Internship on particle transport in the environment

Keywords	Modelling, Numerical simulation, Data analysis, Dispersed two-phase flow
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Hosting Team	EPC CaliSto, Inria Sophia Antipolis - Méditerranée

Context

Solid particles are omnipresent in our daily life and in the environment. To name a few examples, particles are present in atmospheric sciences (dispersion of pollutants, aerosols and/or pollens) or in marine sciences (plastic contamination in rivers or oceans). These particles are transported by turbulent flows; they can interact with each other to form aggregates which can fragment later on; they can accumulate on surfaces and form complex deposits which can clog flow passage sections. All these intricate phenomena form the field of dispersed two-phase flows, which is concerned with fluids that contain inclusions (bubbles, droplets, solid particles).

Objectives

Studies on dispersed two-phase flows have investigated each of the four mechanisms that are depicted in Figure 1, namely: (a) particle transport by a turbulent flow; (b) deposition on surfaces; (c) re-suspension due to the action of the flow; (d) inter-particle collisions leading to their agglomeration and fragmentation. Yet, unified models need to account simultaneously for all these phenomena as well as their intricate coupling. This requires to properly address all the interactions at play, including: particle-fluid interactions (especially the rich dynamics near boundaries due to the flow anisotropy), particle-surface interactions (related to physico-chemical forces) and inter-particle forces. Hence, this internship is at the frontier between physics, mathematics and engineering.

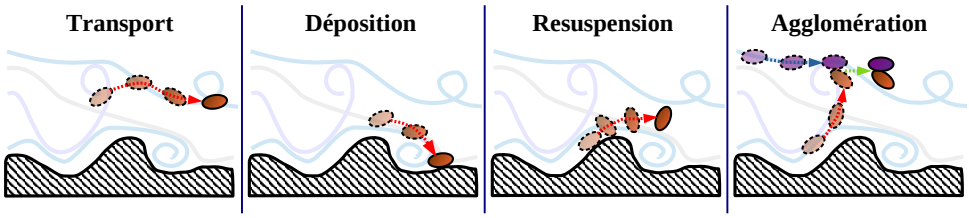

Figure 1: Sketch showing the four mains mechanisms at play in dispersed two-phase flows.

The aim of this internship is to develop more advanced models for the simulation of dispersed two-phase flows. Depending on the student preferences, a number of topics can be studied, among which:

i. the development of a higher-order agglomeration model, which reproduces the effect of correlated inter-particle collisions (due to turbulence);

ii. the development of a refined resuspension model, which reproduces the effect of inter-particle collisions on particle resuspension, together with its implementation in a CFD Code and its validation with experimental data;

iii. the development of higher-order boundary models to capture the complex dynamics of particles in the near-wall region, together with its implementation in a stochastic approach and its validation;

iv. the development of refined models for the dynamics of non-spherical particles near boundaries and their interaction with it.

The student will be encouraged to write a publication in an international journal at the end of the internship. Motivated students will be encouraged to pursue their work on this topic with a PhD thesis.

Candidate profile

We are looking for candidates with a strong background in applied mathematics (Numerical methods, Numerical simulations, Statistics), physics (Statistical Physics, Fluid dynamics, Modelling) or mechanical engineering (Chemical Engineering).

Candidates should be fluent in English, have a good experience in programming (C, C++) and in data analysis.

We will appreciate candidates with the following skills (optional):

- Knowledge in fluid dynamics
- Knowledge in statistical physics
- Knowledge in statistical analysis (sensitivity analysis, uncertainty quantification)
- Rigorous, autonomous and creative thinking
- Interest in environmental applications

Duration and period

The internship will cover a period of 5-6 months, between February and September 2023. The exact starting/end dates are quite flexible and can be adapted to the constraints of the student.

Host institution

The internship will take place within Team CaliSto at Inria Sophia Antipolis - Méditerranée. The student will be in contact with researchers that collaborate with the team members across France and Europe.

To apply

Interested candidates are required to send a cover letter, a CV, a transcript of their grades from their Master studies and at least one recommendation letter to mireille.bossy@inria.fr and christophe.henry@inria.fr

References

[1] Banari, A., Henry, C., Eidt, R. H. F., Lorenz, P., Zimmer, K., Hampel, U., & Lecrivain, G. (2021): Physical Review Fluids, 6(8), L082301.
[2] Henry, C., & Minier, J. P. (2014): Progress in Energy and Combustion Science, 45, 1-53.