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Transverse momentum fluctuations and the QCD speed of sound in small systems

It has recently been realized that in the ultra-central heavy-ion collisions, mean transverse momentum of hadrons contains the information of the fundamental thermodynamic properties of quark-gluon plasma (QGP). In particular, in nucleus-nucleus collisions the linear correlation between the mean transverse momentum and the charged multiplicity is attributed to the QCD speed of sound, which promotes theoretical and experimental investigations. However, these studies suffer from the contamination of fluctuations, either physical or non-physical.

In this talk we focus on the ultra-central collisions of small colliding system, such as proton-lead, where effects of fluctuations are more pronounced in comparison to the nucleus-nucleus collision systems. Following the standard strategy, via event-by-event hydrodynamical simulations, we investigate the QCD speed of sound by analyzing the variation of the mean transverse momentum with particle multiplicity in the mid-rapidity region. Although a linear correlations is realized in our results, between the mean transverse momentum and the effective temperature as well as between the charged particle multiplicity and the total entropy, the extracted speed of sound is significantly suppressed due to the presence of fluctuations. To remove such suppression from fluctuations, we propose a systematic subtraction scheme via the corrections captured by the measured variance of the mean transverse momentum (or the effective temperature), etc.

Given the consistent extraction of the speed of sound in small colliding systems, our results support the correlation between mean transverse momentum and charged multiplicity from QCD thermodynamics, which further provides an alternative and direct signature of QGP thermalization.

Category

Theory

Collaboration (if applicable)

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