Title of the course:

Kinetic theory of reactive gas mixtures

Lecturers:

M. Groppi, Università di Parma (1st week)

V. Giovangigli, Ecole Polytechnique (2nd week)

Abstract

Mathematical modelling of multicomponent gaseous flows with chemical reactions is related to a wide range of important applications including spacecraft flights, plasma physics, combustion processes and chemical reactors. Consideration of governing equations at the kinetic level is often essential in order to properly account for the molecular aspects of the flows and to go deeper into the physical understanding of the model. Moreover, kinetic equations represent also the starting point for a consistent derivation, via suitable expansion algorithms and closure strategies, of hydrodynamic equations at a macroscopic level.

The aim of the course is to present some basic concepts and recent advances on the kinetic modelling of gas mixtures with chemical reactions. In particular, the lectures will present:

- an introduction to the Boltzmann equation and its main features (collision invariants, collision equilibria, H-Theorem, asymptotic expansion and fluid dynamic limits); kinetic models of Boltzmann type for gas mixtures of monoatomic and polyatomic gases with simple chemical reactions; relaxation-time approximations of BGK type for inert and reactive gas mixtures (6 hours, first week)

- kinetic models for complex chemical reaction mechanisms; link between the kinetic theory and the mathematical structure of the resulting fluid system of partial differential equations; fast and accurate evaluation of multicomponent transport coefficients; kinetic models and macroscopic fluid equations out of thermodynamic equilibrium (6 hours, second week)