Event-by-Event p/K Fluctuations from A+A Collisions at RHIC

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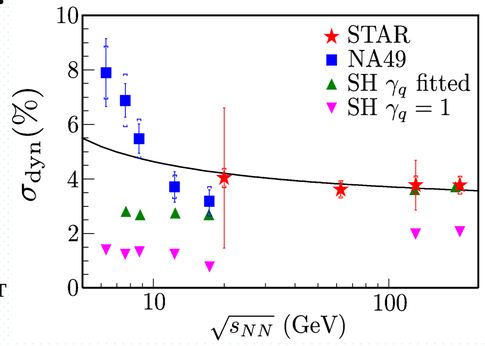
Abstract

Event-by-event fluctuations may probe the dynamics of dense matter hadronization and possibly be sensitive to the nature of phase transition for QCD matter. In the framework of quark coalescence for particle production, baryon to meson ratios are related to local parton densities. Fluctuations in these densities could be used to search for possible critical point in nucleus-nucleus collisions. We will present measurements of fluctuations on $(p+\overline{p})/K^{+}+K^{-}$ multiplicity ratios from Au+Au collisions using the STAR detector. Fluctuations from various collision centralities from Au+Au $\sqrt{s_{NN}}=$ 200 GeV and 62.4 GeV beam energies will be presented.

Motivation

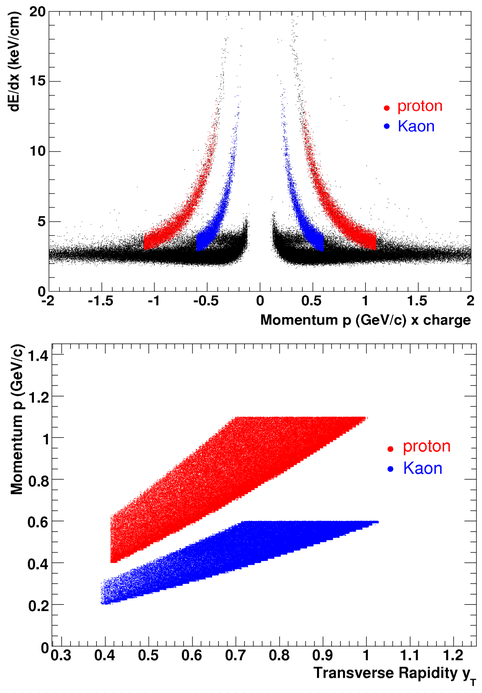
- **Measured event-by-event K/π fluctuations show strong incident energy dependence at low energy range but a little dependence on the higher RHIC energies [1, 2]. What will happen to baryon to meson ratio fluctuation?**
- **Critical Point → Local Density Fluctuation**
  quark coalescence for hadron formation
  baryons ~ n^3 , mesons ~ n^2
  baryon/meson ~ n quark density
  we use protons, Kaons,
  i. The selected proton and Kaon are at same y_T range.
  ii. For proton and kaon, the resonance correlations are reduced.
  iii. The number of inclusive protons is a reliable measure of baryon number..
- **RHIC has a unique capability to scan the full energy range from AGS to RHIC.**



Particles selection

Extract the number of particles event-by-event using energy loss and momentum measured with the STAR TPC.

Run04 Au+Au 200 GeV Data
- Vertex Z |vz| < 15cm
- pseudo rapidity | η | < 1.0
- n σ_K < 2
- n σ_p < 2
- n σ_π > 2
- Proton momentum :
  p_T > 0.4GeV/c, p <1.1GeV/c
- Kaon momentum:
  p_T > 0.2GeV/c, p <0.6GeV/c



The transverse rapidity y_T here define as,

$$y_T = \ln\left(\frac{m_T + p_T}{m_0}\right)$$

Fluctuations measurement

The relative width σ_{data} of the measured event-by-event particle ratio distributions is,

$$\sigma_{data}^{\ 2} = \sigma_{mixed}^{\ 2} + \sigma_{dyn}^{\ 2}$$

Here, we calculate sigma mixed events with four events mixing method,

$$\sigma_{data} = \sigma\left(\frac{Nproton_i}{NKaon_i}\right)$$

$$\sigma_{mixed} = \sigma\left(\frac{Np_i + N\overline{p}_j}{NK_k^{+} + NK_l^{-}}\right)$$

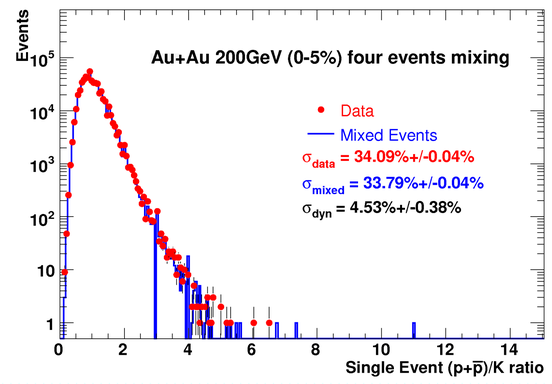
Mixing events require the same reference multiplicity and |vertex Z difference| < 6cm

The non-statistical fluctuations σ_{dyn} are then estimated by [3],

$$\sigma_{dyn} = sign(\sigma_{data}^2 - \sigma_{mixed}^2)\sqrt{|\sigma_{data}^2 - \sigma_{mixed}^2|}$$

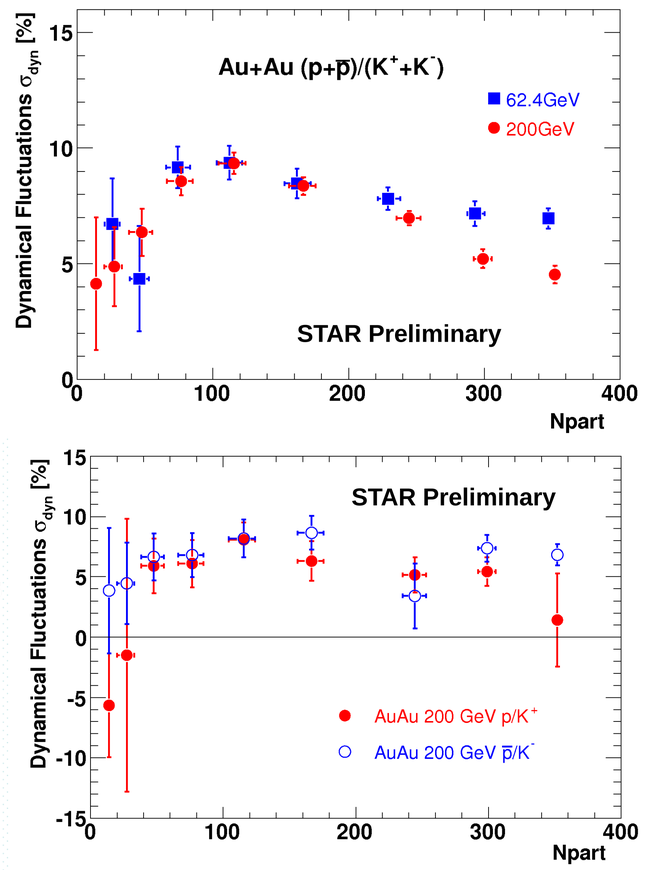
Results and discussions (I)

- **The distribution of event-by-event proton to Kaon ratio from data (points) are compared with the same quantity from mixed events (histograms).**
- **The distribution of data is wider than the distribution of mixed events.**



Results and discussions (II)

- **The proton to Kaon ratio fluctuation has a maximum at mid-centralities for both 200 GeV and 62.4 GeV collisions. The errors are statistical only.**
- **For the central collisions, 62.4 GeV have bigger fluctuations than 200GeV.**
- **Within errors, the fluctuations of same charge proton to Kaon ratio are equal, and with no obvious centrality dependence.**



Summary and Outlook

- **We presented STAR preliminary results on p/K ratio fluctuations for various centrality bins from Au+Au collisions at 200 Gev and 62.4 GeV.**
- **We will use different event mixing methods to investigate resonance effect, and compare our results with AMPT models.**
- **We plan to extend our study to low energy in the search for possible QCD critical point at low RHIC energy.**

References:

[1] C. Alt et al. (NA49 Collaboration), arXiv:0808.1237v2 [nucl-ex] (2008).

[2] B.I. Abelev et al. (STAR Collaboration), arXiv:0901.1795v1 [nucl-ex] (2009).

[3] S.V. Afanasiev et al. (NA49 Collaboration), Phys. Rev. Lett. 86, 1965 (2001).