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Relaxation-time approximation and relativistic viscous hydrodynamics from kinetic theory

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By employing Chapman-Enskog like expansion for the non-equilibrium single-particle phase-space distribution function, I solve iteratively the Boltzmann equation with relaxation time approximation for the collision term. I demonstrate that this method of obtaining the non-equilibrium distribution function has several welcome features in contrast to the widely used Grad's 14-moment approximation. Subsequently, by employing the distribution function thus obtained, I derive second-order hydrodynamic evolution equation for the shear stress tensor, directly from its definition [1]. This method of deriving the second-order viscous equation does not make use of the two major approximations/assumptions inherent in the traditional Israel-Stewart theory, namely, Grad's 14-moment approximation and second moment of Boltzmann equation. Eventually, I present the derivation of a novel third-order evolution equation for the shear stress tensor [2]. Within one-dimensional scaling expansion, I demonstrate that the results obtained here for the evolution of hot and dense matter are in excellent agreement with the exact solution of Boltzmann equation as well as the transport results.

[1] A. Jaiswal, Phys. Rev. C 87, 051901(R) (2013)

[2] A. Jaiswal, Phys. Rev. C 88, 021903(R) (2013)

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