Offer #2025-08722

PhD Position F/M Development of numerical strategies for the computation of multiscale compressible multiphase flows

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Context

This PhD thesis project is part of a general effort in the INRIA CAGIRE team for developing accurate and robust numerical methods for the computation of multiphase flows. It will be co-advised by Vincent Perrier and Kevin Schmidmayer.

Compressible multiphase flows are known to be complicated to address because of their essentially multiscale nature: even when starting from a flow with well resolved large scale interfaces, the evolution of the flow may lead to very small droplets or bubbles.

Several strategies can be used for the computation of multiphase flows:

- Sharp interface methods These methods include for example the Level-set methods [8] or the Volume-of-fluid methods [6]. In these methods, all the interfaces are resolved, and all the inclusions must be resolved with the mesh. This make them unaffordable in the case of very dispersed inclusions (small droplets or bubbles).

- Kinetic methods In kinetic methods, see e.g. [11], the flow is no more described exactly, but rather statistically, through the approximation of the probability density function of a polydispersed phase in a carrier phase. These are also costly methods, because a discretization in the phase space is necessary, in addition to the classical

spatial discretization.

- Diffuse interface methods These methods [1, 10] are in between the two previous methods, in the sense that they can correctly address interface flows, even if they are more diffusive than the sharp interface methods, but can also be seen as the first moment of kinetic methods.

Assignment

The aim of this PhD project is to develop novel diffuse interface methods. The team recently proposed a new model for compressible two-phase flows in disequilibrium (velocity, pressure, and temperature) [9]. Based on [5], this model uses a simple stochastic approach to evaluate interface and relaxation terms, determining the local topology of the mixture. It employs a few additional variables to describe sub-grid topology, compromising some generality compared to kinetic methods but reducing computational cost. This allows a continuous transition from dispersed phase to resolved interface models, potentially constituting a breakthrough modelling method, enabling simultaneous and dynamic computation of multiscale flows.

Main activities

The hired PhD will contribute to the following tasks:

- The development of a code for ab-initio one-dimensional multiphase computations. By ab-initio, we mean the development of a code in which all interfaces between phases are resolved.

- The development of one-dimensional and multi-dimensional two-phase models based on stochastic ideas.

- The development of numerical methods for these models.

- The implementation and the validation of these numerical methods.

- The benchmarking of the numerical method with respect to identified test cases such as: interface instabilities [7, 4], essentially multiscale multiphase flows [3, 2].

Skills

Master in scientific computing or master in computational fluid dynamics.

Interest in programming.

Would be a plus:

– Experience with numerical methods for compressible flows.

– Experience with compiled languages (C++, C, Fortran).

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

2200€ / month (before taxs)

General Information

- **Theme/Domain :** Numerical schemes and simulations
  Scientific computing (BAP E)
- **Town/city :** Pau
- **Inria Center :** Centre Inria de l'université de Bordeaux
- **Starting date :** 2025-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2025-04-11

Contacts

- **Inria Team :** CAGIRE
- **PhD Supervisor :**
  Schmidmayer Kevin / kevin.schmidmayer@inria.fr

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other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

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Instruction to apply

Thank you to send:

- CV
- Cover letter
- Master marks and ranking
- Support letter(s)

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This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

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