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Resummed hydrodynamic expansion for an electromagnetic interacting plasma

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Anomalous currents produced a renewed interest in the physics of a plasma interacting with an electromagnetic field. In order to carefully study the anomalous currents one must be confident on the formalism for the non-anomalous contributions. We apply a modified version of the method of moments to the Boltzmann-Vlasov equations, in order to extract the behavior of macroscopic quantities and check the convergence properties. We didn't consider a classical gradient expansion, since there is a mounting evidence that the standard Chapman-Enskog expansion has a vanishing radius of convergence. The method of moments, on the other hand, is free from such problems in the absence of external fields. However, if one introduces an electromagnetic field interacting with the plasma, this systematic expansion breaks down: Successive moments are found to couple not only to energy moments of higher, but also of lower order, which diverge in the ultra-relativistic (massless) limit, or require unrealistic machine precision.
We solve the issue using resummed moments which consist of a sum of all the moments of the same tensorial rank, but different energy weights. The resulting equations are always well defined. The evolution of the hydrodynamics moments (four-velocity, energy density, pressure, pressure corrections etc.) is exactly the same as the one provided by the traditional method of moments, which is ill defined only for higher orders. We tested numerically the convergence properties of the resummed expansion for some known solutions of the microscopic theory, and we checked that the convergence remains intact in the simplest case in which the traditional expansion breaks down. Namely the Boltzmann-Vlasov equation for charged mass-less particles coupled to the Maxwell equations in a (0+1)-dimensional expansion.

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