Master Internship proposal 2018-2019

Numerical modelling of phase change in a two-fluid Direct Numerical Simulation solver

In two-phase flows with heat transfer, phase change (condensation or evaporation) may occur at the liquid-vapour interface. This produces a mass transfer which takes place as soon as the interface is forced away from its thermodynamic equilibrium, either by heat transfer or by pressure change. Such phase changes, condensation or evaporation, occur at the free-surface of a flowing liquid film in contact with hot vapour, depending on pressure or temperature or boundary conditions.

Amongst the numerical methods describing those phenomena, the *mixing* approach is well suited to model mass transfer. Indeed, flow homogenisation formally insures mass conservation in the control volume, even when the exact position of the interface is unknown. On the contrary, sharp capturing methods (Level Set or Volume Of Fluid) and tracking methods (Front Tracking) cannot.

In this *mixing* method, the integration of the phase change problem is quite convenient but its resolution is not straightforward. If the linear conservation equations (mass, energy, volume) are naturally coupled locally, the equation of state representing the liquid-vapour thermodynamic equilibrium applies at the global scale via pressure and is strongly non-linear. Resolution might then be challenging, depending on the numerical implementation selected and on the numerical requirements (accuracy, robustness or computing time).
The objectives of this internship are 1) to develop such resolution algorithms for phase change, 2) to implement them into the LIMSI low-Mach two-fluid Direct Numerical Simulation research code, and 3) to validate the code on various test cases including evaporating/condensing liquid film or droplets.

This work gathers two research themes in LIMSI: numerical modelling for two-phase flows and thermodynamics modelling. The former axis is led by N. Grenier and the latter by M. Pons. Both of them will bring their expertise to supervise this internship.

Expected profile of the candidates

- Second year Master student or Third year *École d'Ingénieur*
- Solid background in numerical methods and/or in fluid mechanics, with good skills in programming languages (Fortran, C).

Supervisors

- Nicolas Grenier (Associate Professor Université Paris-Sud, LIMSI), grenier@limsi.fr, 01 69 15 81 29
- Michel Pons (CNRS Senior Researcher, LIMSI)

Location

- LIMSI laboratory : Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, Bâtiment 507, Campus, Orsay. www.limsi.fr

Duration

- 5 months, starting Spring 2019 (stipend: 606€/month)
- Possibility of Ph.D. funding on same subject