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Modelling and numerical approximation for the nonconservative bi-temperature MHD model

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In order to achieve inertial confinement fusion, one has to improve the knowledge of the laser-plasma interaction. There exists two main ways of describing this phenomenon, the microscopic (kinetic) approach and the macroscopic (hydrodynamic) approach. The kinetic approach is not competitive since it is too expensive in computational time. This is why we investigate an intermediate model in thermal nonequilibrium, which is between the kinetic model and the hydrodynamic model.

In the first stage of the confinement the magnetic field is negligible, the relevant intermediate model is than the nonconservative bitemperature Euler model. Recently in [1], an entropic approximation of this system has been derived thanks to numerical schemes based on an underlying conservative kinetic model.

However in the last stage of the confinement the target is penetrated by relativistic electrons, which induces a strongly variable magnetic field. This is why we want to deal with an intermediate model which takes into account the magnetic field.

In this work we propose to study a bitemperature MHD model. This system consists in four conservation equations for mass, impulsion and magnetic field and two nonconservation equations, that is to say, one for each energy. Physically, the model describes the interaction of a mixture of one species of ions and one species of electrons in thermal nonequilibrium subjected to a transverse variable magnetic field.

A first result is to have been able to established the hydrodynamic model from an underlying kinetic model. More precisely, using an out of equilibrium Chapman-Enskop procedure, the bitemperature MHD model is constructed from a BGK model coupled with Maxwell equations with full Lorentz force, which includes the magnetic field.

Finally, we approximate the weak solutions of the bitemperature MHD model using a kinetic scheme, based on the underlying kinetic model.

References

[1] D. Aregba-Driollet, S. Brull, J.Breil, B. Dubroca and E. Estibal, Modelling and numerical approximation for the nonconservative bitemperature Euler model, preprint, 2015.

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