

On Some Kinetic-Fluid Coupling Strategies

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We will present some recent results about the development of numerical methods which are able to efficiently capture the multiscale aspects of some problems described by kinetic equations. In particular we will focus on fluid dynamics problems which present localized regions of departure from thermodynamical equilibrium. The basic idea, on which the methods rely, is to couple macroscopic hydrodynamics models and microscopic kinetic models through transition regions in which both equations are solved, to smoothly pass from one regime to the other. We will show comparisons obtained using different decompositions of the probability distribution function, and then we consider the possibility of moving, merging, creating or deleting interfaces in time through the evolution of a transition function which avoid the use of boundary conditions between different models. The unsteady regions decomposition is achieved considering a synergy of different breakdown criteria. An interesting criterion is obtained through inspections of the distribution function status, which however, at least in fluid regions, lead to evaluation of the non-equilibrium state of the gas only through the knowledge of macroscopic variables. In the last part we will consider the development of the same dynamic decomposition methods to the case in which a Monte-Carlo (DSMC) resolution of the kinetic model is used instead of a deterministic one in order to build up more realistic models and simulations. To this aim, the methodology must be adapted to the DSMC method. In particular, the possible degradation of the quality of the fluid solver by the noise induced by the DSMC method and the larger difficulties in the definition of the different regions should be carefully explored and suitable prevention measures will have to be designed.

Références

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