Investigating the role of partonic and hadronic interactions towards collective dynamics in small systems

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Introduction

The anistropic emission of the charged particles relative to reaction plane in ultra relativistic heavy ion collisions has been considered to be a principal signature of collectivity. This observation is found to be in compliance with the hydrodynamical response of a strongly interacting system to the initial asymmetry of the overlap geometry of the colliding nuclei. Recently, two-particle and multi-particle correlation measurements in p-Pb [1, 2] and d-Au [3] data at the LHC and RHIC energies respectively have featured evidences qualititively indicating towards collective dynamics. Arguably, small size in the overlap geometry of such colliding systems may not be suitable for hydrodynamical treatment that demands an early thermalization. However, simillar effect can also be realized by virtue of CGC based initial conditions. To acquire further insight on the possible origin of the collective behaviour in small systems correlation analysis are performed with identified particles. In this article we report our findings on v_2 measurements in p-Pb collisions at 5.02 TeV based on A Multiphase Transport Model (AMPT). The final state momentum anisotropy represented in terms of elliptic flow (v_2) is calculated for pions and protons as a function of p_t and charged particle multiplicity using the String melting version of the AMPT event generator[4]. Our results indicate that with a parton scattering cross-section of 3mb the response of the system at higher multiplicity cases can be analogus to what has been considered as a signature of collectivity in heavy ion collisions [5].

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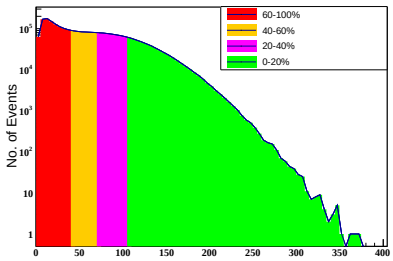

FIG. 1: (colour online)Event classification from charged particle multiplicity distribution for details refer to text.

A Multiphase Transport Model

In the string melting (SM) version of the AMPT model which is used in the present study, minijet partons and soft strings produced from HIJING model are converted into quark and antiquarks. Then, their evolution in time and space is modeled by the ZPC parton casade model with scattering cross section

$$\sigma_p \simeq 9\pi\alpha_s^2/2\mu^2 \quad (1)$$

The notations have their usual meanings. Eventually the quarks and anti-quarks are coalesced spatially to form Hadrons. The subsequent evolution in the hadronic stage is modelled by A Relativistic Transport (ART) model.The detailed description of the AMPT model can be found in [6].
For this study, we have set the partonic scattering cross-section to 3 mb by tuning the QCD coupling constant α_s=0.47 and Debye screening mass μ=3.22 fm^{-1}.

v_2 extraction

The anisotropy in the azimuthal distribution has been calculated using 2-particle Q-Cumulant method [7, 8] as a function of p_t .

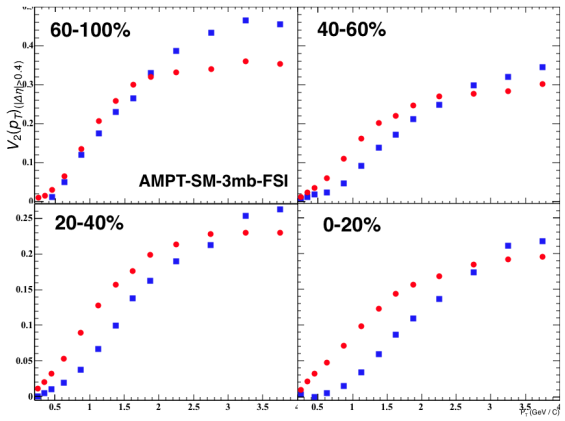

FIG. 2: (colour online)Transverse moentum dependence of v_2 in different multiplicity classes

To suppress non-flow contributions a pseudo-rapidity gap is introduced between the particles. In the process, each event is divided into two sub-events with a pseudo-rapidity separation ($|\Delta\eta|$) > 0.4 at least. Detailed analytical formulation for flow extraction will be presented in the conference.

Results and Discussion

The entire analyzed sample has been divided into four multiplicity classes, based on the total amount of charged particles producd(with p_T >0.02 GeV/c) within $|\eta|$ <1.0. The multiplicity classes are denoted as 60-100%, 40-60%, 20-40%, 0-20% from the lowest to the highest multiplicicty as shown in Fig 1.The incohrent elastic scattering of partons (as implemented in AMPT model) with scattering cross section of 3mb qualitatively reproduces the mass ordering of elliptic flow in higher multiplicity classes of pPb collisions. The mass ordering pattern is more prominent in the high multiplicity event classes compred to the lower ones. This mass ordering of v_2 is one of the key signatures of presence of collectivity in ultrarelativistic heavy ion collisions [5]. But the same pattern has also been observed in high multiplicity pPb collisions at LHC energy[1]. This work shows that v_2 mass ordering is not uniquely associated with the hydrodynamical expansion of the medium(which assumes thermalization of the medium) produced in high energy collisions .

Acknowledgments

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