One-day Meeting on

Theory and Numerics in Kinetic Theory

Parma - December 13th 2019
Aula B - Plesso di Matematica
Dipartimento di Scienze Matematiche, Fisiche e Informatiche
Università di Parma

Titles and abstracts

- *Kazuo Aoki* – National Cheng Kung University & visiting at Università di Parma
  A kinetic model for a polyatomic gas with temperature-dependent specific heats and its application to shock-wave structure

Abstract: The ellipsoidal statistical (ES) model of the Boltzmann equation for a polyatomic gas with constant specific heats (calorically perfect gas), proposed by Andries et al. [P. Andries et al., Eur. J. Mech. B/Fluids Vol. 19, 813 (2000)], is extended to a polyatomic gas with temperature-dependent specific heats (thermally perfect gas). Then, the new model equation is used to investigate the structure of a plane shock wave with special interest in CO2 gas, which is known to have a very large bulk viscosity, and in the case of relatively strong shock waves. A numerical analysis, as well as an asymptotic analyses for large bulk viscosity, are performed in parallel to our previous paper [S. Kosuge and K. Aoki, Phys. Rev. Fluids Vol. 3, 023401 (2018)], where the structure of a shock wave in CO2 gas was investigated using the ES model for a polyatomic gas with constant specific heats. From the numerical and analytical results, the effect of temperature-dependent specific heats on the structure of a shock wave is clarified. This is a joint work with Shingo Kosuge (Kyoto University) and Hung-Wen Kuo (National Cheng-Kung University).

- *Giacomo Dimarco* – Università di Ferrara
  The Aw-Rascle traffic model: Enskog-type kinetic derivation and generalisations

Abstract: In this talk, we discuss the derivation of second order macroscopic traffic models from kinetic descriptions. In particular, we recover the celebrated Aw-Rascle model as the hydrodynamic limit of an Enskog-type kinetic equation out of a precise characterisation of the microscopic binary interactions among the vehicles. In a second part, we discuss optimal control strategies related to the kinetic model under consideration.

- *Aldo Frezzotti* – Politecnico di Milano
  Numerical study of the evaporation of a liquid film in contact with a non-ideal vapor

Abstract: In the past, a considerable research effort has been devoted to study kinetic models for boundary conditions at the vapor-liquid interface, assuming that the vapor is ideal and described by the Boltzmann equation or a kinetic model equation. Less studied are evaporation/condensation processes when the vapor is non-ideal, in spite of their practical relevance. In this work, the rapid variations of macroscopic variables across the vapor-liquid interface of a monatomic fluid are investigated, in the case of slow evaporation of a planar liquid film. The validity of existing theoretical and numerical interfacial jump relationships is investigated in a temperature range close to the critical temperature, when the vapor phase is not ideal. The study is based on Molecular Dynamics simulations of Lennard-Jones fluid. Results are also compared with the predictions of an approximate kinetic equation which describes both the liquid and vapor phases of fluid composed by spherical molecules whose interaction potential is the superposition of a hard sphere and a soft attractive contributions.

- *Silvia Lorenzani* – Politecnico di Milano

  Microchannel flow applications of a linearized kinetic Bhatnagar-Gross-Krook-type model for inert gas mixtures with general intermolecular forces

Abstract: The behavior of binary gas mixtures in microchannels is analyzed using the linearized Boltzmann equation based on a Bhatnagar-Gross-Krook-type model, able to describe general collision kernels corresponding to realistic intermolecular potentials. In order to assess the reliability of this BGK model, we have studied the Poiseuille problem, that is, the flow of a binary gas mixture driven by a pressure gradient and the propagation of high-frequency sound waves in microchannels. Semi-analytical solutions have been obtained through a transformation in integral equations and the results compared with those derived by more refined kinetic models, which have revealed a good consistency with the experimental data.

- *Andrea Mentrelli* – Università di Bologna

  Shock structure behaviours in Extended Thermodynamics with higher order closures

Abstract: In Extended Thermodynamics, the standard closure of the moment equations is the linear one. We discuss how the maximum entropy principle with a second (and possibly higher) order closure allows to predict shock structure solutions closer to those obtained by means of kinetic theory and in close agreement with experiments, for both monatomic and polyatomic gases. Shock structure profiles obtained for polyatomic gases are compared to those recently obtained by Aoki and his collaborators with a kinetic theory approach.

- *Mario Pulvirenti* – Univeristà di Roma *La Sapienza*

  A stochastic particle system for the Boltzmann equation in a stationary regime

Abstract: The time evolution of a large system of interacting particles are often conveniently described in terms of a single nonlinear PDE under suitable scaling limits describing the system in the macroscopic regime in which we are interested. Examples are, for instance, the most popular kineti equations like Vlasov, Boltzmann or Landau.
A rigorous proof of the validity of such scaling limits and hence the mathematically well founded derivation of the corresponding macroscopic equations, is difficult and often conceptually subtle.
Of particular interest in Physics is the analysis of stationary, non-equilibrium states. In this framework very few results are known. In this talk I discuss some of them and the very many open problems.

- *Giuseppe Toscani* – Università di Pavia

  Statistical description of human addiction phenomena

Abstract: We study the evolution in time of the statistical distribution of some addiction phenomena in a system of individuals. The kinetic approach leads to build up a novel class of Fokker--Planck equations describing relaxation of the probability density solution towards a generalized Gamma density. A qualitative analysis reveals that the relaxation process is very stable, and does not depend on the parameters that measure the main microscopic features of the addiction phenomenon.