Fluctuations and Correlations as a Signal of Deconfinement

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Event-by-event fluctuations of the K/π, K/p, and p/π ratio in central AA collisions have been studied for SPS and RHIC energies. The HSD transport approach can qualitatively reproduce the measured excitation function for the K/π ratio fluctuations. The di-jet azimuthal correlations also have been investigated within the HSD model. We found that the suppression of the away-side jet in the hadronic medium is not enough to explain the experimental data from RHIC. The additional suppression should be attributed to a QGP produced in heavy-ion collisions.

The measurement of the fluctuations in the kaon to pion ratio might allow to distinguish events with enhanced strangeness production attributed to the QGP phase [1]. The excitation functions for K/π, as well as for K/p and p/π fluctuations are available in a wide range of energies [2]: from the NA49 Collaboration at the CERN SPS and from the STAR Collaboration at RHIC. Another informative probe of the high-energy-density matter created in relativistic nucleus-nucleus AA collisions are partons with high transverse momentum (p_T). They loose a large fraction of their energy during the early stage of nucleus-nucleus AA collisions before hadron formation. Such an energy loss is predicted to lead to a phenomenon known as jet quenching [3]. The data on two-particle correlations in AuAu collisions at the top RHIC energy show a long-range pseudorapidity $\Delta\eta$ correlation ('ridge') in the region of the near-side jet [4, 5]. This proceeding presents the results of a systematic study of K/π, K/p and p/π ratio fluctuations as well as di-jet correlations based on the HSD transport approach [6]. For more details we refer the reader to Refs. [7, 8]. Event-by-event fluctuations for charged hadron multiplicities also have been studied in the HSD transport approach [9].

The HSD results as well as statistical model calculations for ratio fluctuations are pre-

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sented in Refs. [7]. In Fig. 1 the HSD results of $\sigma_{\rm dyn}$ for the K/π ratios are shown in comparison with the experimental data by the NA49 and STAR Collaborations [2]. The available results of UrQMD calculations (from Refs. [2]) are also shown by the dashed lines. We find that the HSD model can qualitatively reproduce the measured excitation function for the K/π ratio fluctuations in central collisions. One sees that the UrQMD model gives practically a constant $\sigma_{\rm dyn}^{K\pi}$, which is by about 40% smaller than the results from HSD at the lowest SPS energy. This difference between the two transport models may be probably attributed to different realizations of the string and resonance dynamics in HSD and UrQMD: in UrQMD the strings decay first to heavy baryonic and mesonic resonances which only later on decay to 'light' hadrons such as kaons and pions. In HSD the strings dominantly decay directly to 'light' hadrons (from the pseudoscalar meson octet) or the vector mesons ρ, ω, and K^* (or the baryon octet and decouplet in case of baryon number ± 1). Such a 'non-equilibrated' string dynamics may lead to stronger fluctuations of the K/π ratio.

Details on di-jet correlation studies in the HSD transport approach can be found in Ref. [8]. These correlations are usually measured as a function of relative azimuthal angle $\Delta\phi$ and pseudorapidity $\Delta\eta$ between the trigger and associated particles:

$$C(\Delta\eta, \Delta\phi) = \frac{1}{N_{\rm trig}} \frac{d^2 N_{\rm assoc}}{d\Delta\eta \; d\Delta\phi} \;, \tag{1}$$

where $N_{\rm trig}$ is the number of trigger particles. To obtain the di-jet correlations one has to subtract a background distribution. In our calculations we use the mixed events method which allows to properly subtract the background by taking associated particles for each trigger particle from another randomly chosen event.

In Fig. 2 we present the HSD results for pp and AuAu collisions for the associated differential particle ($\Delta\eta$, $\Delta\phi$) distribution (1). We use the same cuts as the STAR Collaboration, $4 < p_T^{\rm trig} < 6$ GeV/c and $2 < p_T^{\rm assoc} < 4$ GeV/c [4]. We obtain on average 0.5 trigger particle in an HSD event for this set of cuts. The away side structure is suppressed in AuAu collisions in comparison to pp, however, HSD doesn't provide enough high p_T suppression to reproduce the AuAu data. The additional suppression should be attributed to a QGP produced in relativistic heavy-ion collisions. The di-jet correlations obtained in the HSD transport simulations of AuAu collisions (Fig. 2b) do not show a ridge structure in the pseudorapidity for the near-side jet as in the data [4, 5].

ACKNOWLEDGMENTS

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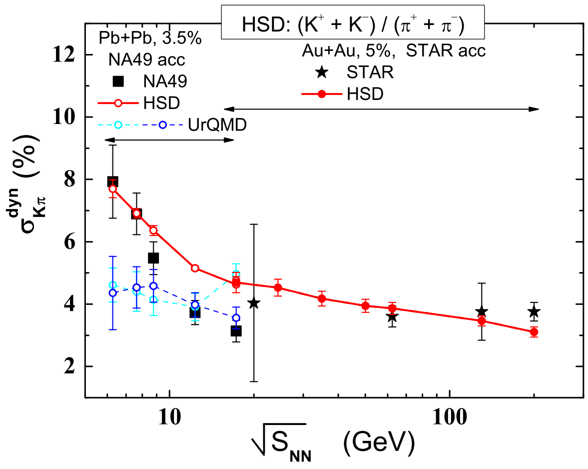

Figure 1. The HSD results of σ_{dyn} for the K/π ratios are shown in comparison with the experimental data by the NA49 and STAR Collaborations [2]. The available results of UrQMD calculations (from Refs. [2]) are also shown by the dashed lines.

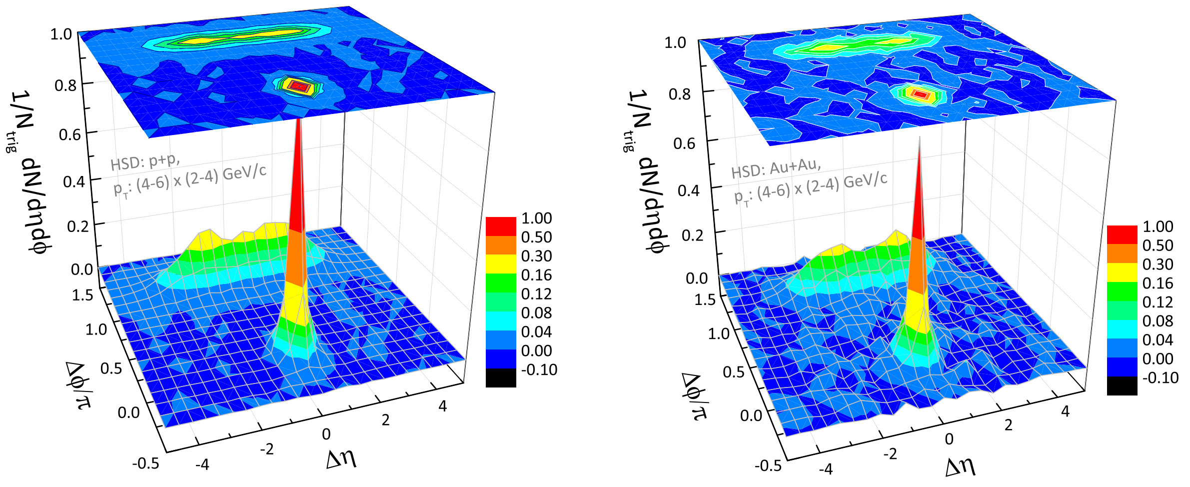

Figure 2. The associated particle ($\Delta\eta$, $\Delta\phi$) distribution for pp (a) and central AuAu (b) collisions at $\sqrt{s} = 200$ GeV within the HSD transport approach. The selection of trigger hadron with $4 < p_T^{\mathrm{trig}} < 6$ GeV$/c$ corresponds to the STAR experiment [4].

FIGURE CAPTIONS

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