Jet Quenching and Event-by-Event Charge Fluctuations in Ion-Ion collisions at RHIC and LHC energies

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Studies involving event-by-event (ebe) charged fluctuations in hadronic and ion collisions at relativistic energies have drawn considerable attention of both the experimental and theoretical Physicists because:
i. *QGP Signature:* A suppression in the ebe net charge fluctuations in local phase space has been theoretically predicted[1] as a signature of the plasma state. Such a decrease is expected because the charges spread more evenly throughout the QGP volume than that in a hadronic gas.
ii. *Thermodynamic Signature:* An enhanced charge fluctuations have been observed at RHIC and SPS energies, which might be due to the anomalous proton number fluctuations at the critical point[2]
iii. *ρ, ω mesons:* Charge fluctuations are influenced by the decay of hadronic resonances. In the absence of QGP, the deviations of such fluctuations from the statistical behaviour can be used to determine the abundance of ρ and ω mesons.
The most commonly used measure of the ebe net charge fluctuations is the D-measure, defined in terms of the variance of the ebe net charge, $\delta Q = < Q^2 > - < Q >^2$, where $Q = n^+ - n^-$; n^+ and n^- being the multiplicities of positively and negatively charged hadrons in a particular phase space in an event. the D-measure of the charged fluctuations is given by $D(Q) = 4\frac{\delta Q^2}{<n_{ch}>}$;$n_{ch}$ being the total charged particle multiplicity, while the quantities in the angular brackets denote the event averaged values. In order o account for a non-zero net charge due to the baryon stopping and the charge conservation in a large pseudorapidity(η) window two corrections are applied to the D-measure and the redefined parameter is given by $D_{corr}(Q) = \frac{D(Q)}{C_\mu C_y}$, where $C_\mu = \frac{<n^+>_{\Delta\eta}}{<n^->_{\Delta\eta}}$ and $C_y = 1 - \frac{<n_{ch}>_{\Delta\eta}}{<n_{ch}>}$.

In the present study, an attmpt is made to study the ebe net charge fluctuations in ion-ion (AA) collisions at RHIC and LHC energies. Effect of the jet quenching on these fluctuations are also examined. For the purpose, three sets of Monte Carlo events for each of the $Au^{197} - Au^{197}$ collisions at 200A GeV/c and $Pb^{208} - Pb^{208}$ collisions at 5.5A TeV have been generated using the code HIJING-1.35: HIJING default with jet quenching on, with quenching off and with jets/minijets production switched off. Since the jet quenching effect is expected to be most significant in the central collisions, the events were generated with impact parameter, $b < 2fm$, which corresponds to top 5% centrality.
Variations of $D(Q)$ and $D_{corr}(Q)$ with the size of central pseudorapidity window, $\Delta\eta$ for the three sets of events at the two energies are displayed in Figs.1 & 2. According to the theoretical predictions, D $\sim$ 1 for a QGP, 2.8 for the resonance gas and 4 for uncorrelated pion gas. These predictions are indicated in the figures. Variation $D(Q)$ with $\Delta\eta$ for the events simulated by assigning random charge +1 or -1 to each particle are also plotted in Fig.1. It is interesting to note that $D(Q)$ values for this data set is $\sim$ 4 irrespective of the fact that how large or small is the η window. This indicates that the ebe analysis may be successfully applied to the narrow phase space bins having a very limited number of particles.

$D(Q)$ values for both Pb-Pb and Au-Au data are observed to decrease with increasing η window size, starting from $\sim$ 4 to 1 and even below. Data points corresponding to the

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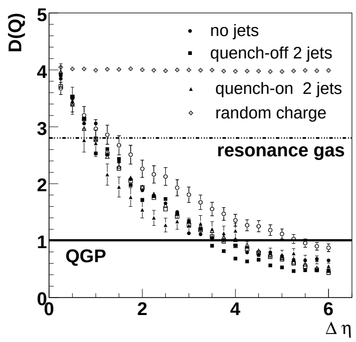

FIG. 1: Variation of $D(Q)$ and with the size of central η window for the three sets of HIJING events. The solid and open markers correspond to the Pb-Pb and Au-Au data respectively.

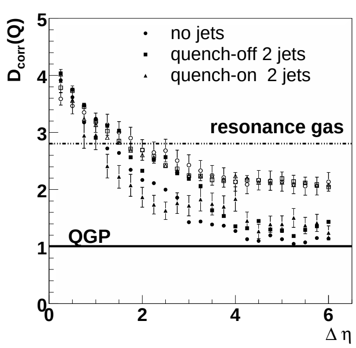

FIG. 2: The same plot as in Fig.1 but for the corrected measure, $D_{corr}(Q)$.

various sets of events are seen to almost overlap except for the Au-Au events with jet production switched off. The values of $D_{corr}(Q)$ for the three sets of Au-Au data are noticed to first decrease and then tend to acquire almost constant values ~ 2.0 for the η window $\geq$ 2.5. These findings are consistent with those reported earlier[3, 4] for the 200A GeV Au-Au collisions using the URQMD and HIJING models. $D_{corr}(Q)$ values for the Pb-Pb data sets are observed to decrease rather faster and acquire a saturation. beyond $\Delta\eta \sim 2.5$. The $D_{corr}(Q)$ values in this region are ~ 1.2, i.e. much smaller than those obtained for the Au-Au data.

Shown in Fig.3 is the dependence of

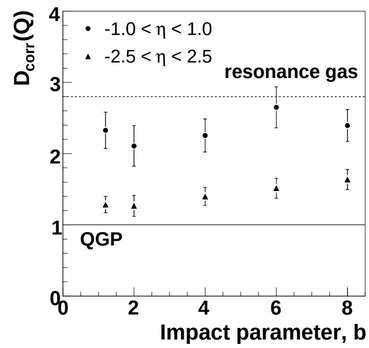

FIG. 3: Dependence of $D_{corr}(Q)$ on the impact parameter, b for Pb-Pb Collisions at 5.5A TeV.

$D_{corr}(Q)$ on the impact parameter for the Pb-Pb data at 5.5A TeV. The data points for each η window are for the five of sets events (HIJING default), each generated for the different impact parameter values. The data points for both the η windows lie below the resonance gas and above than that expected for a QGP. A slight centrality dependence of the $D_{corr}(Q)$ may also be noticed in the figure. The values of $D_{corr}(Q)$ for the various b values for the two η windows are much smaller than those reported in ref.3 for the 200A GeV Au-Au data. The smaller values of $D_{corr}(Q)$ at LHC energy as compared to those at RHIC energy might be due to the difference in gluon populations at these energies.Pb-Pb data at 5.5A TeV will be simulated by using the other Monte Carlo codes, e.g., URQMD, VNIb and the results will be compare with the present findings and also with those obtained for the pp data at LHC energies. this would lead to distinguish between the different gluon populations present in different Monte Carlo models.

References

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