Triangular flow in Au + Au collisions at $\sqrt{s_{NN}}$ = 17.3 GeV from RHIC-STAR

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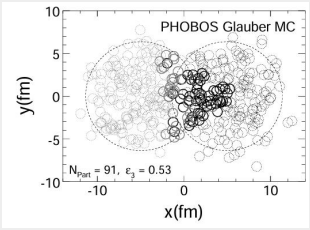
Abstract

Triangular flow in heavy-ion collisions, v_3, represents the third harmonic coefficient in the Fourier expansion of the azimuthal distribution of produced particles relative to the collision event plane. Since v_3 is sensitive to initial fluctuations of nucleons, it serves as a valuable tool for studying the fluctuations of the initial conditions of the system and the subsequent evolution process.

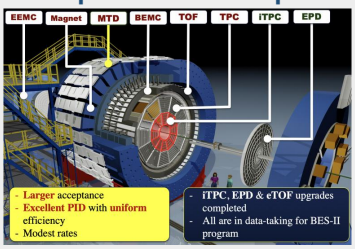
We will present measurements of the third-order flow coefficient v_3 for $\pi^{\pm}$,$K^{\pm}$,$p\bar{p}$, ,Λ, $\bar{\Lambda}$, K^0_S Ξ^-, $\bar{\Xi}^+$,Ω^-, $\bar{\Omega}^+$, and ϕ mesons in Au+Au collisions at $\sqrt{s_{NN}}$ = 17. 3 GeV, utilizing the Beam Energy Scan (BES-II) dataset from the STAR experiment at RHIC. We will discuss the centrality dependence of v_3 as well as the number of constituent quark scaling (NCQ scaling) for all the particles mentioned above.

Motivation



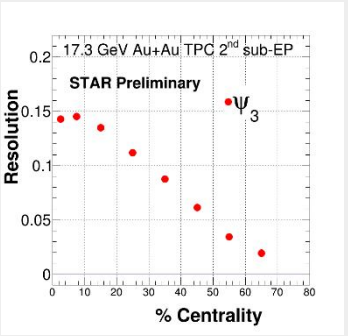
v_3 is an important probe for studying the initial geometry of heavy-ion collisions, and sensitive to the hydrodynamical viscosity of the produced medium.

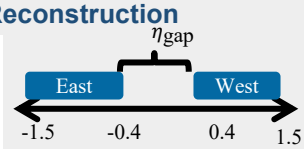
Experimental setup



The Time Projection Chamber(TPC) and Time of Flight(TOF) are used for particle identification.

Event Plane Reconstruction





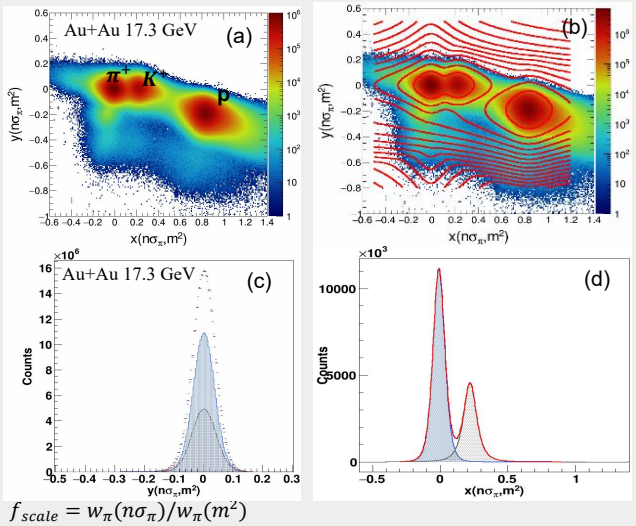
Minimize the influence of non-flow effects through this ηgap.

$$R_{3,sub} = \sqrt{\langle \cos[3(\Psi_{3,east} - \Psi_{3,west})] \rangle}$$

$$\left\langle \frac{1}{R_3} \right\rangle = \frac{\sum_i^R N(i) * \frac{1}{R_3(i)}}{\sum_i^R N(i)}$$

$$\langle v_3 \rangle = \langle v_3^R \rangle \left\langle \frac{1}{R_3} \right\rangle$$

Particle Identification



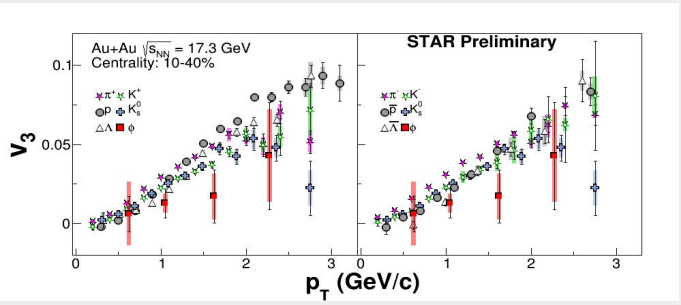
$$f_{scale} = w_\pi(n\sigma_\pi)/w_\pi(m^2)$$

$$\alpha = -\tan^{-1}\left(\frac{y_k}{x_k}\right) = -\tan^{-1}\left(\frac{\mu_K(m^2) - \mu_\pi(m^2)}{[\mu_K(n\sigma_\pi) - [\mu_K(n\sigma_\pi)]] * f_{scale}}\right)$$

$$\begin{pmatrix} x(n\sigma_\pi, m^2) \\ y(n\sigma_\pi, m^2) \end{pmatrix} = \begin{pmatrix} cos\alpha & -sin\alpha \\ sin\alpha & cos\alpha \end{pmatrix} \begin{pmatrix} x' \\ y' \end{pmatrix} \qquad n\sigma_\pi \propto \ln\left[\left\langle \frac{dE}{dx} \right\rangle_\pi / \left\langle \frac{dE}{dx} \right\rangle_{Bichsel}\right]$$

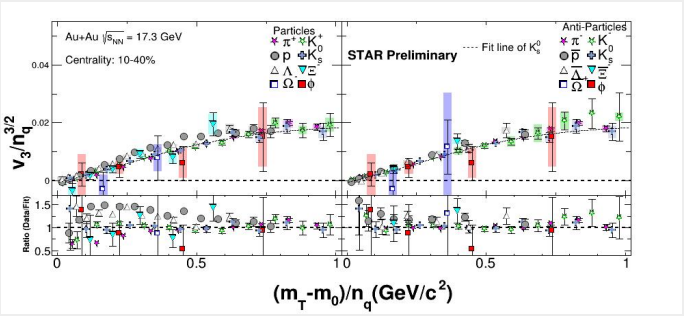
- The widths $w_\pi(n\sigma_\pi)$ *and* $w_\pi(m^2)$, and peak position, $\mu_{(\pi,K)}(n\sigma_\pi)$ and $\mu_{(\pi,K)}(m^2)$ were used to fist normalize the m^2 axis to the $n\sigma$ axis.
- Then based on the transformation of the combined TOF m² and TPC $n\sigma_\pi$ information to have a maximal separation between kaons and pions.

Transverse Momentum Dependence



- At low p_T, triangular flow (v_3) shows mass ordering within uncertainties: lighter particles have larger v_3.

NCQ Scaling



- NCQ scaling holds within uncertainties and consistent with the expectation from development of collectivity during the partonic stage of the system evolution.

Reference

- STAR Collaboration, Phys. Rev. C 88, 014902 (2013).
- E877 Collaboration, Phys. Rev. C, 56 (1997).
- STAR Collaboration, Phys.Rev.C 107, 2, 024912 (2023).

Summary

- In the low momentum region (p_T < 1.5 GeV/c), there is a clear mass ordering.
- NCQ scaling holds within uncertainties for v_3 in Au+Au collision at $\sqrt{s_{NN}}$ = 17. 3 GeV.

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