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Latest developments in 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, even for small shear viscosity over entropy ratios.

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 large pressure 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. In previous works simplifying symmetries were considered in order to extract the leading order of of anisotropic hydrodynamics, like longitudinal boost invariance, or cylindrically symmetric radial expansion. The equations have been extended to the 3+1-dimensional expansion, however in the first attempt it were not possible to fully recover the very good agreement with the exact solutions of the Boltzmann equation. We present the very latest prescription, which is lacking any symmetry constraint on the space-time evolution, it is fully consistent with second order hydrodynamics in the close-to-equilibrum limit, and it is providing an unprecedented agreement with the exact solutions in the 0+1 dimensional expansion, comparing to other leading order prescriptions and second order viscous hydrodynamics.

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