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Causal third-order viscous hydrodynamics from kinetic theory

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We derive a linearly stable and causal theory of relativistic third-order viscous hydrodynamics from the Boltzmann equation using the relaxation-time approximation. We employ a Chapman-Enskog-like iterative solution to the Boltzmann equation to obtain the viscous correction to the distribution function. Our derivation emphasizes the necessity of incorporating a new dynamical degree of freedom: specifically, an irreducible tensor of rank three. This approach differs from the recent formulation of causal third-order theory derived from the method of moments, which requires two dynamical degrees of freedom: an irreducible third-rank tensor and a fourth-rank tensor. We verify the linear stability and causality of the proposed formulation by examining perturbations around a global equilibrium state.

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