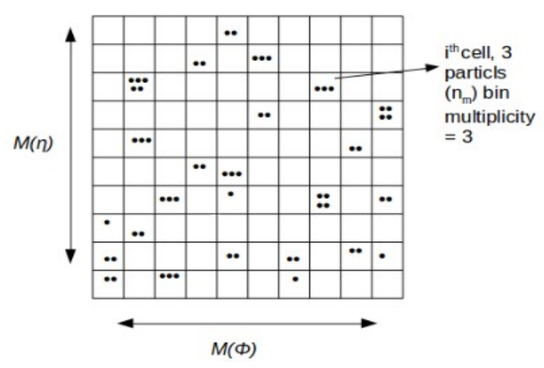
Here a *study of scaling properties of multiplicity fluctuations over wide range of bin sizes using* Normalized Factorial Moments referred to as Intermittency analysis is presented.

METHODOLOGY

- **An event-by-event, two dimensional intermittency analysis in 2D(η,φ) phase space.**
- **Phase space is divided into a square lattice of MxM bins**
- **Number of bins along one dimension M =(82).**
- **$|\eta| \leq 0.8$, $0 \leq \varphi \leq 2\pi$, $p_T \leq 1.0$ GeV/c**
- **For multiplicity (n_{ie}), the NFM F_q is**

$$F_q(M) = \frac{\frac{1}{N}\sum_{e=1}^{N}\frac{1}{M}\sum_{i=1}^{M} f_q(n_{ie})}{\left(\frac{1}{N}\sum_{e=1}^{N}\frac{1}{M}\sum_{i=1}^{M} f_1(n_{ie})\right)^q} \quad \text{..(1)}$$

Eta-phi phase space of an event is binned into M×M bins



- ***If* F_q has power law dependence on M as,** **(M-scaling)**

$$F_q(M) \propto (M)^{\phi_q} \quad \text{..(2)}$$

then, it is termed as intermittency.

ϕ_q: known as intermittency index

F_q has power law dependence on F_2 *as,* **(F-scaling)**

$$F_q \propto F_2^{\beta_q} \quad \text{..(3)}$$

Where $\beta_q = (q-1)^{\nu}$

ν : known as scalingexponent[2]

PREDICTION

$\nu_{GL} = 1.304$ in Ginzburg Landau formalism for second-order phase transition [2].

A MULTIPHASE TRANSPORT MODEL (AMPT)

- **Is a hybrid transport model and is designed to model the heavy-ion collisions available at relativistic energies [3].**
- **500K String melting (SM) minimum biased Xe-Xe events at $\sqrt{s_{NN}} = 5.44$ TeV generated.**
- **Analysis is performed for central events with impact parameter $0 \leq b \leq 3.5$ fm.**

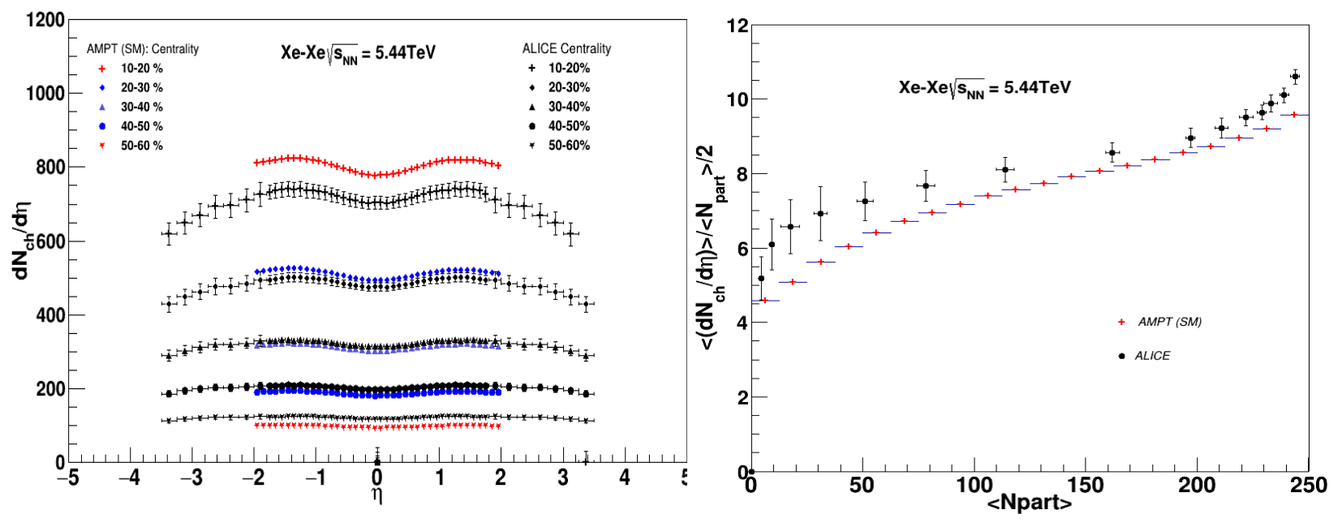


Fig .1.(left) Pseudorapidity density distribution of charged particles for various centralities and (right) charged particle density vs number of participants from the generated events is given and compared with the ALICE data for Xe-Xe collision at $\sqrt{s_{NN}} = 5.44$ TeV [4].

OBSERVATIONS AND RESULTS

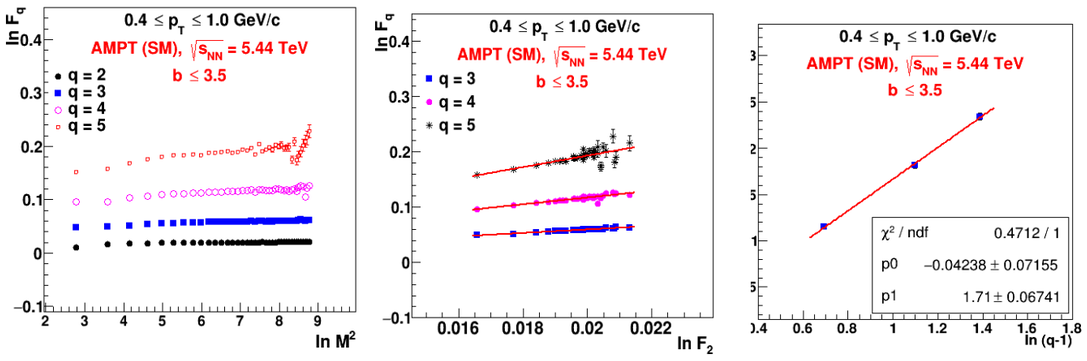
- **Dependence of qth order NFM (F_q) on :**

  Left Fig : number of bins (M) ..... (M-scaling)

  Middle Fig: 2nd order NFM (F_2) .....(F-scaling)

  for $0.4 \leq p_T \leq 1.0$ GeV/c is shown below.

  Right Fig : Scaling exponent extracted from $\ln \beta_q$ vs $\ln(q-1)$



$F_q(M) \propto (M)^{\phi_q}$ $\quad F_q \propto F_2^{\beta_q}$ $\quad \beta_q = (q-1)^{\nu}$

Fig .2. Scaling and scaling exponent in [0.4 – 1.0] p_T bin

- **Analysis of the scaling behaviour is carried to study dependence of scaling exponent on p_T bins and p_T bin width. Results given below along with the comparison of results from other system and energies.**

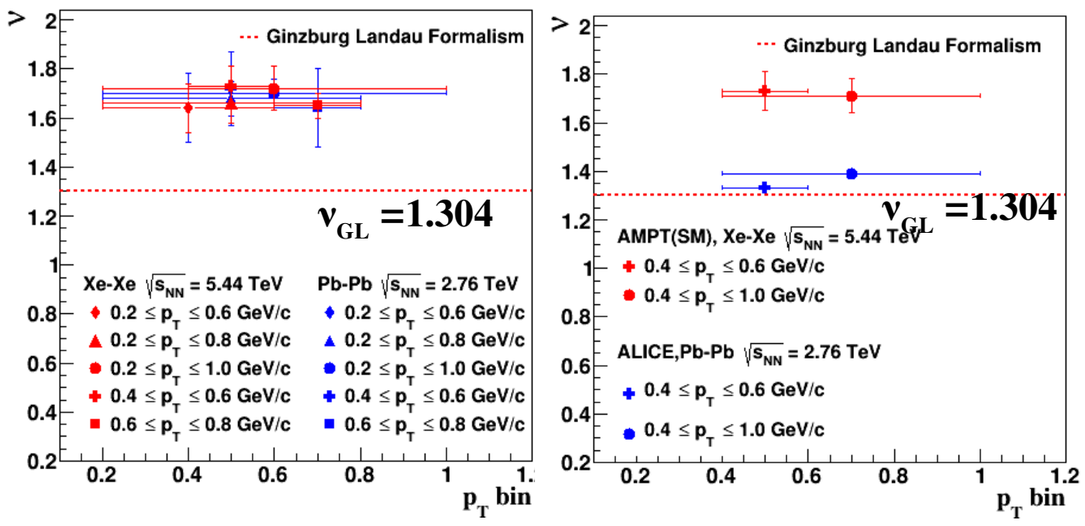


Fig .3. Figures shows scaling exponent (ν) vs p_T for Xe-Xe at $\sqrt{s_{NN}} = 5.44$ TeV. ν value obtained for Pb-Pb collision at $\sqrt{s_{NN}} = 2.76$ TeV from AMPT(SM) model [5](left panel) and ALICE experiment [6] (right panel) are also given.

SUMMARY

- **Scaling properties of the charged particles generated in the mid rapidity region in Xe-Xe collisions at $\sqrt{s_{NN}} = 5.44$ TeV have been studied in the framework of intermittency analysis.**
- **A power-law growth of NFM (F_q) with M is observed to be absent at high M values in all the p_T bins.**
- **However F-scaling is observed.**
- **With no phase transition physics implemented in (SM) AMPT model**
  - **Scaling behaviour in line with intermittency is absent.**
  - **Scaling exponent different from value predicted by theory for second – order phase transition.**

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