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Anisotropic hydrodynamics

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In ultrarelativistic heavy-ion collisions nuclear matter is heated to a temperature exceeding that necessary to create a quark-gluon plasma (QGP). Traditionally, second order viscous hydrodynamics has been used to reproduce the soft collective flow of the QGP and hadronic spectra; however, due to rapid longitudinal expansion in the early stages of evolution, the system may possess substantial pressure anisotropies which are a consequence of large viscous corrections.

These large corrections violate the viscous hydrodynamics assumption of small deviation from local equilibrium. They may lead to unphysical results, and, comparing to the exact 0+1 solutions of the Boltzmann equation, they often badly reproduce the longitudinal pressure (especially for initial stages) and provide the wrong asymptotic behavior.

In order to more accurately treat systems possessing such large anisotropies, a new approach, called anisotropic hydrodynamics, was recently developed. In this approach, the pressure anisotropy is treated in a non perturbative manner at the leading order in the hydrodynamic expansion. This allows one to match with second order viscous hydrodynamics in the close to equilibrium limit where viscous hydrodynamics is justified.

We present the very latest prescription for the leading order of the anisotropic expansion. Differently from previous formulations it lacks any symmetry constraint on the space-time evolution, like longitudinal boost invariance or cylindrically symmetric radial flow. Therefore it can be used directly without the need of a next to leading order treatment for describing non trivial transverse dynamics. Checking numerically the agreement with the known solution of the Boltzmann equation in the Bjorken flow limit we found a very striking agreement, improving the already good agreement of previous 0+1 and 1+1 dimensional formulations.

References

[1] L. Tinti, Anisotropic matching principle for the hydrodynamics expansion, arXiv:1506.07164.

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