Initial fluctuations and triangular flow in AMPT Model at FAIR Energy

Soumya Sarkar and Amitabha Mukhopadhyay*
Department of Physics, University of North Bengal, Siliguri-734013, West Bengal, India

The proposed Compressed Baryonic Matter Experiment (CBM) [1] scheduled to be held some time around 2019, will provide enough scope to explore the extended QCD matter at high baryonic density and low/moderate temperature. The azimuthal anisotropy of the final state hadrons resulting from the initial spatial anisotropy of the overlapping region of two colliding nuclei, is believed to be one of the key signatures of the QCD matter [2]. The anisotropic flow parameter is defined as the n-th Fourier coefficient (v_n) of the azimuthal distribution with respect to the reaction plane. Considering the effect of event by event fluctuations in the position of the participating nucleons, the azimuthal distribution is expressed as [3],

$$\frac{dN}{d\phi} \propto 1 + 2\sum_{n=1}^{\infty} v_n cos[n(\phi - \psi_n],$$

where ψ_n is the event plane angle of the n-th event which varies from event to event. The initial geometric deformation of the overlapping region is quantified as,

$$\varepsilon_n = \frac{\sqrt{\langle r^2\cos(2\phi_{part})\rangle^2 + \langle r^2\sin(2\phi_{part})\rangle^2}}{\langle r^2\rangle}$$

After taking the initial fluctuations into account the anisotropic flow parameter is defined as,

$$v_n = \langle\cos[n(\phi - \psi_n)]\rangle\,,$$

of which v_2 and v_3 are of special interest. Originally the contribution from the odd harmonics like v_3 was thought to be zero due to the

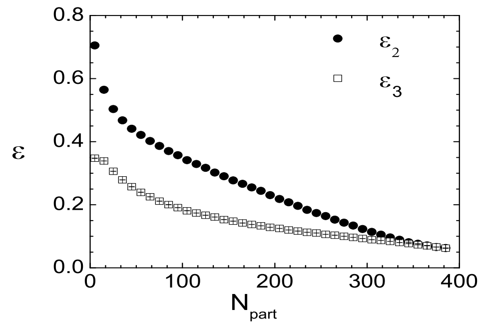

FIG. 1: ε_n as a function of centrality.

left-right symmetry in the transverse plane of the collision. But recent works in RHIC and LHC experiments [3, 4] have reported that v_3 can be non-zero. We have investigated the issue using the latest version of AMPT model (string melting version) [5], simulating 1 million Au+Au events at 30A GeV incident energy in laboratory system, typical of the CBM experiment. In Fig.1 we find that the initial

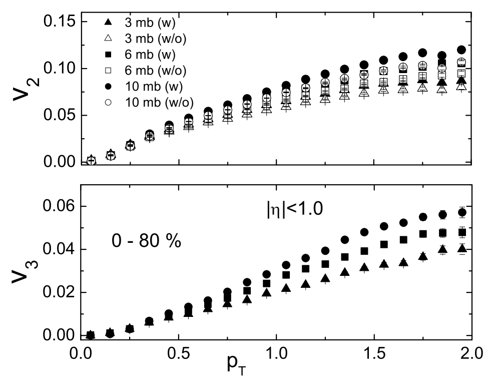

FIG. 2: p_T dependence of v_2 & v_3 at mid-rapidity for different parton scattering cross-sections.

geometric deformation (ε_n) increases with the number of nucleons participating in a collision

*Electronic address: amitabha_62@rediffmail.com

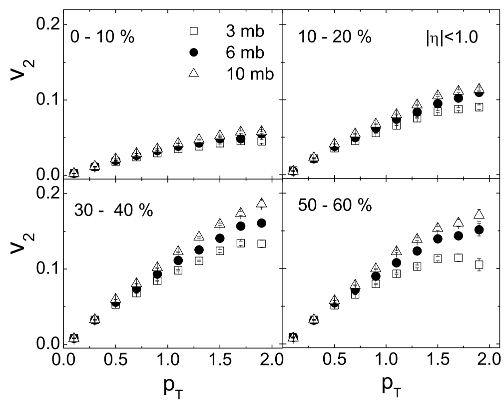

FIG. 3: v_2 as a function of p_T for different centrality classes at mid-rapidity.

N_{part}, a measure of the centrality of collision. Further it should be noted that the eccentricity measure (ε_2) is greater than the triangularity (ε_3), except in most central collisions. In Fig.2(a) we have shown the parton scattering cross-section (σ) dependence of v_2 versus p_T with (w) and also without (w/o) taking the initial fluctuations in the position of the nucleons into account. It is interesting to note that the initial fluctuations have very less effect on v_2 for all available cross-sections. It is obvious from Fig.2(b) that v_3 arises from the event by event fluctuations present in the initial colliding geometry, and its overall p_T dependence is nearly same as that of v_2. We should also note that relative value of v_2 is more than v_3 for all p_T bins. The probable reason is that, while v_2 arises from the asymmetry of the overlap region, v_3 results from the initial fluctuations, the later being weak in comparison with the former. From Fig.2 we conclude that the conversion efficiency of the initial spatial anisotropy to final state momentum anisotropy increases with σ as increasing partonic cross-section leads to an increase in hadronic interactions. Fig.3 shows the centrality dependence of v_2 versus p_T. The most central collisions are almost independent of the partonic scattering cross-section. However, a σ dependence is revealed as we approach towards the peripheral collisions. The magnitude of v_2 increases smoothly from $0-10\%$ centrality to $50-60\%$, which is obviously due to the increase in the spatial anisotropy of the colliding system. Finally, in Fig.4 we present centrality dependence of v_3 versus p_T plot. One should note that the centrality dependence of v_3 is less prominent than that of v_2. This is a preliminary simulation analysis of triangular flow at a typical FAIR-CBM energy, other aspects of which will need to be critically dealt with in future.

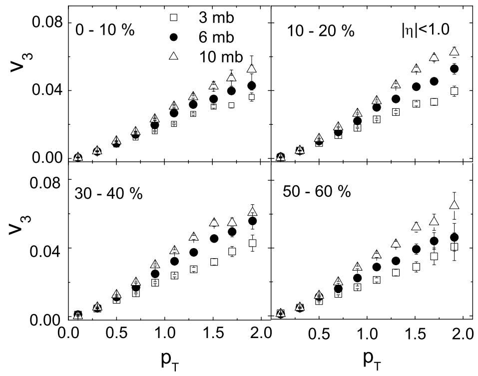

FIG. 4: Same as Fig 3 but for v_3 .

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