Charged hadron production for asymmetric and deformed nuclear collisions in Wounded Quark Model

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Introduction

In heavy ion collisions the charged particle multiplicity (n_{ch}) and pseudorapidity density ($dn_{ch}/d\eta$) are helpful to characterize the properties of matter created. These observables depends on collision energy and collision geometry which are a key tool to understand the particle production mechanism. Phenomenologicalliy a unified model which describes the experimental data coming from various kind of collision experiments, is much needed to provide the physical insights about the production mechanism in heavy ion experiments. In this paper, firstly we have calculated the charged hadron multiplicities for nucleon-nucleus (such as proton-lead (p-Pb) and asymmetric nuclei collisions like deutron-gold (d-Au), and copper-gold (Cu-Au) within our modified Wounded Quark Model (WQM). Further we have used the suitable density function of our WQM to calculate pseudorapidity density at mid-rapidity in the collision of deformed uranium nuclei. Moreover, we have calculated speed-of-sound in different nuclear collisions with the help of pseudorapidity distribution.

Model Description

We have used Eq. (1) to calculate average charged hadron multiplicity in nucleus-nucleus collisions. For small deutron nuclei, we have used the Hulthén function for expressing charge density of deutrium nuclei (see Eq. (2)) and for deformed nuclei we have used the modified form of Wood-saxon charge distribution (see Eq. (3)). We have used the idea of two-component model in our WQM to calculate pseudorapidity distribution according to Eq. (4). For notations please see the Refs. [1, 2].

$$< n_{ch} >_{AB}= N_q^{AB}\left[a' + b' ln\left(\frac{\sqrt{s_{AB}}}{N_q^{AB}}\right) + c' ln^2\left(\frac{\sqrt{s_{AB}}}{N_q^{AB}}\right) + d' ln^3\left(\frac{\sqrt{s_{AB}}}{N_q^{AB}}\right)\right]. \quad (1)$$

$$\rho(r) = \rho_0\left(\frac{e^{-ar}+e^{-br}}{r}\right)^2, \quad (2)$$

where $a = 0.457$ fm^{-1} and $b = 2.35$ fm^{-1}.

$$\rho(x,y,z) = \rho_0\frac{1}{1+\exp\frac{(r-R(1+\beta_2 Y_{20}+\beta_4 Y_{40}))}{a}}, \quad (3)$$

$$\left(\frac{dn_{ch}}{d\eta}\right)^{AA}_{\eta=0} = \left(\frac{dn_{ch}}{d\eta}\right)^{pp}_{\eta=0}\left[(1-x)\,N_q^{AB} + xN_q^{AB}\nu_q^{AB}\right]. \quad (4)$$

Results and Discussions

In Fig. 1 we have presented the variation of charged hadron pseudorapidity density at midrapidity with respect to centrality for Pb-Pb collisions at 2.76 TeV. Further, we have shown our model results with the experimental data along with other model results obtained from HIJING, AMPT and DPMJET. In Fig. 2, the model results for the variation of mean charged hadron multiplicity with respect to centrality is shown for d-Au collisions at 200 GeV. In Fig. 3, We have calculated the model results for the variation of $dn_{ch}/d\eta$

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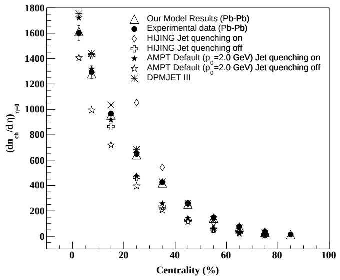

FIG. 1: Variation of pseudorapidity density with respect to centrality for Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV.

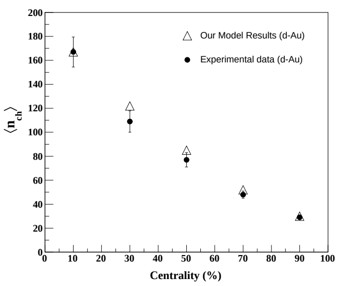

FIG. 2: Variation of total charge hadron multiplicity with respect to centrality for d-Au collisions at $\sqrt{s_{NN}} = 200$ GeV.

with respect to centrality for asymmetric Cu-Au collisions. We have also shown comparison of WQM results with the IP-Glasma model. In Fig. 4, we show the variation of square-of-speed of sound (c_s^2) in Au-Au and in Cu-Cu systems, the medium created in smaller colliding system like Cu-Cu, the finite size effects have important role which causes fluctuation in the mean value of c_s^2 which makes speed of sound a bit random. Further, we have calculated pseudorapidity density of $U-U$ in minimum bias and tip-tip at $\sqrt{s_{NN}} = 193$ GeV by our model 797 and 739 respectively and compared with RHIC data (830.4±67.8) in 0-5% centrality bin.

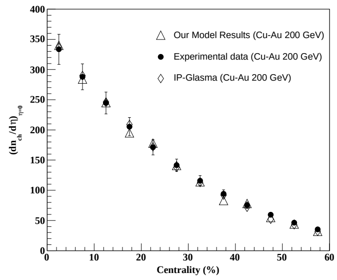

FIG. 3: Variation of pseudorapidity density at midrapidity with respect to centrality for Cu-Au collision at $\sqrt{s_{NN}} = 200$ GeV.

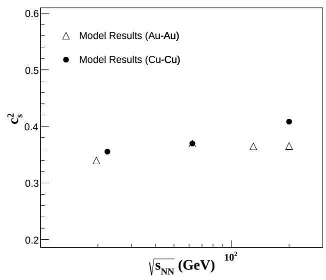

FIG. 4: Variation of c_s^2 in Cu-Cu and Au-Au with $\sqrt{s_{NN}}$ at RHIC energy.

Acknowledgments

OSKC and PKS is grateful to Council of Scientific and Industrial Research (CSIR), New Delhi for providing a research grant. AK would like to acknowledge the financial support provided by Department of Science and Technology (DST), New Delhi, India.

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