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FORWARD–BACKWARD MULTIPLICITY CORRELATIONS IN AuAu COLLISIONS*

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We investigate the wounded nucleon model contribution to the forward–backward multiplicity correlation coefficient measured by the STAR Collaboration in AuAu collisions at $\sqrt{s} = 200$ GeV.

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1. Introduction

Recently the STAR Collaboration presented the preliminary results [1] on the forward–backward multiplicity correlation coefficient in AuAu collisions at $\sqrt{s} = 200$ GeV. It was found that for the most central AuAu collisions the correlation coefficient b is significantly larger than in pp collisions. Moreover, it remains constant across the measured midrapidity region while it decreases (with increasing η) in pp collisions. Usually, this result is interpreted as a signal of dense partonic matter created in heavy-ion collisions [2, 3].

The main difficulty, however, is to distinguish between correlations arising from the presence of the quark–gluon plasma and correlations that do not depend on this new phenomenon. These need to be understood and subtracted in order to access the true signal of the quark–gluon plasma.

In the present paper we discuss the wounded nucleon model [4] contribution to the measured correlation coefficient. Our main conclusion is that for the most central collisions this contribution is sufficient to explain more than 85% of the effect. This seems to question this experimental finding as a signal of the quark–gluon plasma.

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2. Correlation coefficient

The correlation coefficient (or correlation strength) b is defined as

$$b = \frac{\langle n_{\mathrm{B}} n_{\mathrm{F}} \rangle - \langle n_{\mathrm{B}} \rangle \langle n_{\mathrm{F}} \rangle}{\langle n_{\mathrm{F}}^2 \rangle - \langle n_{\mathrm{F}} \rangle^2}\,, \tag{1}$$

where n_{B} and n_{F} are event by event particle multiplicities in backward (B) and forward (F) intervals, respectively.

Recently, we have calculated [5] the correlation coefficient b for arbitrary nucleus–nucleus collision and at any (pseudo)rapidity range in the framework of the wounded nucleon model. In the midrapidity region, were the preliminary STAR data is available, b has a particularly simple form

$$b = 1 - \left[1 + \frac{\bar{n}}{4} \left(\frac{2}{k} + \frac{\langle w^2 \rangle - \langle w \rangle^2}{\langle w \rangle} \right) \right]^{-1} . \tag{2}$$

The parameters $\bar{n}$ (average multiplicity) and k (deviation from Poisson distribution) come from the negative binomial (NB) fit to the pp multiplicity distribution data in the combined interval B+F. These parameters are known for various energies and different pseudorapidity intervals [6]. $\langle w \rangle$ is the average number of wounded nucleons in both colliding nuclei.

In order to obtain the result (2) we assumed that the contribution to the multiplicity in backward B and forward F intervals is provided by independent contributions from left- and right-moving wounded nucleons. This is the main assumption of the wounded nucleon model [7]. Moreover, it is assumed that a single wounded nucleon may populate particles both to B and F intervals [7, 8][1].

3. Results

At the STAR experiment the intervals B and F of width 0.2 each were located symmetrically around $\eta = 0$ with the distance $\Delta\eta$ between bin centres ranging from 0.2 to 1.8.

NB distribution fits to pp multiplicity data in the midrapidity region give approximately constant $\bar{n} = 0.96$ (central plateau) and $k = 1.8$ [6]. The nontrivial part is the calculation of $\Omega \equiv [\langle w^2 \rangle - \langle w \rangle^2] / \langle w \rangle$. As shown in [9], different centrality selections (*e.g.* via impact parameter, number of wounded nucleons, number of produced particles) lead to rather different Ω, except the most central collisions, where Ω weakly depends on the centrality class definition. In consequence, direct comparison of our result (2) with the preliminary STAR data can be performed only for the most central collisions.

[1] In the midrapidity region the precise shape of a single wounded nucleon fragmentation function is not important.

We performed the standard MC calculations [10] with the centrality class definition via the number of wounded nucleons w in both colliding nuclei. We obtained $\Omega = 3.04, 2.07, 1.71, 1.4, 1.26$ for 0–10%, 10–20%, 20–30%, 30–40% and 40–50% centrality class selections, respectively.

In Fig. 1 the correlation coefficient b (2) *versus* the distance $\Delta\eta$ between bin centres is shown. The intervals were chosen according to the recent STAR measurement.

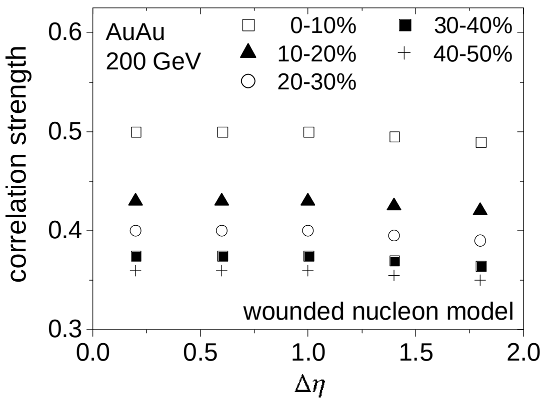

Fig. 1. Wounded nucleon model prediction for the correlation coefficient b in the midrapidity region *versus* the distance $\Delta\eta$ between bin centres.

It is interesting to note that for the $0 - 10\%$ centrality class collisions (where direct comparison is possible) the wounded nucleon model can explain more than 85% of the effect. This conclusion seems to question this experimental finding as a signal of the quark–gluon plasma. Unfortunately, the STAR data is still in a preliminary stage, thus the final conclusion cannot be reached.

4. Summary

In summary, we have studied the forward–backward multiplicity correlation coefficient in the framework of the wounded nucleon model. In the midrapidity region correlation coefficient b can be written in a particularly simple form. This expression allows to explain the natural enhancement of b with increasing scaled variance of the number of the wounded nucleons $\left\langle [w - \langle w\rangle]^2 \right\rangle / \langle w\rangle$. We have performed explicit calculations for AuAu collisions at $\sqrt{s} = 200$ GeV. Increase of b with increasing centrality as well as almost no rapidity dependence was observed. Our results are in a good qualitative agreement with the preliminary STAR data, although exact comparison can be performed only for the most central collisions. This conclusion seems to question this experimental finding as a signal of the quark–gluon plasma.

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