Measurement of energy dependence of particle ratio fluctuations in STAR experiment at RHIC

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Introduction

Event-by-event fluctuations and correlations of global observables have been considered as one of the signatures of Quark Gluon Plasma(QGP) phase transition. The nature of this phase transition from hadronic state of matter may also be revealed in the study of fluctuations of global obsrvales. Fluctuations in kaon-to-pion ration on an event by event basis has been predicted to reveal nature of QGP phase transition [1]. Very recently, in the year 2010, the Relativistic Heavy Ion Collider(RHIC) at Brookhaven National Laboratory initiated an unique program of "Beam Energy" scan involving beam energy in Au+Au collisions from top collison energy($\sqrt{s_{NN}}$=200 GeV) down to as low as 7.7 GeV [2]. The aim of this beam energy scan program is to study QCD critical point. Particle ratio fluctuations, particularly K/π fluctuation has been studied as a function of energy and system-system size in earlier measurements. The present study from beam energy in combination with previous results may provide more insight into the study of QGP phase transition and location of QCD critical point. we report results in Au+Au collisions from $\sqrt{s_{NN}}$ =7.7 - 200 using STAR experiment at RHIC.

In the present study, we have used a measure called, $\nu_{dyn,K\pi}$ defined as :

$$\nu_{dyn,K\pi} = \frac{<N_K(N_K-1)>}{<N_K>^2} + \frac{<N_\pi(N_\pi-1)>}{<N_\pi>^2} - 2\frac{<N_K N_\pi>}{<N_K><N_\pi>}$$

where, N_K and N_π are the number of kaons and pions in an event. The average is being done over large number of event sample being analyzed. The variable $\nu_{dyn,K\pi}$ is assumed to be independent of tracking efficiencies and was first used in STAR Collaboration for net charge fluctuation study[3, 4]. The NA49 collaboration[5] at SPS used the variable $\sigma_{dyn,K\pi}$ defined as :

$$\sigma_{dyn,K\pi} = \sqrt{\sigma^2_{data} - \sigma^2_{mixed}} \qquad (1)$$

where σ_{data} is the width of the K/π distribution of real data and σ_{mixed} that of mixed events. It can be shown that $\sigma_{dyn,K\pi} = \sqrt{(\nu_{dyn,K\pi})}$

1. Particle Identification and track selection

The data analyzed were measured using Time Projection Chamber(TPC) detector in STAR experiment located inside solenoidal magnetic field. The particle identification is based on specific energy loss(dE/dx) measured in the TPC. In the present analysis, all tracks within $-1 < \eta < 1$ and $200 < pt < 600$ MeV/c are selected for TPC track selection. We select a particle to be pion if $N_{\sigma,\pi} < 2$ and $N_{\sigma,K} > 2$, similarly for kaon is selected if $N_{\sigma,K} < 2$ and $N_{\sigma,\pi} > 2$, where

$$N_{\sigma x} = [\frac{dE}{dx_{meas.}} - < \frac{dE}{dx} >]/[\frac{0.55}{\sqrt{N}}\frac{dE}{dx_{meas.}}] \qquad (2)$$

where, x being any particle type, N number of hits on a track. For removing electron contamination, we give a tighter cuts on electron. A particle is called electron, if $N_{\sigma,e} < 1$. To extend the particle identifiaction for higher momentum range , another STAR detector, Time of Flight(TOF) was used. TOF identified particles extended the transeverse momentum range of pions and kanons from 0.6 GeV/c to 1.8 GeV/c.

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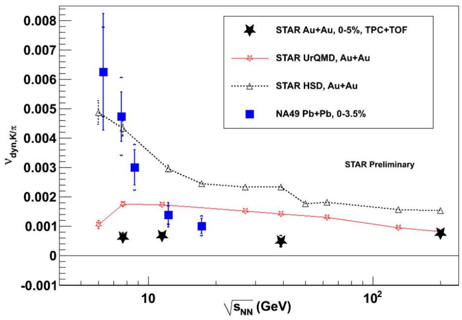

FIG. 1: The measured dynamical fluctuations in STAR experiment. The filled stars corresponds to STAR results and the filled squares indicate the NA49 results. The solid line corresponds to UrQMD predictions where as the dashed line corresponds to HSD models within the STAR acceptance.

2. Results and Discussion

The Measured dynamical fluctuations has been shown in fig.1 as function of beam energy for top $0-5\%$ central events. Results presented here includes the combined track selection using TPC and TOF from 0.2 GeV/c to 1.4 GeV/c in transverse momentum. The solid filled stars corresponds to STAR results. The filled squares correspond to NA49 collaboration results. The NA49 $\sigma_{dyn,K\pi}$ values has been converted into $\nu_{dyn,K\pi}$ using the formula, $\sigma_{dyn,K\pi} = \sqrt(\nu_{dyn,K\pi})$. It is observed that the STAR results are independent of beam energy where as the NA49 resuilts increases as the beam energy decreases. We have also compared our results with UrQMD and HSD model predictions within the STAR acceptance. Our results are bellow the models calculations. However UrQMD shows energy independence where as HSD models predicts the increase in dynamical fluctuations at lower energies resembling with the NA49 results. This could be due to production of resonance which is treated differently in both the models.

References

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