Forward-Backward Multiplicity Correlations in ^{16}O-AgBr Collisions at 60A and 200A GeV/c

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Correlations amongst the particles produced in the forward (F) and backward (B) pseudorapidity (η) regions are regarded as an important tool to search for the phase transition in nucleus-nucleus (AA) collisions at relativistic energies[1]. The inclusive two particle correlations have two components[2]; the short-range correaltions (SRCs) and the long-range correlations (LRCs). The observed strong SRCs have been found to remain confined to a region of ± 1 η unit around the central η value. The SRCs are, however, expected to extend over a longer region($>$ 2 η units). The SRCs are envisaged to arise due to tendency of particle to be grouped in clusters which finally decay isotropically, in their c.m.system to real hadrons[3]. The LRCs, on the other hand, arise due to overall multiplicity fluctuations and are expected to be observed at higher energies[4]. In the case of AA collisions, LRCs are expected to be observed due to the multiparton interactions and would extend to rather longer range as compared to one observed in hadron-hadron (hh) collisions at the same incident energy. The CGC picture of particle production and multiple scattering model also predicts the presence of LRCs in AA collisions. After the availability of RHIC and LHC data, interest in the studies involving F-B correlations have revived considerably because of idea that a shortening in the correalation length, if observed, at these energies, may be taken as a signal of transition to a QGP[5]. However, before looking for the new signals at RHIC and LHC energies, a baseline contribution to the observed correlations should be identified first. It was, therefore, considered worthwhile to undertake a systematic study of F-B Correlations at SPS energies. Considering that only a few attempts are made[6]. Experimental data as ^{16}O-AgBr at 60 and 200A GeV/c are analysed for this purpose and the findings are compared with the predictions of Monte Carlo model HIJING.

F-B correlation strength is estimated by examining the linear dependence of mean charged multiplicity in the B-region, $< n_b >$ on the event multiplicity in the F-region, n_f, of the form $< n_b >= a + bn_f$, where b measures the strength of the correlation[1]. The values of b may also be estimated using the following relation:

$$b = \frac{< n_f n_b > - < n_f >< n_b >}{< n_f^2 > - < n_f >^2} = \frac{D_{bf}^2}{D_{ff}^2} \quad (1)$$

Where D_{ff} and D_{bf} are respectively denote the forward-forward and backward-forward dispersions.

Dependence of $< n_b >$, on n_f for the experimental and HIJING events are examined at the two energies considered. The values of b are estimated using Eq.1 and also from the linear dependence, $< n_b >= a + bn_f$. These values are presented in Table 1.

TABLE I: Values of correlation coefficient, b at the two energies.

Energy (GeV)		b (Linear fit)	b $(=\frac{D_{bf}^2}{D_{ff}^2})$
60A	Expt.	1.30±0.05	1.33±0.03
	HIJING	1.10±0.03	1.10±0.03
200A	Expt.	1.21±0.05	1.20±0.05
	HIJING	1.07±0.05	1.12±0.06

It may be noted in the table that the values of b obtained from the linear fits and from Eq.1 are nearly the same and indicate the presence of strong SRCs in both real and simulated data samples. It may also be noted from the table that the correlation strength, b decreases with increasing beam energy. This result is in contrast with those reported for pp collisions in the c.m. energy range $\sqrt{s}$ ∼200-900 GeV, where, the values of b have been found to increase with increasing incident energy[4]. Larger values of b at lower energies, observed in the present study may be due to the uncorrelated emission for which F-B correlations depend on the mean multiplicity and multiplicity fluctuations in the combined F-B regions[7]. The observed strong F-B correlations, when there is no or small separation between the F and B regions with respect to the centre of symmetry η_c, may be ascribed mainly due to the clusters produced around mid-rapidity, whose decay products would go to both F and B regions giving rise to the SRCs.

In order to examine the presence of LRCs, if any, contributions from SRCs are to be eliminated. For this purpose, η windows of small but equal widths are placed in F and B regions such that they are separated by equal gaps (in η units), η_{gap} with respect to η_c. Multiplicities, n_f and n_b are then counted by changing the η_{gap} from 0 to 2.0 in steps of 0.25 on each side of η_c and the values of b are estimated for each separation. Variations of b with η_{gap} for various data sets are displayed in Fig.1. It is observed in the figure that the values of b, for 60A GeV/c data (real and HIJING) first increase then quickly decrease to zero. This indicates that the correlations are limited to η-region < 1.5 and are of short range in nature. However, for 200A GeV/c data, b acquires almost a constant value ~ 0.7 until $\eta_{gap} \sim 1.25$ and thereafter decreases slowly to ~ 0.2 with increasing η_{gap}. Futhermore, HIJING simulated values are noted to be in good agreement with the experimental data except some fluctuations in the lower η_{gap} region. This indicates the presence of some LRCs which is absent at lower energies.

These findings, thus, tend to suggest that LRCs might be present in AA collisions at higher energies, particularly when heavy target nuclei, such as, Ag or Br are involved. The Monte carlo model also supports the results obtained from the analysis of real events.

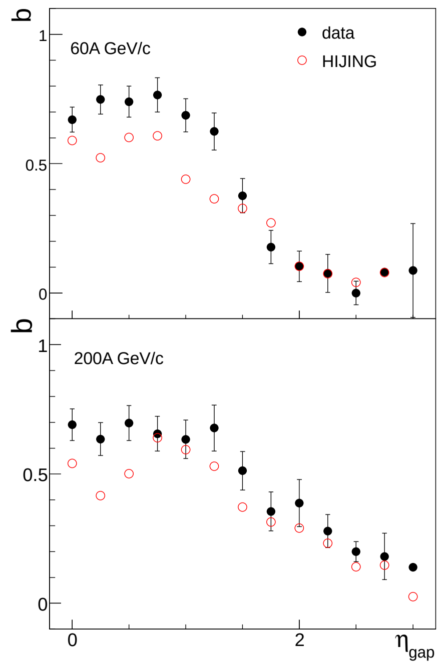

FIG. 1: Variations of b with η_{gap} for 60A and 200A GeV/c ^{16}O-AgBr collisions

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