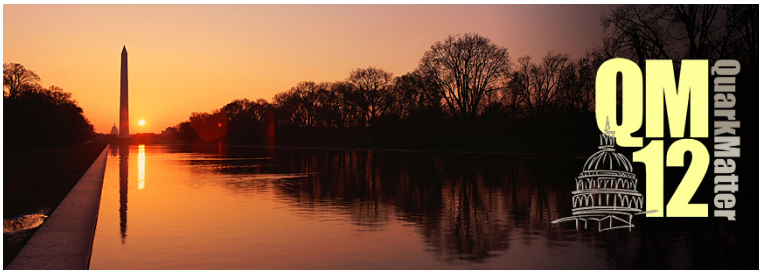

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A direct measure of anisotropic velocity in relativistic heavy ion collisions

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The radial flow parameters are important quantities in relativistic heavy ion collisions [1]. They constrain the equation of state [2] and in particular, the anisotropic parameter relates to shear viscosity [3]. They are usually extracted from the spectrum of transverse momentum by the parameterizations of Blast-wave model [4].
In the present work, we suggest a direct measure of radial velocity, i.e., microscopic average velocity of freeze-out particles in azimuthal plane. It contains three parts: average radial expansion velocity, average anisotropic velocity (the amplitude of modulation in radial expansion velocity as function of the relative angle to the reaction plane), and average thermal velocity.
Using the sample of Au+ Au collisions at 200 GeV produced by AMPT with string melting model, we demonstrate that this microscopic average velocity is well fitted by two parts: an average isotropic velocity, and an average anisotropic velocity, which is azimuthal angle dependent. This form of radial velocity is the same as theoretically expected radial flow parameterization [5]. But the difference is that the average isotropic velocity contains the contributions of thermal motion. From the particle species dependence of the average isotropic velocity, we demonstrate that the heavier the mass of the particles, the smaller the isotropic velocity is. It is just the character of thermal motion.
Fortunately, average thermal velocity is isotropic and therefore has no contribution toward the average anisotropic velocity. In order to confirm this, the centrality dependence of average radial velocity is presented. We find that its anisotropic part is close to zero when the collisions approach to the central ones. It shows indeed no anisotropic velocity in an ideal central collision.
Moreover, we carefully extract kinetic freeze-out parameters in the same sample by fitting pt spectrum and elliptic flow using the parameterization of blast-wave model [4,6]. It is found that the average anisotropic velocity is well coincident with the anisotropic flow velocity extracted by blast-wave model. Furthermore, the centrality dependence of average anisotropic velocity is also consistent with that of extracted from the Blast-wave model. So microscopic average anisotropic velocity of final state particles is a good approximation of anisotropic flow velocity.

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