Study of Initial conditions for Pb-Pb Collisions

Snigdha Ghosh,* Sushant K. Singh, Sandeep
Chatterjee, Jane Alam, and Sourav Sarkar
[1] *Theroretical High Energy Physics Division, Variable Energy Cyclotron Centre,*
1/AF Bidhannagar , Kolkata - 700064, India

Introduction

The study of initial condition (IC) for matter produced in heavy ion collision is one of the most important topics of research over few decades. Several Monte-Carlo based models on IC exist in literarure which produce event-by-event(E/E) fluctuattion in various observables. Recently we have modified the two component Monte-Carlo Glauber model (MCGM) by incorporating the shadowing of the nucleons in the interior by the leading ones in Ref.[1]. The shadowed MCGM (shMCGM) well expalins the ellipticity (v_2) vs multiplicity($dn_{ch}/d\eta$) data for U-U and Au-Au collisions at RHIC energies as dynamical models like IP-Glasma does. The prediction from MCGM disagrees with E/E v_2 distribution data [2] for Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV. In this work, we evaluated the centrality dependence of eccentricities and their E/E distributions using shMCGM [3] and they are found to match with data as well as results from IP-Glasma [4].

The Model

In shMCGM, the amount of energy deposited on the transverse plane from a particular participant or binary-collision (BC) energy source, depends on the positions of the nucleons that constitute the energy source. In this approach, we introduce a factor $S_i = e^{-n_i\lambda}$ to i^{th} energy source where λ is the shadow parameter. For a participant source n_i is the number of nucleon of the parent nucleus in front of the participating nucleon and for a BC source, n_i is the number of nucleons in between the two participating nucleons. The i^{th} energy source at (x_i, y_i) will deposit energy $\epsilon_i = \epsilon_0(1-f)S_i$ in case of a participant source and $\epsilon_i = \epsilon_0 f S_i$ in case of a BC source where ϵ_0 is a constant and f is the hardness parameter. The total energy deposited $\epsilon(x, y)$ at a particular point (x,y) on the transverse plane is given by,

$$\epsilon(x,y) = \sum_{i \,\in\, sources} \left(\frac{\epsilon_i}{2\pi\sigma^2}\right) e^{\frac{-(x-x_i)^2-(y-y_i)^2}{2\sigma^2}}, \tag{1}$$

where, σ is the smearing parameter. Having obtained $\epsilon(x, y)$, we can calculate the eccentricities (ε_n) of the energy deposited in the overlap region,

$$\varepsilon_n = \sqrt{\langle r^n \cos n\phi\rangle^2 + \langle r^n \sin n\phi\rangle^2}/\langle r^n\rangle, \tag{2}$$

where (r, ϕ) are the polar coordinates and $\langle ...\rangle$ represents averaging over transverse plane with $\epsilon(x, y)$ as weight function.

Results

The model parameters are given in Ref.[3]. In Fig. 1, we have plotted the mean eccentricities $\langle\varepsilon_n\rangle$ with the centrality as calculated from final state charged particle multiplicitiy obtained using MCGM, shMCGM and they are compared with results from IP-Glasma[4]. The shMCGM results are in good agreement with that of IP-Glasma. In all the models, $\langle\varepsilon_n\rangle$ increases with centrality. This is due to the increase of the impact parameter leading to formation of higher elliptic overlap zone. The increase of ε_2 in shMCGM over MCGM is due to the fact that the ends of the minor axis of the overlap zone suffers more shadowing than that of major axis leading to the increase in ellipticity.

Next in Fig. 2, we have plotted the E/E distribution of the scaled ε_n and these are compared with those of IP-Glasma and ATLAS

---

*Electronic address: `snigdha.physics@gmail.com`

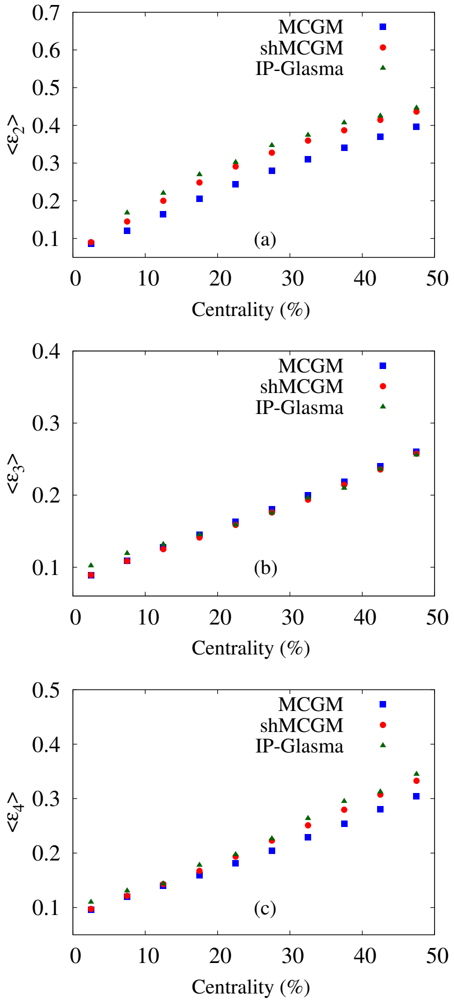

FIG. 1: The centrality dependence of eccentricities compared between the IP-Glasma model, the MCGM, and the shMCGM.

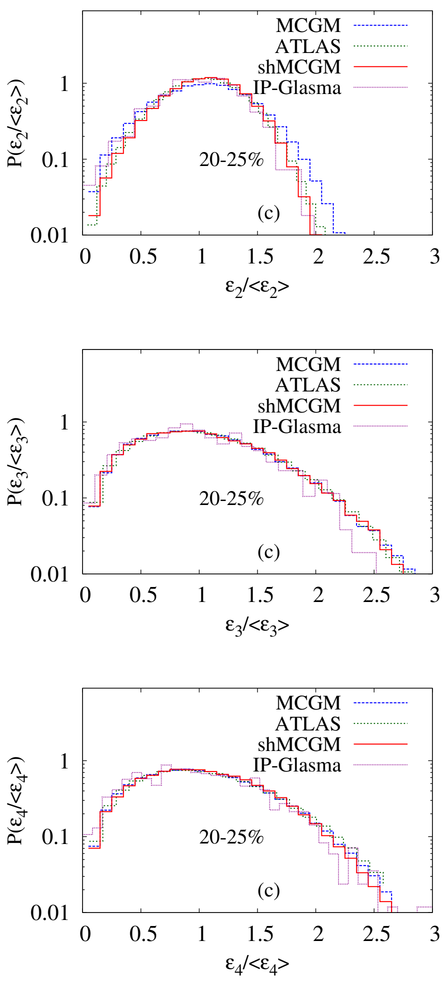

FIG. 2: The E/E distribution of ε_n compared among data, the IP-Glasma model, the MCGM, and the shMCGM for $20-25\%$ centrality.

data of v_n. As given in Ref.[1], the shMCGM produces narrower distribution which matches with IP-Glasma and data.

Acknowledgments

SG and SC acknowledge Department of Atomic Energy, Govt. of India for support.

References

[1] S. Chatterjee, S. K. Singh, S. Ghosh, M. Hasanujjaman, J. Alam and S. Sarkar, Phys. Lett. B **758**, 269 (2016)
[2] G. Aad *et al.* [ATLAS Collaboration], JHEP **1311**, 183 (2013)
[3] S. Ghosh, S. K. Singh, S. Chatterjee, J. Alam and S. Sarkar, Phys. Rev. C **93**, no. 5, 054904 (2016)
[4] C. Gale, S. Jeon, B. Schenke, P. Tribedy and R. Venugopalan, Phys. Rev. Lett. **110**, no. 1, 012302 (2013)