A kinetic approach to the bi-temperature Euler model

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The aim of this work is the study of out-of-equilibirum plasma physics. It is a multiscale problem involving both very small lengths (Debye length) and high-frequency oscillations (electronic plasma frequency). Transport of charged particles (electrons and ions) in context of Inertial Confinement Fusion (ICF) can be modelled by the bi-temperature Euler equations, which are a non-conservative hyperbolic system. It contains so-called non-conservatives terms, which cannot be put in divergential form. Such terms are not well-defined, and, in the situation of shocks, computing exact or approximated solutions is a challenging issue.
The bi-temperature Euler model can be recovered using a Chapman-Enskog expansion from an underlying kinetic approach of this system, the Vlasov-BGK-Ampère system, which is conservative. We are interested in the numerical resolution of this kinetic model, in a macroscopic setting. Hence, a scaling is performed on this model in order to exhibit the behaviour of the system in large scale configurations. The major issue of such a system is that the Maxwell equations are describing small scale electromagnetics. At the macroscopic level, these equations degenerate into algebraic relations, preventing their use for computation purposes. Hence, we derive an Asymptotic-Preserving numerical method, which is able to solve the system even when these small scales (Debye length, electronic plasma frequency) are not resolved, i.e $\Delta t, \Delta x \gg \varepsilon$, with $\varepsilon \to 0$ [2].
Numerical test cases are studied. Several well-known Riemann problems are solved with our method and then compared with methods for the macroscopic bi-temperature Euler model, derived in [1].

Références

[1] Aregba-Driollet, D. and Breil, J. and Brull, S. and Dubroca, B. and Estibals, E., *Modelling and Numerical Approximation for the Nonconservative Bitemperature Euler Model*, ESAIM: M2AN, 2015.

[2] Jin, Shi, *Efficient asymptotic-preserving (AP) schemes for some multiscale kinetic equations*, SIAM J. Sci. Comput., 1999.

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