Searching for the Turn-Off Signature of the QGP via Anisotropic Flow Measurements at RHIC

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Abstract

In these proceedings, we present measurements of elliptic flow for identified hadrons in Au+Au collisions at $\sqrt{s_{NN}} = 19.6$ GeV, as well as at fixed-target energies in the range $\sqrt{s_{NN}} = 3.0$–4.5 GeV from the RHIC Beam Energy Scan - II measure by STAR. We investigate the Number of Constituent Quark (NCQ) scaling at these energies, which can provide insights into the nature of the medium created in these collisions.

Keywords:
Elliptic flow, NCQ scaling

1. Inroduction

Relativistic heavy-ion collision experiments are tools to create a strongly interacting, thermalized medium of quarks and gluons known as Quark-Gluon Plasma (QGP). Collective flow of the produced medium is one of the signatures of QGP. The collective flow has various orders of anisotropies that can be observed in the azimuthal distribution of the final-state particles from the collision and can be measured using Fourier series expansion of this distribution [1]. Elliptic flow(v_2) is the second-order anisotropic flow coefficient. Presence of partonic collectivity in the early produced medium from the collisions can be tested by analyzing Number of Constituent Quark (NCQ) scaling in v_2. At top RHIC energy, presence of NCQ scaling indicates the partonic dominance of the medium created in such collisions [2]. At low energies, deviations from NCQ scaling may suggest a decreasing role of partonic degrees of freedom, hinting towards the onset of hadronic dominance [3, 4].

Using the second phase of RHIC Beam Energy Scan (BES-II) data, STAR

has measured the v_2 of the identified hadrons at $\sqrt{s_{NN}} = 19.6$ GeV and fixed-target energies at $\sqrt{s_{NN}} = 3.0$–4.5 GeV.

2. Results

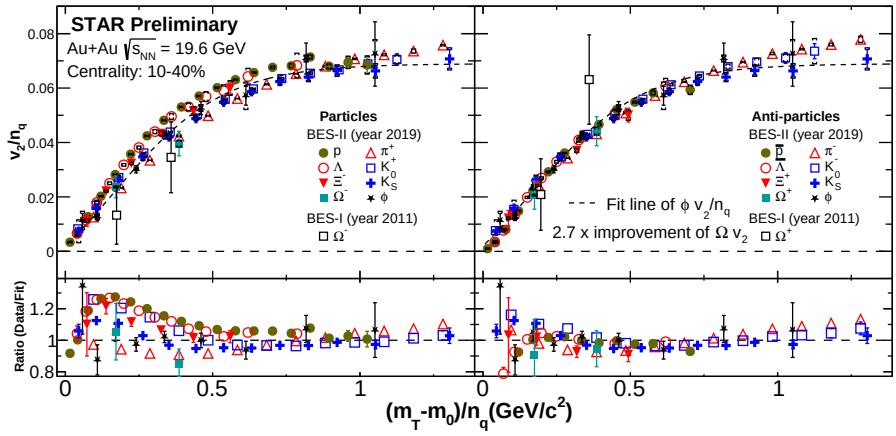

Figure 1: Left panel shows the NCQ scaled v_2 plotted as a function of NCQ scaled transverse kinetic energy in Au+Au collisions at $\sqrt{s_{NN}} = 19.6$ GeV in 10-40% centrality for particles. The right panel shows the same for anti-particles.

Figure 1 presents the NCQ-scaled elliptic flow, v_2/n_q, plotted as a function of the NCQ-scaled transverse kinetic energy, $(m_T - m_0)/n_q$, for particles and anti-particles produced in Au+Au collisions at $\sqrt{s_{NN}} = 19.6$ GeV in the 10–40% centrality class. The v_2/n_q values for various hadron species approximately fall on a common curve, indicating the presence of NCQ scaling. To quantify this scaling behavior, the ratios of v_2/n_q for different hadrons with respect to the ϕ meson are shown in the lower panel. The scaling is observed to hold within 10% for anti-particles and within 20% for particles. The improved scaling observed for anti-particles compared to particles could be attributed to the influence of transported quarks, which can propagate to the particles during the hadronization [5].

Figure 2 shows the NCQ scaling behavior at fixed-target energies in the range $\sqrt{s_{NN}} = 3.0$–4.5 GeV in 10-40% centrality. The scaling progressively deteriorates with decreasing collision energy and is observed to completely break down below $\sqrt{s_{NN}} = 3.5$ GeV. This breakdown of NCQ scaling at

lower energies may signal the disappearance of partonic collectivity and the emergence of hadronic dominance in the produced medium, suggesting a transition in the underlying dynamics of the system created in the collisions.

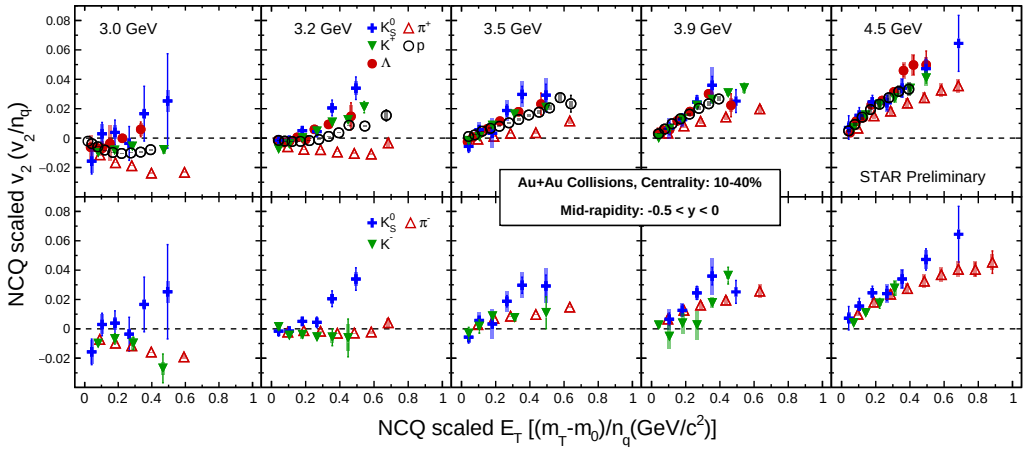

Figure 2: Upper panels show the v_2/n_q plotted as a function of $(m_T - m_0)/n_q$ at $\sqrt{s_{NN}}$ = 3.0 - 4.5 GeV for particles. The lower panels show the same for anti-particles.

3. Summary

We have presented measurements of elliptic flow (v_2) at $\sqrt{s_{NN}} = 19.6$ GeV and at fixed-target energies ($\sqrt{s_{NN}} = 3.0$–4.5 GeV) from the RHIC BES-II. At 19.6 GeV, the observed NCQ scaling indicates partonic collectivity in the medium. In contrast, the scaling worsens with decreasing energy and breaks down below $\sqrt{s_{NN}} = 3.5$ GeV, suggesting the disappearance of QGP and the onset of hadronic dominance.

References

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