Multiparticle production in Xe-Xe collisions at $\sqrt{s_{NN}}$ = 5.44 TeV using Wounded Quark Model

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Introduction

QCD matter can be characterized by the observables like charged hadron multiplicity, elliptic flow, jet quenching, quarkonia suppression etc. The collisions of deformed nuclei like Uranium or Xenon will enhance our understanding about these observables. Further collision of deformed Xe nuclei is useful for the detection of chiral magnetic effect (CME), correlations between multiplicity and transverse momentum etc. similar to U-U collisions due to its different spatial configurations possible [1-3]. Recently, an experiment of Xe-Xe collision has been performed on 5.44 TeV of center-of-mass energy at LHC [2,3]. Therefore, it is worthwhile to investigate whether our recently proposed version of wounded quark model (WQM) [1] can give reliable estimates for pseudorapidity density and total mean multiplicity of charged hadrons in deformed Xe nuclei collisions at the LHC energy. This study will help us to find out the universal role of quark-quark collisions on multiparticle production. In this paper, we have used our new version of WQM [1] and incorporated the nuclear density profile function of deformed nucleus. We have calculated the charged hadron distributions with centrality and compared them with experimental data along with the other model results.

Model description

We have used the idea of two-component model in our WQM to calculate pseudorapidity distribution as follows:

$$\left(\frac{dn_{ch}}{d\eta}\right)^{AA}_{\eta=0} = \left(\frac{dn_{ch}}{d\eta}\right)^{pp}_{\eta=0} \left[(1-x)\,N_q^{AB} + xN_q^{AB}\nu_q^{AB}\right]. \quad (1)$$

For deformed Xe nuclei (A=129) we have used the modified form of Woods-Saxon nuclear density distribution :

$$\rho(r,\theta) = \rho_0 \frac{1}{1+\exp\frac{(r-R(1+\beta_2 Y_{20}+\beta_4 Y_{40}))}{a}} \quad (2)$$

where Y_{20} and Y_{40} are spherical harmonics. Deformation parameters are β_2=0.162 and β_4=-0.003. The values of other parameters are taken from Refs. [4]. The profile function $D_A(b)$ is related to nuclear density, $\rho(r,\theta)$ by following expression :

$$D_A(b) = \sum_\theta \int_{-\infty}^{\infty}\int_0^{2\pi} \rho(r,\theta)dzd\phi. \quad (3)$$

Results and Discussion

Fig. 1 presents the variation of pseudorapidity density, $(dn_{ch}/d\eta)_{\eta=0}$ at midrapidity with respect to centrality obtained by WQM choosing two different distribution of centrality classes i.e., Type I and Type II. In Type I we have used two different but fixed values of x (here x signifies the relative contributions of hard and soft processes) which are 0.005 and 0.00002 to calculate $(dn_{ch}/d\eta)_{\eta=0}$. Further, we have also used varying values of x in Type I. On the other side we have used a fixed value of x = 0.00002 to calculate $(dn_{ch}/d\eta)_{\eta=0}$ in Type II. We found that our model in Type I with varying x, and in Type II with fixed x suitably explains the experimental data over the entire centrality region. Fig. 2, demonstrates the variation of $(dn_{ch}/d\eta)/(2N_q)$ with

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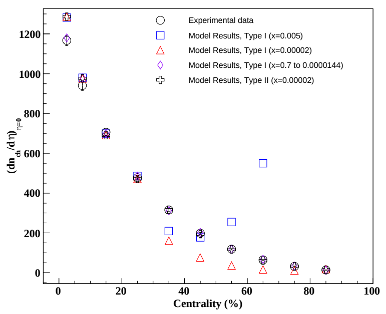

FIG. 1: Variation of pseudorapidity density of charged hadrons produced in Xe-Xe collisions with respect to centrality obtained by Eq. 1. The Experimental data used here are taken from Refs. [2-3].

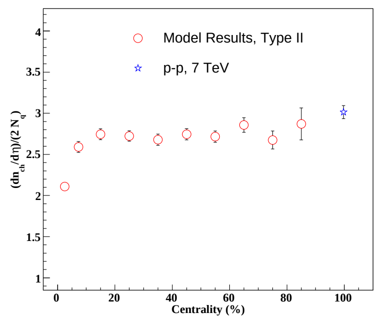

FIG. 2: Variation of $(dn_{ch}/d\eta)/(2N_q)$ as a function of centrality for Xe-Xe collisions at $\sqrt{s_{NN}}$ = 5.44 TeV. Here, N_q is calculated within WQM and the experimental data of $(dn_{ch}/d\eta)$ are taken from Refs [2-3].

centrality and the results are compared with the $p-p$ data to show the scaling behaviour in Type II centrality class and we found that our model results very well scales with p-p data and thus signifies the basic role of quark picture in nucleus-nucleus collisions. In Fig. 3, we have shown the variation of $(dn_{ch}/d\eta)_{\eta=0}$ with centrality in our model using Type II centrality distribution and compared the results with the various theoretical models [2]. We found that the experimental data are well sat-

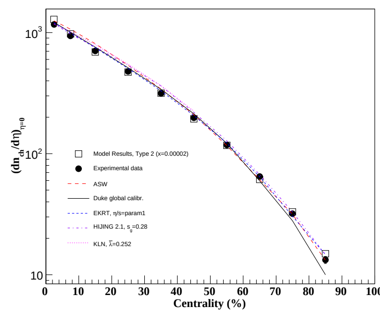

FIG. 3: Variation of pseudorapidity density of charged hadrons with respect to centrality obtained by WQM and compared with various models.

isfied by WQM results ranging from most central to most peripheral collisions. Most of the other models are not able to reproduce the experimental data over whole range of centrality simultaneously. However, in WQM, it is utmost important to understand the role of x in the light of Xe-Xe collisions. In conclusion, we demonstrate that a model based on basic quark-quark interaction is able to predict the production of charged hadrons in deformed Xe-Xe collisions.

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References

[1] O.S.K. Chaturvedi, P.K. Srivastava, Ashwini Kumar, and B.K.Singh, Eur. Phys. J. Plus **131**, 438 (2016), and Eur. Phys. J. Plus **132**, 430 (2017).

[2] ALICE Collaboration, arXiv:nucl-ex/1805.04432.

[3] ALICE Collaboration, Phys. Lett. B **784**, 82 (2018).

[4] Phys. Rev. C **97**, 034904 (2018), Eur. Phys. J C **78**, 427 (2018).