Triangular Flow as a Measure of Initial State Granularity*

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Introduction

Higher order flow coefficients have recently been recognized as new observables to gain information about the creation of the quark gluon plasma in relativistic heavy ion reactions and its properties [1]. Pressure gradients translate the initial state coordinate space eccentricity to the final state momentum space ellipticity and this connection is affected by the viscosity and the equation of state [2]. The higher odd anisotropic flow coefficients require the treatment of event-by-event fluctuations, since for smooth initial conditions they vanish by symmetry constraints. The ultimate goal is to understand the initial energy deposition which is related to the distributions of the nucleons/partons in the incoming nuclei and the interactions they are undergoing [3].

Anisotropic Flow Coefficients

By using a hybrid transport approach that is based on the Ultra-relativistic Quantum Molecular Dynamics including an (3+1) dimensional ideal hydrodynamic expansion, we demonstrate that triangular flow is directly related to the amount of fluctuations in the initial state.

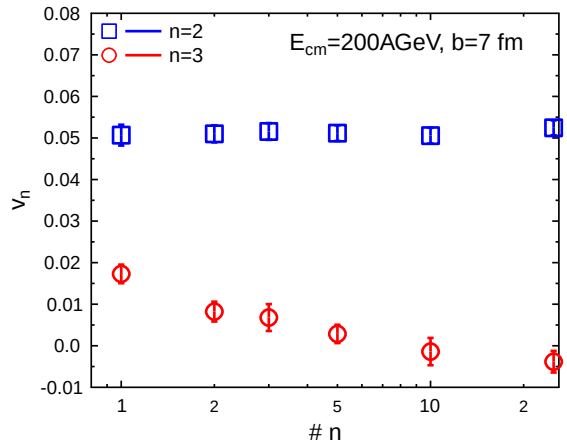

Figure 1: Anisotropic flow for different granularities in mid-central ($b = 7$ fm) Au+Au collisions at $\sqrt{s_{\rm NN}} = 200$ GeV.

In Fig. 1 below results for the averaged $v_{2,3}$ coefficients for charged particles calculated for different granularities ($n = 1, ..., 25$) via the event plane method are presented. The clear dependency of the mean values of triangular flow in non-central collisions on the number of events over which the initial average has been performed proves that one can constrain the granularity of the initial state by comparing flow coefficients of calculations to experimental data. The average elliptic flow stays constant since it is related to the overall geometry of the event.

Constraints on Granularity

To get a first impression on the amount of fluctuations that is consistent with the PHENIX data on triangular flow, the transverse momentum dependence of triangular flow of charged particles has been calculated in the hybrid approach (see Fig. 2).

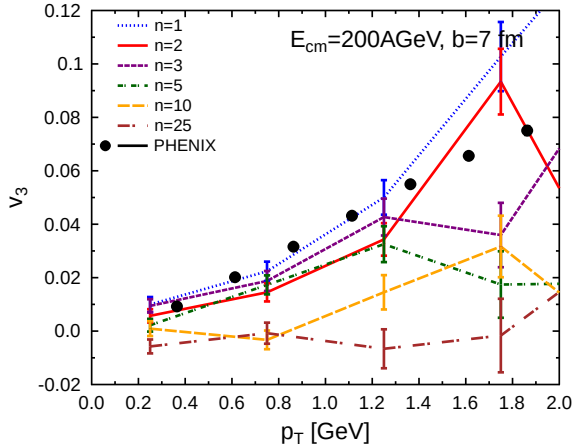

Figure 2: Triangular flow versus transverse momentum for different granularities mid-central ($b = 7$ fm) Au+Au collisions at $\sqrt{s_{\rm NN}} = 200$ GeV compared to PHENIX data.

This first comparison to data indicates that the full single-event configuration is close to the amount of initial state fluctuations that is necessary. That indicates that a hadron-based initial state description with a particle size of the order of 1 fm generates the least amount of fluctuations that is needed. Since additional viscosity during the hydrodynamic evolution would dilute fluctuations faster this is a lower bound on the initial state granularity.

References

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