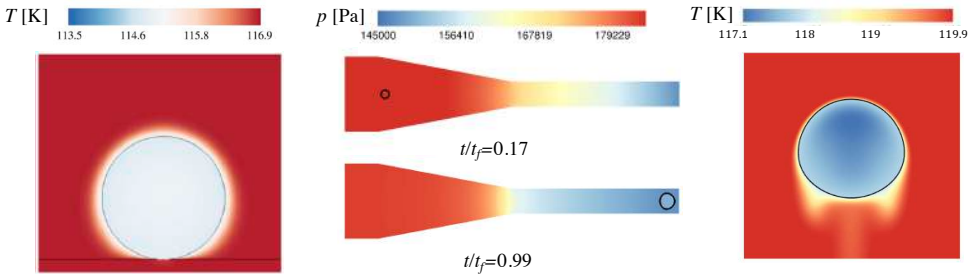
Postdoc position in

Direct Numerical Simulation of Two-Phase Compressible Flows with Phase Change

In the context of the TRED project funded by ANR, led by Prof. A. Urbano, starting in 2025, ISAE SUPAERO is opening a postdoc position. The postdoc will be hosted in the Space Advanced Concepts Laboratory (SaCLaB) in the DCAS department. She/he will integrate a multi-disciplinary team working on numerical simulation of reactive and two-phase flows for liquid propulsion applications.

Context

Compressible two-phase flows changing phase are of interest for a very large number of applications going from combustion and fluid management in liquid rocket engines, to cavitation for bio-medical applications. To allow their study at a fundamental level, a solver able to account for capillary phenomena, phase change, acoustics and being accurate in terms of thermodynamics is required. This has motivated the development of a direct numerical simulation solver based on a semi-implicit projection compressible method. The solver uses a level set/ghost fluid approach. While being accurate at low Mach number (asymptotically preserving), the solver allows to simulate acoustic waves propagation. Furthermore, it has been possible to extend methodologies for the simulation of two-phase flows with phase change developed since years in the context of incompressible flow solvers to the present formalism. The solver has been presented in two recent articles [1, 2], and its ability to correctly handle interface acoustic interaction, expansion phenomena, heat transfer driven problem and phase change phenomena, including boiling and cavitation, has been demonstrated. The immersed boundary formalism allows the description of complex geometries, like for instance hydrodynamic cavitation in a convergent nozzle (see Fig.1 b) and c)).



a) CH_4 bubble cavitation at the wall in zero gravity

b) hydrodynamic cavitation in a convergent duct, H_2O

c) corresponding temperature field around the bubble at $t/t_f = 0.99$

Figure 1: Different examples of compressible two-phase flows simulations with phase change.

Objectives and developments

During the TRED project the solver will be developed to allow the simulation of reactive droplets. The goal of the postdoc will be to carry out specific numerical developments needed for the study of droplets evaporation and atomization in compressible flows under acoustic excitation.
For more details, please directly contact Prof. A. Urbano.

Supervisors: Prof. A. Urbano (annafederica.urbano@isae-supaero.fr), Prof. S. Tanguy (tanguy@imft.fr)

Duration: 18 months. Starting: January 2025.

Requirements: The candidate must hold a PhD in fluid mechanics. She/he must have experience in numerical methods for computational fluid mechanics.

References

[1] A. Urbano, M. Bibal and S. Tanguy, "A semi-implicit compressible solver for two-phase flows of real fluids", Journal of Computational Physics, 456:111034 (2022)
[2] M. Bibal, M. Deferrez, S. Tanguy and A. Urbano, "A compressible solver for two phase-flows with phase change for bubble cavitation." Journal of computational physics 500 (2024), 112750, https://doi.org/10.1016/j.jcp.2023.112750.