Probing the Early Medium in Heavy Ion Collisions with the Energy and System-Size Dependence of Long-Range Multiplicity Correlations

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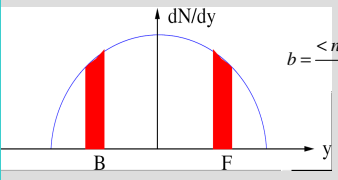
Abstract

Long-range forward-backward multiplicity correlations have been measured in heavy ion collisions at RHIC. New results for short and long-range multiplicity correlations (forward-backward) are presented for several systems (Au+Au, Cu+Cu, and pp) at energies of √sNN = 62.4 and ~ 200 GeV. A strong, long-range correlation has been seen previously in central heavy ion collisions at √sNN= 200 GeV, which vanishes in semi-peripheral events and pp collisions. The long-range component of the correlation has been attributed to a multiple partonic interactions, while the origin of the short-range correlation is due to independent sources. This scenario tends to support the view that there is a partonic core formed in heavy ion collisions surrounded by a hadronic corona.

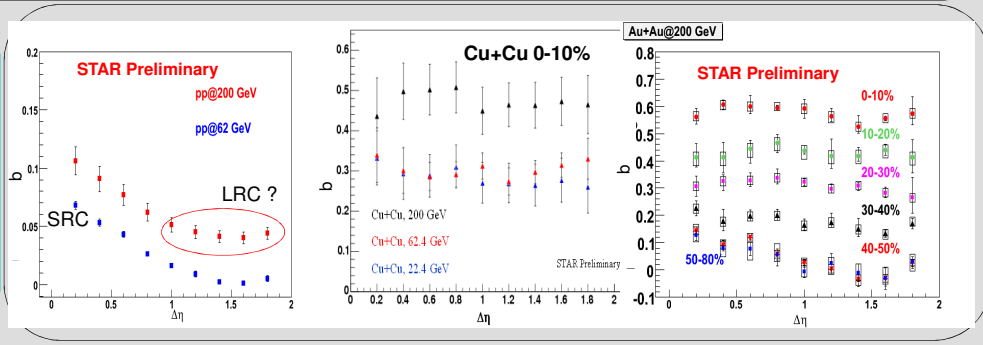
Correlations have always been expected to reflect the features of multiparticle production, including eventual phase transitions. Simplistic, multipurpose picture of multiparticle production: first formation of sources, then coherent decay of the sources into particles.

One source characterized by exponentially damped rapidity correlations D_{bf}^2

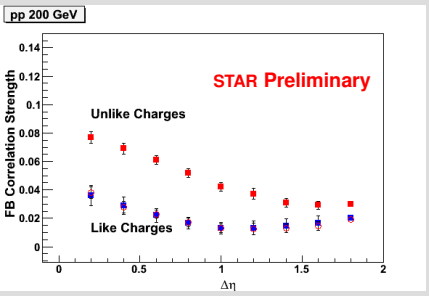


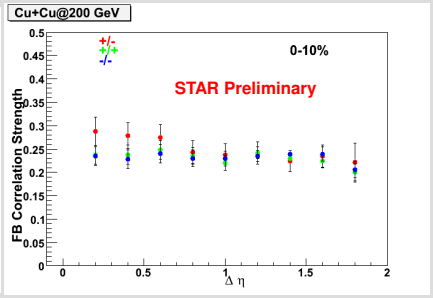
$$b = \frac{< n_f n_b > - < n_f >< n_b >}{< n_f^2 > - < n_f >^2} = \frac{D_{bf}^2}{D_{ff}^2}$$

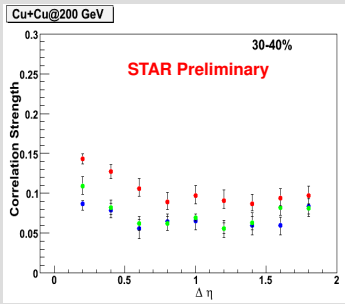
In hadronic collisions, D_{ff}^2 characterizes the **short range correlations**, related with the number of emitted particles per cluster, while , D_{bf}^2 **long range for a gap > 1.0, is related with the number of sources**

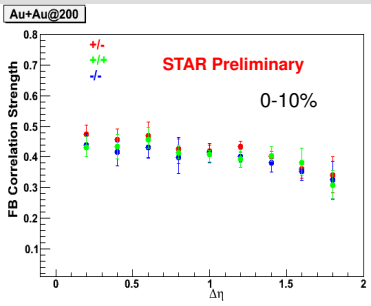


Unlike and like sign charge correlation





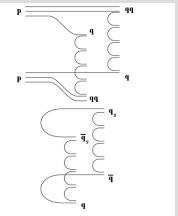




Interpretation of the results:

Two phenomenological models Dual Parton Model (DPM) and Color Glass Condensate (CGC) have considered the origin of Long range Correlations.

In DPM it is due to the multiparton interactions (Color strings).



In DPM long-range correlations are due to superposition of fluctuating number of strings.

SRC

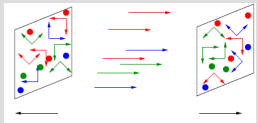
$$D_{bf}^2 = < N_f N_b > - < N_f >< N_b > =$$

$$< n > (< N_{0f} N_{0b} > - < N_{0f} >< N_{0b} >) +$$

LRC

$$[(< n^2 > - < n >^2)] < N_{0f} >< N_{0b} >$$

In CGC LRC origin lies in the longitudinal color field created in Glasma similar to strings in DPM. Predicts increase of correlation with centrality.



$$\sigma_{FB} = \frac{\langle N_F N_B \rangle - \langle N_F \rangle \langle N_B \rangle}{\langle N^2 \rangle - \langle N \rangle^2} = \frac{1}{1 + c\alpha_s^2}$$

For gluons the LRC increases with energy and decreases with $|y_1-y_2|$. Baryons -> Smaller correlations.

References:

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SUMMARY

Long range correlations have been observed in Au+Au and Cu+Cu system at collision energies of 62 and 200 GeV for most central events.

The LRC is more energy dependent than the system size. The correlation is same for like sign and unlike sign charges in central collisions indicating the possibility of cluster formation. Based on CGC one can argue that the long range rapidity correlations are due to the fluctuations of the number of gluons and can be created early time only.

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The STAR Collaboration: http://drupal.star.bnl.gov/STAR/presentations

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