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Bulk viscous evolution within anisotropic hydrodynamics

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Experimental and theoretical studies of relativistic heavy-ion collisions showed that the behavior of matter produced in such collisions is very well described within viscous hydrodynamic models. However, due to rapid longitudinal expansion in the early stages of evolution of matter the studied system undergoes substantial pressure anisotropies, which often may lead to unphysical results. In order to more accurately treat systems that can possess potentially large pressure anisotropies, a new approach called anisotropic hydrodynamics was developed recently. Here we address an open issue in anisotropic hydrodynamics concerning how to describe systems of massive particles within this framework.

For this purpose at first we solve exactly one-dimensional boost-invariant Boltzmann kinetic equation for a relativistic massive system of partons with the collision term treated in the relaxation time approximation. Using exact solutions we are able to numerically establish correct forms of the kinetic coefficients of a massive system. Subsequently, we compare the proper-time evolution of the bulk viscous pressure obtained from the exact solution with results obtained from the dynamical equations of second-order viscous hydrodynamics and leading-order anisotropic hydrodynamics.

In the latter case we use recently derived system of moment-based dynamical equations that describe the proper-time evolution of a transversally homogeneous massive gas undergoing boost-invariant longitudinal expansion including the effect of bulk viscosity explicitly. We show that none of the standard viscous hydrodynamics formulations seems to accurately describe the early-time evolution of the bulk viscous pressure. These results indicate that there may be something incomplete in the manner in which 2nd order viscous hydrodynamics treats the bulk pressure. We also show that the inclusion of the bulk degree of freedom highly improve agreement between anisotropic hydrodynamics and the exact solution for a massive gass.

Presented work is mainly based on:

1. W.Florkowski, E. Maksymiuk, R.Ryblewski, M.Strickland, arXiv:1402.7348 (accepted for PRC)
2. W.Florkowski, R.Ryblewski, M.Strickland, L.Tinti, arXiv:1403.1223 (accepted for PRC)
3. M.Nopoush, M.Strickland, R.Ryblewski, arXiv:1405:1355 (submitted to PRC)

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