Xe+Xe collisions with Modified Glauber Model

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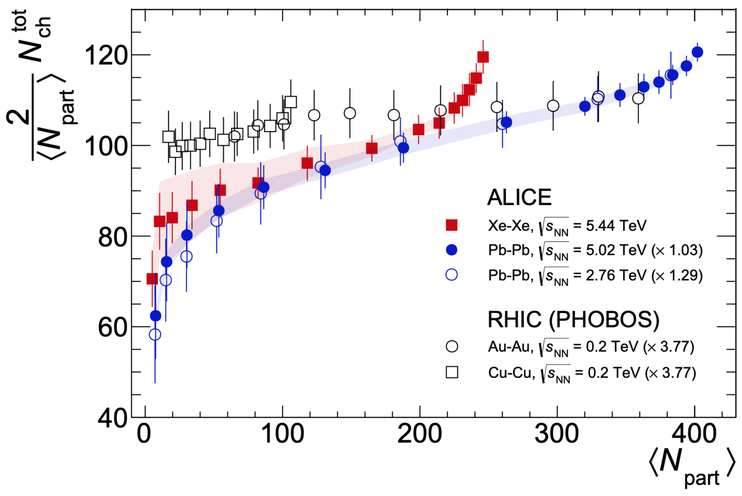
Grigory Feofilov, Karina Namyotysheva, Andrey Seryakov (seryakov@yahoo.com)
Laboratory of ultra-high energy physics, St.Petersburg State University

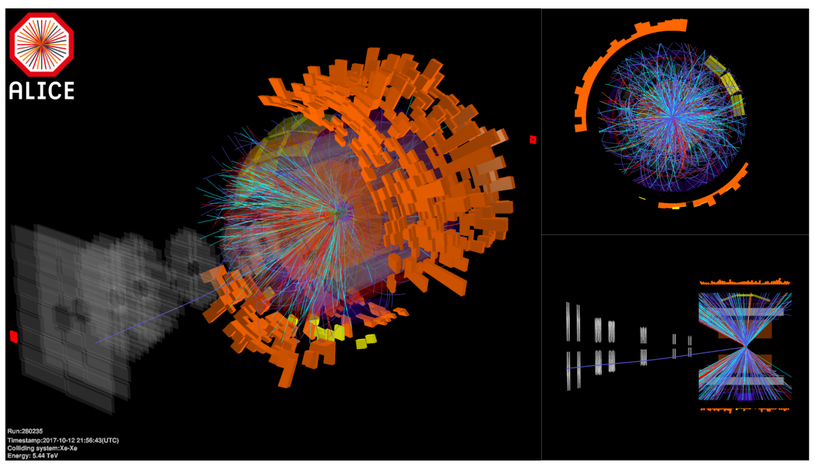
Zimányi School'19
Budapest

Xe+Xe collisions with ALICE

In 2017 the ALICE collaboration successfully collected data of $^{129}Xe + ^{129}Xe$ 5.44 TeV collisions at LHC. That was the first LHC data from the intermediate mass nuclei interaction. The centrality dependence of charged particle production $2N_{ch}/N_{part}$ [1] shows a sharp rise for the most central collision, this effect was called "the uptick effect".



In the current work we argue that the effect can be explained solely by ^{129}Xe geometry and nucleon stopping effect in the frame of the Modified Glauber Model (MGM) [2-4].



Xenon nuclei

^{129}Xe is a deformed nucleus which density can be described by a Wood—Saxon distribution [1][5]:

$$\rho(r,\theta) = \rho_0/(1+\exp\left(\frac{r-R(\theta)}{\alpha}\right))$$

$\alpha = 0.59$ is a nuclear skin thickness, $R(\theta)$ is a nuclear radius, parametrized as a function of the polar angle θ. $R(\theta) = R_0(1+\beta_2 Y_{20}(\theta))$, $R_0 = 5.4$ fm is the average radius, Y_{20} is the Legendre polynomial. $\beta_2 = 0.18$ is a deformation parameter.

Note, the same density function is used to describe spherical symmetric Pb nuclei with $\beta_2 = 0$, $R = 6.63$ fm, $\alpha = 0.55$

Modified Glauber Model

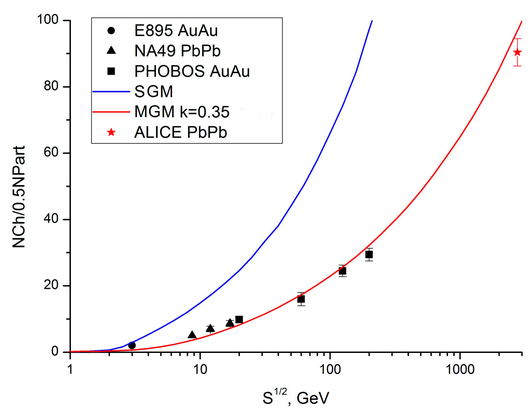
MGM [2-4] includes all main ideas of the standard Glauber model [6]:

- A+A collision is a superposition of independent nucleon-nucleon (n-n) collisions.
- Nuclei density [7] and inelastic nucleon-nucleon cross-section [8] are taken from experimental data
- Nucleon trajectories remain unaltered by n-n collisions and parallel to the beam axes.

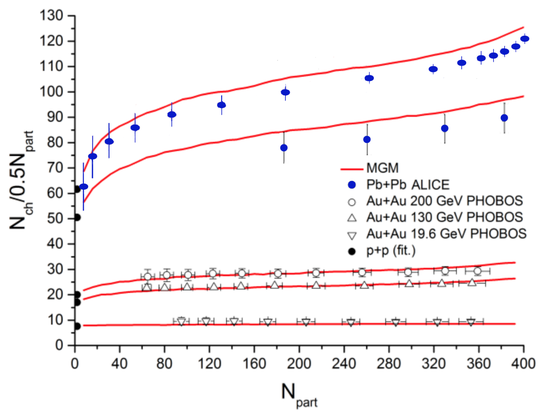
In additional MGM takes into account an energy loss for particle production in each n-n collision by reducing their momentum in the system of mass by a constant factor **k**.

$$p' = k * p$$

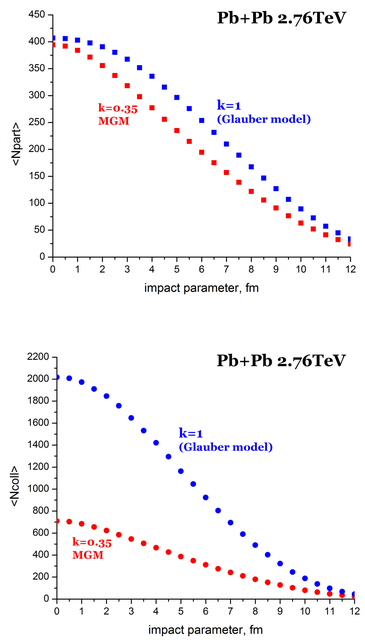
This allows to introduce a number of produced particles to each n-n collision from the available experimental data on multiplicity in p+p collisions [9]. The parameter **k was chosen to be equal 0.35** [2] to reproduce the total multiplicity in the most central **Pb+Pb and Au+Au collision at the energy range from 1.5 to 200 GeV** [10]. After the this procedure MGM was able not only to reproduce centrality dependencies of the total multiplicity but to predict and describe it for the LHC energies [11]. The important results of the model is a several time reduction of the number of binary nucleon collision in the central A+A collision with the same number of nucleon-participants.



$2N_{ch}/N_{part}$ energy dependence for the most central Au+Au and Pb+Pb collisions. Red and blue lines represent MGM with k=0.35 and k=1 respectively [3].

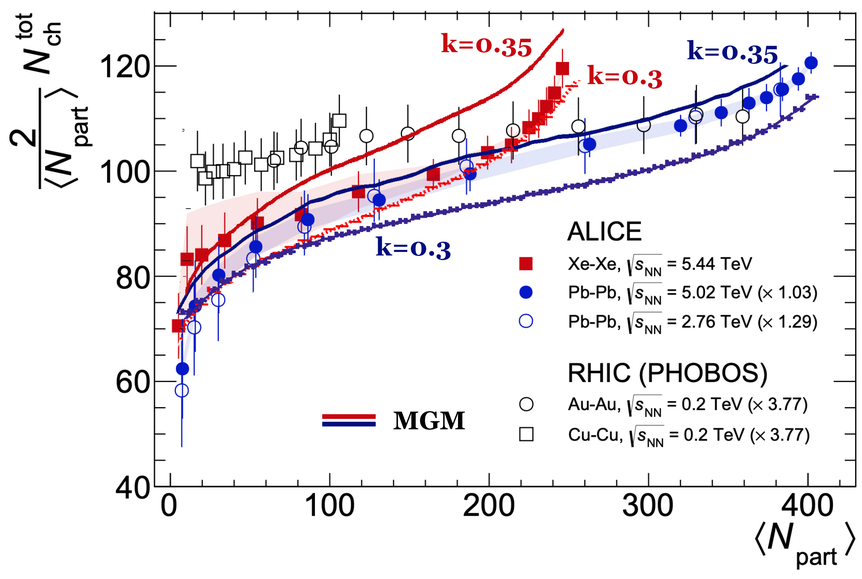


$2N_{ch}/N_{part}$ dependence of N_{part} for Au+Au and Pb+Pb collisions. Red lines represent MGM with k=0.35 [3][11].



Xe+Xe Results

The $2N_{ch}/N_{part}$ for Xe+Xe collisions at $\sqrt{s_{NN}} = 5.44$TeV as a function of N_{part} [1]. Also shown in the figure is the result from Pb+Pb collisions at $\sqrt{s_{NN}} = 5.02$TeV. Data from lower energies at [13][14] are shown for comparison. Multiplicity predictions for Pb+Pb collisions at = 5.02TeV are based on the MC Modified Glauber model (done on the 13th Dec 2015 [11]). The parameters **k** wasn't fitted for calculations at the LHC energies. Although, a small modification of the k parameter may improve the description.



Saint Petersburg State University
www.spbu.ru

Conclusions

1. The Modified Glauber model (MGM) developed earlier with a simplified assumptions of some mean momentum loss in multiple nucleon-nucleon collisions is found to be successful in case of the existing AA data in a broad energy range
2. Predictions of the MGM for the total yields of charged particle multiplicity normalized on the number of participants in Xe+Xe and Pb+Pb collisions are in a reasonable agreement with the experiment at the LHC energies. The single parameter k=0.35 fitting was obtained earlier using the SPS and RHIC data

References

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