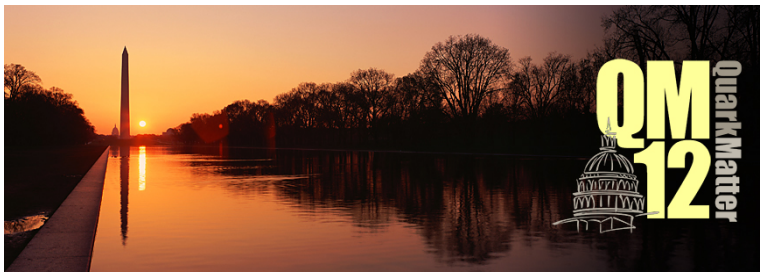

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Collision Energy Dependence of Viscous Hydrodynamic Flow in Relativistic Heavy-Ion Collisions

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We present a systematic study on the evolution of hadron spectra and their azimuthal anisotropy from the lowest collision energy studied at the Relativistic Heavy Ion Collider (RHIC), √s = 7.7A GeV, to the highest energy reachable at the Large Hadron Collider (LHC), √s = 5500A GeV [1]. As the collision energy increases, the resulting increases of the initial temperature, and fireball lifetime, as well as the evolution of the centrality dependence of final charged particle multiplicity are quantitatively studied and compared between the two most popular initial state models, the Monte Carlo Glauber and Monte-Carlo Kharzeev-Levin-Nardi (MC-KLN) models. For Glauber model initial conditions with a small specific shear viscosity eta/s = 0.08, the differential charged hadron elliptic flow v_2ˆ{ch}(pT, √s) is found to exhibit a very broad maximum as a function of √s around top RHIC energy, rendering it almost independent of collision energy for 39 < √s < 2760A GeV. Compared to ideal fluid dynamical simulations [2], this "saturation" of elliptic flow is shifted to higher collision energies by shear viscous effects. For color-glass motivated MC-KLN initial conditions, which require a larger shear viscosity eta/s = 0.2 to reproduce the measured elliptic flow, a similar "saturation" is not observed up to LHC energies, except for very low pT. We emphasize that this "saturation" of the elliptic flow is not associated with the QCD phase transition, but arises from the interplay between radial and elliptic flow which shifts with √s depending on the fluid's viscosity and leads to a subtle cancellation between increasing contributions from light and decreasing contributions from heavy particles to v_2 in the √s range where v_2ˆ{ch}(pT, √s) at fixed pT is maximal. By generalizing the definition of spatial eccentricity ecc_x to isothermal hyper-surfaces, we calculate ecc_x on the kinetic freeze-out surface at different collision energies. Up to top RHIC energy, √s=200A GeV, the fireball is still out-of-plane deformed at freeze out, while at LHC energy the final spatial eccentricity is predicted to approach zero.

[1] Chun Shen and Ulrich Heinz, "Collision Energy Dependence of Viscous Hydrodynamic Flow in Relativistic Heavy-Ion Collisions,", arXiv:1202.6620 [nucl-th].

[2] Gregory Kestin and Ulrich Heinz, "Hydrodynamic radial and elliptic flow in heavy-ion collisions from AGS to LHC energies," Eur. Phys. J. C 61, 545 (2009)

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