Cold Nuclear Matter Effects on the Correlation between Eccentricity and Multiplicity

Sushant Kumar Singh, Sandeep Chatterjee, Md Hasanujjaman, Snigdha Ghosh, Jan-e Alam, Sourav Sarkar*
Variable Energy Cyclotron Centre, 1/AF Bidhan Nagar, INDIA

Abstract

Nuclear shadowng effects have been included in the Monte Carlo Glauber Model (MCGM) to study the correlation between multiplicity and the eccentricity of the geometry of the matter formed in relativistic nuclear collision.

Introduction

Collision of two nuclei at relativistic energies may produce a deconfined system of quarks and gluons. Assuming it gets thermalized, its subsequent evolution is determined by relativistic hydrodynamic equations together with an equation of state. Solving these equations require an initial energy density and velocity profile as inputs (in case when the net baryon number is zero). A first principle calculation for energy deposition in relativistic heavy ion collisions (rhic) is yet to be achieved. Several models have been proposed to understand the correlation between the initial energy profile and multiplicity. Among these, one of the successful models is the IP-Glasma model [1] based on the Color Glass Condensate approach. The Glauber model (GM) which has successfully reproduced several experimental results has predicted a knee-like structure in the variation of eccentricity with multiplicity. However, in the present work we show that the "knee" in such correlation disappear if some of the legitimate physical effects relevant for cold nuclear matter like shadowing is included within the framework of GM.

The quantum mechanical fluctuations in the space time coordinates of the nucleons will reflect as the fluctuation in initial energy density of the system formed in rhic. This fluctuation may influence the bulk observables, like anistropic flow coefficients. Therefore, it becomes important to study the correlations between the anisotropic flow and the energy deposited in the medium created in rhic. The amount of energy deposited is reflected through the produced multiplicity and the fluctuations in space time structure is reflected through the ecentricity (measured via flow coefficients, like, elliptic, triangular, etc). In the present work the correlations between the multiplicity and ecentricity are studied by taking into account the effects of shadowing in nuclear collisions within the framework of Monte Carlo GM (MCGM).

Model

A practical approach to include the nuclear shadowing in MCGM is to modify the thickness function by taking into account the effects of shadowing [2]. The number of participants and collisions are then estimated within this scheme which are subsequently used to obtain the energy density, $\epsilon(x, y)$,

$$\epsilon(x, y) = \epsilon_0[(1 - f)n_{part}(x, y) + fn_{coll}(x, y)] \quad (1)$$

and the charged multiplicity as:

$$\frac{dN_{ch}}{dy} = N_0 \left[(1 - f)\frac{N_{part}}{2} + fN_{coll}\right] \quad (2)$$

where y is the rapidity variable, N_{part} and N_{coll} are the total number of participants and binary collisions respectively.

Results

In Fig. 1 the probability distribution of the (elliptic) ecentricity is depicted. We observe

*Electronic address: sushantsk@vecc.gov.in

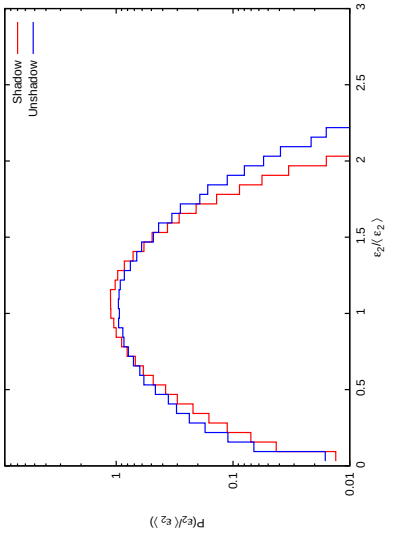

FIG. 1: The variation of $P(\epsilon_2/ < \epsilon_2 >)$ with $\epsilon_2/ < \epsilon_2 >$.

a narrowing of the distribution when shadowing effects are included. The shadowing reduces the effective number of participants in the collision process and hence the flucuations which is manifested as narrowing down of the distribution. The results obtained here with shadowing for Au+Au collisions matches well with IP-glasma.

Fig. 2 displays the variation of ϵ_2 with multiplicity for collisions of non-spherical system, like U+U collisions. A knee-like structure is observed [3] when conventional MCGM is used. However, the "knee" disappears when the effects of shadowing is included in the calculations. The physics behind the disappearence of the knee will be discussed in the presentation.

Summary

The effects of nuclear shadowing is included in estimating the initial energy density profile within the framework of MCGM. It is observed that the shadowing effect makes the probability distribution of ecentricity (ϵ_2) narrower. We also noticed that the knee-like structure that appears at large multiplicity in

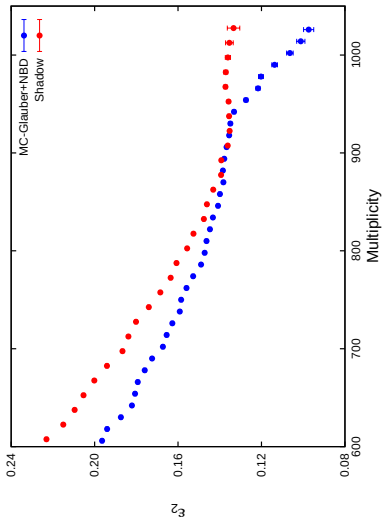

FIG. 2: The variation of ϵ_2 with multiplicity.

the ϵ_2 vs multiplicity plot for U+U collision vanishes with the inclusion of shadowing.

Acknowledgement: M. H., S.G. and S.C. acknowledge the support from Department of Atomic Energy, Govt. of India

References

[1] B. Schenke *et al.*, Nucl.Phys. A931 (2014) 288-292
[2] S. Singh *et al.*, to be published.
[3] A. Goldschmidt, Z. Qiu, C. Shen, and U. Heinz, (2015), arXiv:1502.00603 [nucl-th]