Université de Lille

iemn

Master internship in Physics of Fluids at IEMN (Université de Lille):

Liquid interface and particle interactions in shallow waters

Anticipated start: from January 2023
Duration: 4-6 months

It has been well known for many years that the rimming flow[1] of a granule-free homogeneous fluid can display a number of different characteristic flow states with various degrees of complexity (Figure 1). However, the interaction of the liquid interface with particles with various wetting characteristics has attracted little attention of the scientific community.

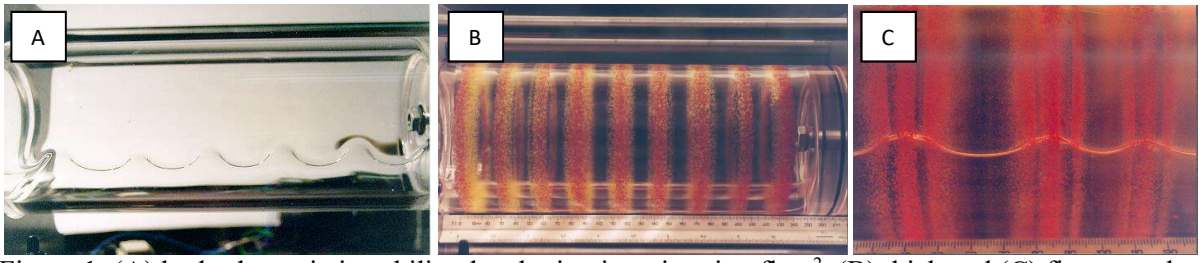

Figure 1: (A) hydrodynamic instability developing in a rimming flow[2], (B) thick and (C) fine granular banding in two-phase rimming flow[3]

The goal of this internship is to explore experimentally the regimes where wall wetting characteristics (those of the cylinder and the particles) may become an important factor, in particular, in the case of very thin liquid layers. We propose to investigate experimentally these unexplored regimes. We expect to discover new phenomena that will require, in turn, an understanding of the underlying governing physics. A comprehensive parameter study for the independent experimental parameters will be performed. The ultimate goal being to compile a complete phase diagram, summarizing all observed phenomena in phase space. That includes, for instance, all modes of granular banding, with their different physical characteristics that one may encounter in particle-laden rimming-flow systems.

Activities

The candidate is expected to undertake the following activities during the internship:

- Improve the existing experimental setup, especially as regards flow-visualization methodologies.
- Acquire and analyze data for comprehensive variations of the independent parameters.
- Modify the surface wettability using the clean room facilities of the IEMN laboratory
- Develop basic theoretical models
- Provide a report at end of the internship.

Skills/profile

The candidate (F/M) must have a strong background in physics of Fluids/ Soft Matter and a desire to perform tabletop experiments investigating fundamental flow phenomena. The candidate is expected to have a taste for experimental research and teamwork in a highly international environment.

Working environment

The work will be carried out in the CNRS laboratory 'Institut d'électronique de microélectronique et de nanotechnologie' (IEMN) at the University of Lille (France) in close collaboration with Prof. Peter J. Thomas of the University of Warwick (UK).

The work will be jointly supervised by and by Farzam Zoueshtiagh (farzam.zoueshtiagh@univ-lille.fr), Peter J. Thomas (P.J.Thomas@warwick.ac.uk) and Alexis Duchesne (alexis.duchesne@univ-lille.fr).

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[1] Rimming flow is, essentially, the flow established inside a partially fluid-filled cylinder spinning with a rotational velocity ω around a horizontal axis as illustrated in Figure 1A.

[2] Boote, O., & Thomas, P.J. (1999) "Effects of Granular Additives on Transition Boundaries between Flow States of rimming flows". *Phys. Fluids* **11** , 2020-2029

[3] Thomas, P.J. , Riddell, G.D., Kooner, S. & King, G.P. (2001) "Fine Structure of Granular Banding in Two-Phase Rimming Flow". *Phys. Fluids* **13** , pp.2720-2723