Study of mean transverse momenta correlations in rapidity and azimuthal windows in heavy-ion collisions

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The toy model

Motivation

In [1] the interaction between chromoelectric tubes in hadron-hadron collisions is discussed. Such interaction leads to azimuthal asymmetry in the distribution of secondary particles. The picture is considered to be the following:

1. quark-gluon tubes (strings) have a finite radius.
2. depending on the transverse distance between them, strings may overlap and interact.
3. strings *attract* or *repel* each other in the transverse direction.

In this poster, the string *repulsion* is studied. It is believed that this stage could be prior to the hydrodynamical phase of the system evolution.

The string interaction model

- Consider Pb-Pb collisions and use Glauber MC for initial nucleon positions.
- In each nucleon put some number of partons using Gauss distribution with mean parameter **nPartons**.
- Pair of partons from colliding nucleons creates a «string» if the distance between partons is < 0.25 fm.
- Strings repel each other according to some law. In this model, a simple «Woods-Saxon» law is adopted, with a variable **interaction distance** parameter, see Fig.1 to the right.

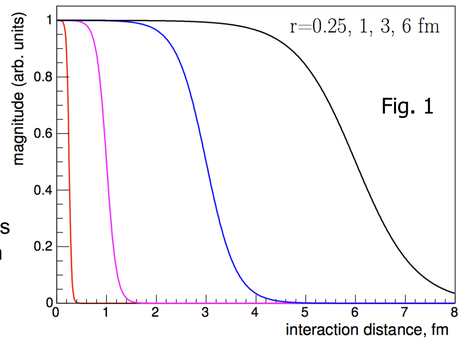


Fig. 1

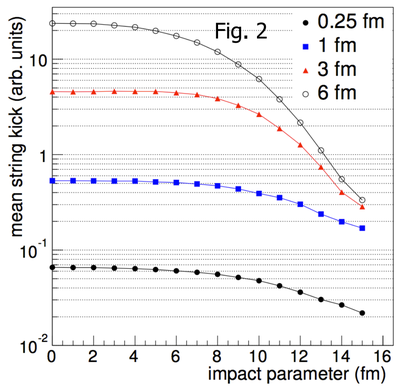
In such a model, each string acquires some total momentum kick, in some arbitrary units. The distribution of the magnitude of such kicks is shown at Fig. 2 for several string interaction distances.

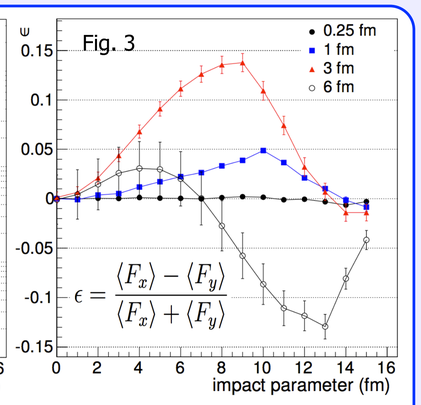
String decays

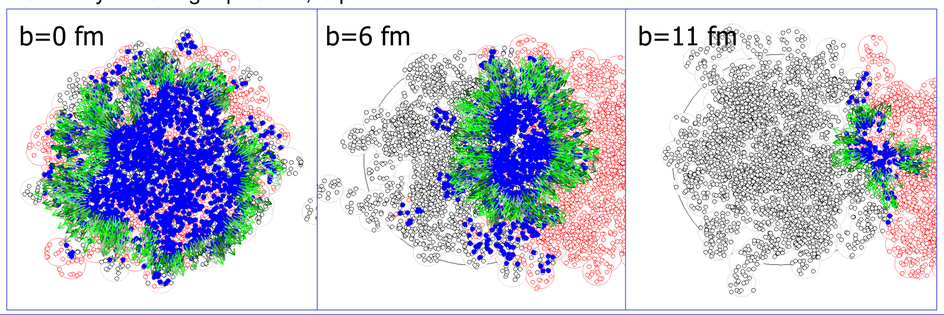
- In its rest frame, each string decays into particles isotropically in azimuth with uniform pseudorapidity density and random transverse momentum given by exponential distribution («soft physics»).
- However, since there is a kick for each string, all particles are boosted in a kick direction. Conversion of the string kick units into momentum in GeV/c is done with a free parameter *kick_pT_Coeff*.

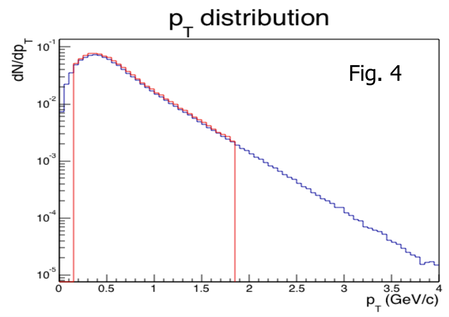
In the cartoons below three events are shown for impact parameters 0, 6 and 11 fm. Strings are shown as blue circles, and repulsion vectors are represented by green arrows.

On Fig. 3 the string kick «*x-y eccentricity*» is shown for several model parameterizations. On Fig.4 a typical p_T distribution, affected by the string repulsions, is plotted.









Observables

A set of different observables can be suggested to study consequences of the string repulsion. Among them are mean p_T, *v2*, di-hadron correlations and other. In this report, the *η-φ* topology of the long-range correlations is obtained using the toy model described above.

The long-range correlations are studied between observables in two different and significantly separated rapidity and azimuthal intervals η_F and η_B, which are conventionally refereed as forward(F) and backward(B) rapidity windows. Two types of correlations are considered in this poster:

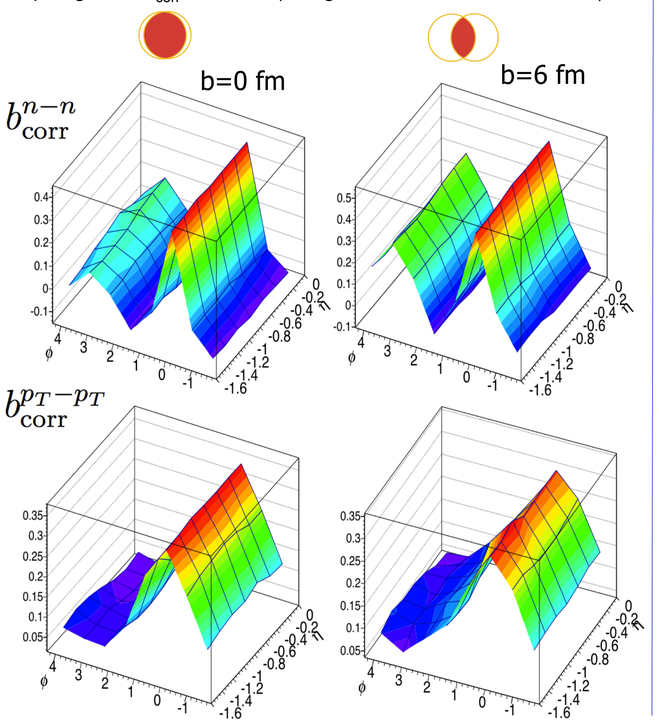
between *multiplicities* in two windows:

$$b_{\mathrm{corr}}^{n-n} = \frac{\langle n_{\mathrm{F}}\, n_{\mathrm{B}} \rangle - \langle n_{\mathrm{F}} \rangle \langle n_{\mathrm{B}} \rangle}{\langle n_{\mathrm{F}}^2 \rangle - \langle n_{\mathrm{F}} \rangle^2}$$

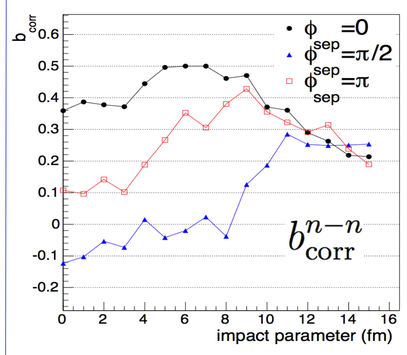
and between *mean event transverse momenta*:

$$b_{\mathrm{corr}}^{p_T-p_T} = \frac{\langle \overline{p_{\mathrm{F}}}\, \overline{p_{\mathrm{B}}} \rangle - \langle \overline{p_{\mathrm{F}}} \rangle \langle \overline{p_{\mathrm{B}}} \rangle}{\langle \overline{p_{\mathrm{F}}}^2 \rangle - \langle \overline{p_{\mathrm{F}}} \rangle^2}$$

Topologies of b_{corr} in Pb-Pb (string interaction distance is 2 fm):



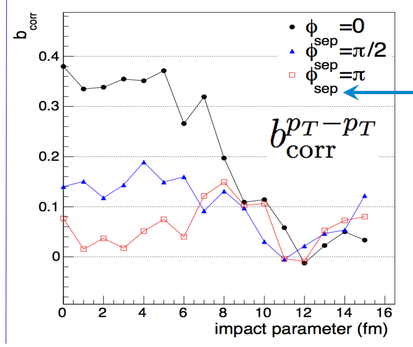
Take 3 *φ-profiles* from the topology for b=6 fm:



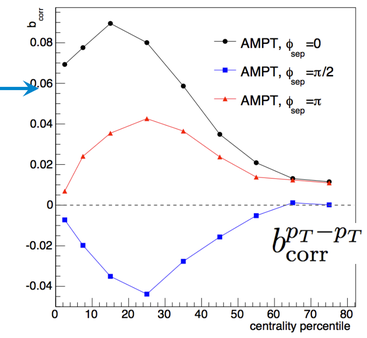
Following observations can be made:

1. For n-n, the near- and away-side «ridges» are reproduced by the model.
2. For p_T-p_T, only near-side structure in η is visible. This shows that the model needs further understanding and proper parameters tuning.

Also, consistent connection with the hydrodynamical phase is needed.



Comparison with the AMPT event generator for p_T-p_T case:



Conclusions

Within the picture of chromoelectric tubes interactions [1], the toy model is developed for the case of *string repulsion*.

Behavior with different model parameterizations is explored, and a particular observable – long-range correlation coefficient – is studied for the correlations between mean multiplicities and mean transverse momenta.

The model is able to reproduce some experimentally observable features of particle azimuthal asymmetry. In particular, near-side «ridge»-structure can be obtained.

Long-range correlations arised due to another possible string interaction mechanism – string fusion – are studied in [2] for Pb-Pb and in [3] for p-Pb collisions.

References:

[1] V.A. Abramosvkii, E.V.Gedalin, E.G. Gurvich, and O.V. Kancheli, Pis'ma Zh.Eksp.Teor.Fiz. 47, No.6, 281-283 (25 March 1988)

[2] V. Kovalenko, V. Vechernin. EPJ Web of Conferences 66, 04015 (2014), arXiv:1308.6618 [nucl-th]

[3] V. Kovalenko. AIP Conf. Proc. 1606, 174 (2014), arXiv:1402.0281 [nucl-th]