Seventh Workshop on Compressible Multiphase Flows

Rapport sur les contributions

https://indico.math.cnrs.fr/e/13690

ID de Contribution: **1** Type: **Non spécifié**

Visco-elasticity of foam films

mercredi 28 mai 2025 10:30 (1 heure)

Liquid foam exhibits surprisingly high viscosity, higher than each of its phases. This dissipation enhancement has been rationalized by invoking either a geometrical confinement of the shear in the liquid phase, or the influence of the interface viscosity. However, a precise localization of the dissipation, and its mechanism at the bubble scale, is still lacking. To this aim, we simultaneously monitored the evolution of the local flow velocity, film thickness and surface tension of a five films assembly, induced by different controlled deformations. These measurements allow us to build local constitutive relations for this foam elementary brick. We first show that, for our millimetric foam films, the main part of the film has a purely elastic, reversible behavior, thus ruling out the interface viscosity to explain the observed dissipation. We then highlight a generic frustration at the menisci, controlling the interface transfer between neighbor films and resulting in the localization of a bulk shear flow close to the menisci. A model accounting for surfactant transport in these small sheared regions is developed. It is in good agreement with the experiment, and demonstrate that most of the dissipation is localized in these domains. The length of these sheared regions, determined by the physico-chemical properties of the solution, sets a transition between a large bubble regime in which the films are mainly stretched and compressed, and a small bubble regime in which they are sheared. Finally, we discuss the parameter range where a model of foam viscosity could be built on the basis of these local results.

Orateur: CANTAT, Isabelle (CNRS, Université de Rennes)

ID de Contribution: **2** Type: **Non spécifié**

A geometrical Green-Naghdi type system for dispersive-like waves in prismatic channels

lundi 26 mai 2025 15:30 (1 heure)

Orateur: GAVRILYUK, Sergey (Aix-Marseille Université)

ID de Contribution: **3** Type: **Non spécifié**

Two-phase flows involving multiple scales: a study of mass transfer across scales

mardi 27 mai 2025 09:00 (1 heure)

Orateur: KOKH, Samuel (CEA, Maison de la simulation)

ID de Contribution: **4** Type: **Non spécifié**

Derivation of a two-phase flow model accounting for surface tension

lundi 26 mai 2025 14:00 (1 heure)

We are interested in the derivation of a two-phase flow model that incorporates surface tension effects using Hamilton's principle of stationary action. The Lagrangian functional, which defines the action, consists of kinetic energy—accounting for interface characteristics—and potential energy.
A key feature of the model is the assumption that the interface separating the two phases possesses its own internal energy, which satisfies a Gibbs form that includes both surface tension and interfacial area. Consequently, surface tension is considered in both the kinetic and potential energy terms that define the Lagrangian functional.
Applying the stationary action principle leads to a set of PDE governing the dynamics of the two-phase flow. This includes evolution equations for the volume fraction and interfacial area, incorporating mechanical relaxation and surface tension terms.

Orateur: MATHIS, Hélène (Université de Montpellier)

ID de Contribution: **5** Type: **Non spécifié**

An incompressible/compressible model for magma flow in a volcanic conduit

mercredi 28 mai 2025 11:30 (1 heure)

In this work we develop a liquid/gas model for magmatic flow that describes the physical processes from the microscopic and macroscopic scales. The resulting two-phase model considers an incompressible liquid phase and a compressible gas phase that exchange mass. It also preserves the conservation of mass and momentum, and a dissipative energy balance under appropriate temperature equations for both phases compatible with thermodynamics theory.

Orateur: NARBONA REINA, Gladys (Universidad de Sevilla)

ID de Contribution: **6** Type: **Non spécifié**

Multiphase flows, variational principle and Cartan's moving frames

mardi 27 mai 2025 14:00 (1 heure)

Developing a variational formulation for multiphase flows immediately raises the challenge of handling multiple reference frames and their relative noninertial motion. This talk discusses the associated theoretical issues encountered in the pursuit of a consistent continuous mixture theory.

Orateur: PESHKOV, Ilya (University of Trento)

ID de Contribution: **7** Type: **Non spécifié**

A general theory of thermo-compositional diabatic convection

mercredi 28 mai 2025 09:00 (1 heure)

By generalizing the theory of convection to any type of thermal and compositional source terms (diabatic processes), we show that thermohaline convection in Earth oceans, fingering convection in stellar atmospheres, and moist convection in Earth atmosphere are deriving from the same general diabatic convective instability. We show also that "radiative convection" triggered by CO/CH4 transition with radiative transfer in the atmospheres of brown dwarfs is analog to moist and thermohaline convection. We derive a generalization of the mixing length theory to include the effect of source terms in 1D codes. We show that CO/CH4 radiative convection could significantly reduce the temperature gradient in the atmospheres of brown dwarfs similarly to moist convection in Earth atmosphere thus possibly explaining the reddening in brown-dwarf spectra. By using idealized two-dimensional hydrodynamic simulations in the Ledoux unstable regime, we show that compositional source terms can indeed provoke a reduction of the temperature gradient. The L/T transition could be explained by a bifurcation between the adiabatic and diabatic convective transports and could be seen as a giant cooling crisis: an analog of the boiling crisis in liquid/steam-water convective flows. This mechanism with other chemical transitions could be present in many giant and earth-like exoplanets. The study of the impact of different parameters (effective temperature, compositional changes) on CO/CH4 radiative convection and the analogy with Earth moist and thermohaline convection is opening the possibility to use brown dwarfs to better understand some aspects of the physics at play in the climate of our own planet.

Orateur: TREMBLIN, Pascal (CEA, Maison de la simulation)

ID de Contribution: **8** Type: **Non spécifié**

Pressure-relaxation limit for a one-velocity Baer-Nunziato model to a Kapila model

mardi 27 mai 2025 15:30 (30 minutes)

In this talk, we show that the solutions of the Kapila system, generated by initial data close to equilibrium, are obtained in the pressure-relaxation limit from solutions of a one-velocity Baer-Nunziato (BN) model.
Besides the fact that the quasilinear part of (BN) cannot be written inconservative form, its natural associated entropy is only positive semi-definite such that the entropic variables cannot be used to symmetrize it. Here, using an ad-hoc change of variable, we obtain a symmetric reformulation of (BN) which couples, via low-order terms, an undamped mode and a partially dissipative hyperbolic system satisfying the Shizuta-Kawashima stability condition. This leads to the global well-posedness of (BN) for small data. Moreover, the change of variable is adapted to the pressure-relaxation process, i.e., it isolates the component that vanishes in the limit and provides uniform bounds that allow us to prove a strong convergence result.

Orateur: CRIN-BARAT, Timothée (Université Paul Sabatier)

ID de Contribution: **9** Type: **Non spécifié**

Hyperbolic turbulent two-phase flow models obtained from Hamilton's principle

lundi 26 mai 2025 16:30 (30 minutes)

We present a class of hyperbolic systems modeling two-phase, two-velocity flows that can be obtained from Hamilton's principle of stationary action. The hyperbolicity is guaranteed for small relative velocities by the presence of turbulence through a Reynolds stress tensor. Various forms of the turbulent term are proposed, and the ones leading to a hyperbolic system of equations are characterized by a general criterion. The presence of the Reynolds stress tensor is crucial for the hyperbolicity. Indeed, if it is removed from the Lagrangian, the resulting equations are not hyperbolic for small relative velocities.

Orateur: DELÉAGE, Émile (Aix-Marseille Université)

ID de Contribution: **10** Type: **Non spécifié**

Mathematical justification of a compressible two-phase averaged system for ideal gas

mardi 27 mai 2025 11:30 (30 minutes)

Orateur: GONIN-JOUBERT, Pierre (Université Claude Bernard Lyon 1)

ID de Contribution: **11** Type: **Non spécifié**

Formal derivation of a stratified compressible two-phase flow model

mardi 27 mai 2025 10:30 (30 minutes)

Orateur: LE VOURC'H, Pierrick

ID de Contribution: **12** Type: **Non spécifié**

Recent advances for the modelling of multi-scale two-phase flows

mardi 27 mai 2025 11:00 (30 minutes)

Orateur: HAEGEMAN, Ward (Onera, École Polytechnique)