Higher-Order flow Harmonics v_2 and v_3 of strange hadrons in Au+Au collisions at 200 GeV and Pb+Pb collisions at 2.76 TeV with HYDJET++ model

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1. Introduction

The study of azimuthal anisotropy, based on Fourier coefficients, is recognized as an important tool to probe the hot, dense matter created in heavy-ion collisions. In noncentral heavy-ion collisions, the overlapping area has a long axis and a short axis. Rescattering among the systems constituents converts the initial coordinate-space anisotropy to a momentum-space anisotropy [1]. The anisotropic flow is quantified as a Fourier series expansion of hadron distribution in azimuthal plane as:

$$\frac{dN}{d\phi} \propto 1 + \sum_{n=1}^{\infty} v_n \cos[n(\Phi - \Psi_n)] \quad (1)$$

The nth order flow harmonics v_n are represented by the Fourier coefficients as :

$$v_n = << \cos[n(\Phi - \Psi_n)] >> \quad (2)$$

where Φ is the azimuthal angle of particles, n is the order of flow harmonic and Ψ_n is the angle of reaction plane. The averaging is performed overall particles in single event and overall events.

The first harmonic coefficient v_1, called directed flow, and the second harmonic coefficient v_2, called elliptic flow, have been extensively studied both experimentally and theoretically. v_2 arises from the initial collision geometry, v_3 generates by inhomogeneity in the initial nucleon collision and gluon density and v_4 arises from initial collision geometry, fluctuations and the non-linear hydrodynamic response of the medium [2].

2. Model Formalism

A heavy ion event in HYDJET++ is a superposition of the soft, hydro-type and hard state resulting from multi-parton fragmentation. In the model, both the states are treated independently. The soft part generation is based on the thermal and chemical freeze-out hypersurfaces obtained from the parameterization of relativistic hydrodynamics with preset freezeout conditions. The hard part generation is based on the PYQUEN partonic energy loss model which includes generation of initial parton spectra with PYTHIA, radiative and collision energy loss of partons in a dense medium and final hadronization of partons and in medium emitted gluons according to Lund string model [3]. The magnitude of elliptic flow (v_2) in HYDJET++ is generated by spatial anisotropy parameter ϵ_b and momentum anisotropy parameter δ_b at a givenimpact parameter b. The triangular flow (v_3) is generated by parameter $\epsilon_3(b)$ which is responsible for the creation of spatial triangularity of the fireball.

3. Preliminary Results

Fig. 1 shows the variation of v_2 and v_3 as a function of p_T for $K^+ + K^-$ and $\Lambda + \overline{\Lambda}$ observed from HYDJET++ in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The results are presented for $0 - 10\%$ centrality interval alongwith the experimental data. It can be seen that the model reproduces the shape of the distribution but overpredicts the experimental data of $K^+ + K^-$. However, for $\Lambda + \overline{\Lambda}$, the model underpredicts the experimental data at low p_T and overpredicts the experimental data at high p_T. Fig. 2 shows variation of v_2 and v_3 as a function of p_T for Pb+Pb collisions at $\sqrt{s_{NN}}$= 2.76 TeV in $0-5\%$ centrality interval. It can be observed that HYDJET++ reproduces the experimental data of v_2 and v_3 for $K^+ + K^-$. However,

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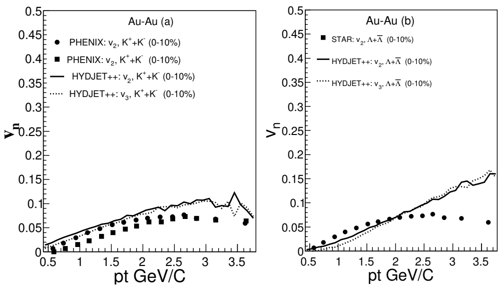

FIG. 1: Variation of v_2 and v_3 as a function of p_T for $K^+ + K^-$ and $\Lambda + \overline{\Lambda}$ calculated within HYDJET++ in Au+Au collisions at $\sqrt{s_{NN}}$= 200 GeV for $0 - 10\%$ centrality interval. Markers represent PHENIX experimental data of v_2 and v_3 and lines represent HYDJET results [4].

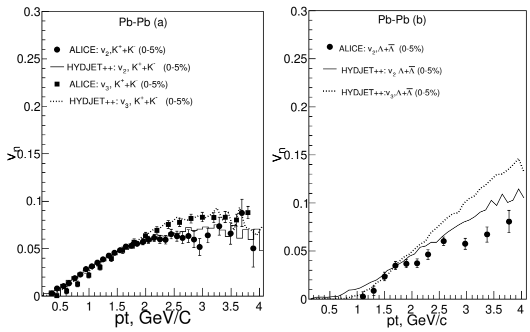

FIG. 2: Variation of v_2 and v_3 as a function of p_T for $K^+ + K^-$ and $\Lambda + \overline{\Lambda}$ calculated within HYDJET++ in Pb+Pb collisions at $\sqrt{s_{NN}}$= 2.76 TeV for $0 - 5\%$ centrality interval. Markers represent ALICE experimental data of v_2 and v_3 and lines represent HYDJET++ results [5].

it overestimates the experimental data v_2 of $\Lambda + \overline{\Lambda}$ for $p_T \geq 2$ GeV. The experimental data of v_3 for $\Lambda + \overline{\Lambda}$ is not avialable, therefore only HYDJET++ results are shown for $\Lambda + \overline{\Lambda}$.

Fig. 3 shows the variation of v_2 and v_3 as a function of p_T for Pb+Pb collisions at $\sqrt{s_{NN}}$= 2.76 TeV in $20 - 30\%$ centrality interval. The model results are presented for $\pi^+ + \pi^-$, $K^+ + K^-$, $p + \bar{p}$, $\Omega^- + \overline{\Omega^+}$, $\Xi^- + \overline{\Xi^+}$, K_s^0 and $\Lambda + \overline{\Lambda}$. It is observed that the model results follow the mass ordering for v_2 and v_3 among various particle. Further, it is obseved that flow of mesons are stronger than the baryons at low p_T.

4. Conclusion

We have presented the preliminary results of v_2 and v_3 for Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV and Pb+Pb collisions at $\sqrt{s_{NN}}$= 2.76 TeV within the framework of HYDJET++ model. We have shown that HYDJET++ provides a good description of the experimental results of v_2 and v_3 for $K^+ + K^-$ and $\Lambda + \overline{\Lambda}$ in Pb+Pb collisions but overestimates in Au+Au collisions. We have also shown that the HYDJET++ follow the mass ordering effect of v_2 and v_3 among various identified hadrons for both the collision system.

Acknowledgments

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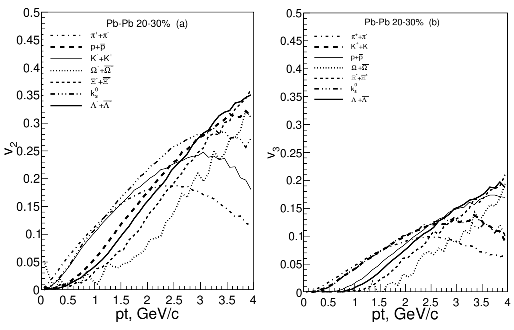

FIG. 3: Variation of v_2 and v_3 for identified hadrons as a function of p_T in Pb+Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV for $20 - 30\%$ centrality interval.