A Study on Forward-Backward Multiplicity Correlation for Charged Particles at FAIR Energies

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Introduction

The Compressed Baryonic Matter (CBM) experiment is one of the major experiments to be conducted at the Facility for Antiproton and Ion Research (FAIR). Unlike LHC, the main objective of this experiment is to realize the QGP phase at the region of moderate temperature and high baryon density. This type of highly dense nuclear matter is believed to be existed at the core of neutron stars. The beam energies for the CBM experiment are chosen in such a fashion that a highly dense nuclear matter of the order of 5-10 times the normal nuclear will be created. Since the lifetime of the fireball created in heavy-ion collision is very small, direct detection of QGP is an impossible task and hence various indirect signatures of QGP was proposed. Correlations and fluctuations among the produced particles are believed to be one of the important tools to study the multi-particle production in heavy-ion collision. In the present investigation an attempt has been made to study the multiplicity correlation of the produced charged particles at FAIR energy using the partonic Multi-Phase Transport Model (AMPT).

Forward-Backward Multiplicity correlation

The strength of forward-backward multiplicity correlation is characterized by the correlation coefficient b_{corr}. Let N_f and N_b represent the charged particle multiplicities in the forward and backward pseudorapidity intervals within a width of $\delta\eta$ on the two sides of the central pseudorapidity η_0. The correlation coefficient b_{corr} is nothing but the slope of a linear relationship between the average multiplicity measured in the backward rapidity hemisphere, $\langle N_b \rangle$, and the multiplicity in the forward rapidity hemisphere, N_f. The expression for b_{corr} is [1],

$$b_{corr} = \frac{\langle N_f N_b \rangle - \langle N_f \rangle \langle N_b \rangle}{\langle N_f^2 \rangle - \langle N_f \rangle^2}. \quad (1)$$

The value of b_{corr} can either be positive, negative or zero. Experimentally, the strengths of the forward-backward multiplicity correlation in elementary and nucleus-nucleus collisions are found to be positive [2, 3].

Event statistics

The partonic version of AMPT model i.e. AMPT (String Melting) is used for the present study. The event-statistics of the present investigation is given by,

TABLE I: Event statistics (AMPT SM).

Collising system	Energy	No. of Events
$Au + Au$	30A GeV	4,40,000
$p + p$	30A GeV	9,40,000

Results and Discussion

Fig. 1 shows the FB multiplicity correlation coefficient b_{corr} as a function of η-gap for Au-Au collisions at energy $30A$ GeV for string melting version of the AMPT model for various centrality intervals. It can be seen from the figure that the magnitude of the FB correlation strength decreases with the decrease in centrality i.e. b_{corr} is large for central collision where energy-momentum transfer is maximum. It can further be seen from the figure that the FB correlation strength is nearly

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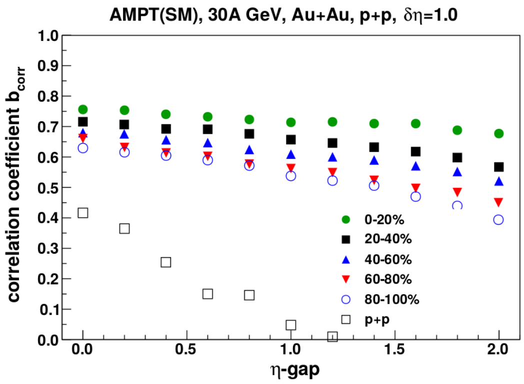

FIG. 1: Correlation strength b_{corr} as a function of η-gap in Au-Au colision for different centralities. The result have been compared with pp collisions at same energy 30A GeV and for same $\delta\eta = 1$

flat as a function of η-gap for 0-20% centrality whereas the correlation strength decreases sharply with η-gap for 60-80% and 80-100% centrality bins. This type of sharp decrease is expected if short-range correlations are dominant. The FB correlation strength values for 80-100% centrality bins at large η-gap is very small indicating the existence of a non-zero Long-range correlation (LRC).

For better understanding, the b_{corr} is calculated for $p+p$ collisions as well. It can be seen from figure that the rate of decrease of FB correlation strength is more in p+p collisions as compared to extreme peripheral $Au + Au$ collisions. This observation can be explained from the fact that the short range correlation (SRC) length is smaller in p+p collisions than in peripheral Au+Au collisions. Further, the observation of zero FB correlation strength for p+p collisions at larger η-gap indicates the presence of only SRC in p+p collisions.

References

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