Collision Energy Evolution of Elliptic and Triangular Flow in a Hybrid Model*

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We have studied the collision energy dependence of elliptic flow v_2 and triangular flow v_3 in Au+Au collisions within the energy range $\sqrt{s_{NN}} = 5 - 200$ GeV, utilizing a transport + hydrodynamics hybrid model [1,2]. The transport part is described by the Ultrarelativistic Quantum Molecular Dynamics (UrQMD), combined with an intermediate (3+1)-dimensional ideal hydrodynamical evolution phase using a chiral model equation of state. This approach provides a consistent framework for investigating both high-energy heavy ion collisions with negligible net-baryon density and a large hydrodynamically evolving medium, and the collisions at smaller energies with finite net-baryon density, where the hydrodynamics phase is very short-lived or does not exist at all.

The hybrid model reproduces the qualitative behavior of the experimentally measured elliptic flow (see Fig. 1(a)). While v_2 produced by hydrodynamics is considerably diminished at lower collision energies, this decrease is partially compensated by the transport dynamics, as shown in Fig. 1(b). The pre-hydrodynamics transport phase is of particular importance for understanding the collision energy evolution, while the hadronic rescatterings after the hydrodynamical phase contribute more systematically $\sim 10\%$ to the total flow at all energies. However, the viscous matter described by transport dynamics is unable to produce triangular flow, which consequently shows a significantly larger relative decrease in midcentral collisions with decreasing $\sqrt{s_{NN}}$ (Fig. 1(c)). Our conclusion is that the triangular flow provides the clearer signal for the formation of low-viscous fluid in heavy ion collisions.

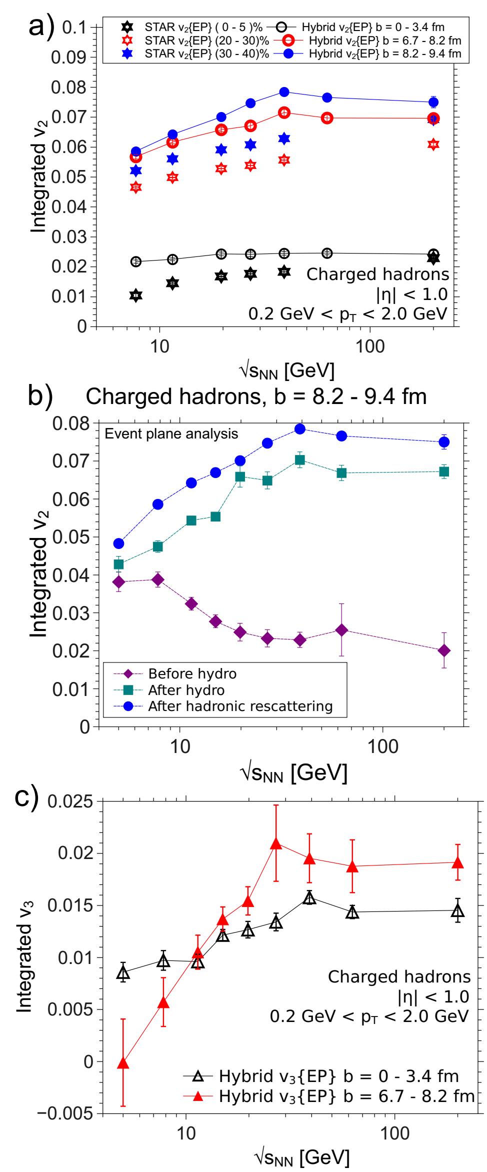

Figure 1: a): Integrated elliptic flow $v_2\{\mathrm{EP}\}$ for charged hadrons with $0.2 < p_T < 2.0$ at midrapidity $|\eta| < 1.0$ in Au+Au - collisions, for collision energies $\sqrt{s_{NN}} = 7.7 - 200$ GeV and three different impact parameter ranges, compared with the STAR data [3, 4]. b): Magnitude of $v_2\{\mathrm{EP}\}$ in midcentral collisions ($b = 8.2 - 9.4$ fm) at the beginning of hydrodynamical evolution (diamonds), immediately after the end of hydrodynamics phase (squares) and after the full simulation (circles). c): Integrated $v_3\{\mathrm{EP}\}$ in central collisions ($b = 0 - 3.4$ fm, open triangles) and midcentral collisions ($b = 6.7 - 8.2$ fm, solid triangles).

References

[1] J. Auvinen and H. Petersen, "Collision Energy Evolution of Elliptic and Triangular Flow in a Hybrid Model", PoS CPOD 2013 (2013) 034

[2] J. Auvinen and H. Petersen, "Evolution of elliptic and triangular flow as a function of collision energy in a hybrid model", Phys. Rev. C 88 (2013) 064908

[3] L. Adamczyk *et al.* [STAR Collaboration], "Inclusive charged hadron elliptic flow in Au + Au collisions at $\sqrt{s_{NN}}$ = 7.7 - 39 GeV", Phys. Rev. C 86 (2012) 054908

[4] J. Adams *et al.* [STAR Collaboration], "Azimuthal anisotropy in Au+Au collisions at $\sqrt{s_{NN}}$ = 200-GeV", Phys. Rev. C 72 (2012) 014904

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