M2 Internship

Laboratoire de Physique de l'ENS (LPENS)
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Internship location: Ecole Normale Supérieure PARIS
Funding: YES
Thesis possibility after internship : YES

Experimental Study of Two-Phase Turbulence in Air-Water Flows

Two-phase turbulence, particularly in air-water systems, plays a critical role in numerous natural and industrial processes. In atmospheric physics, cloud microphysics (where water vapor condenses into liquid droplets) governs precipitation, radiative properties, and climate dynamics [1]. Similarly, in oceanography, the interaction between turbulent air flows and the sea surface influences heat and mass exchanges, wave breaking, and aerosol production. Despite its importance, the fundamental physics of such systems remains incompletely understood, particularly when phase transitions (e.g., vapor-to-liquid) occur within a turbulent environment.

During this internship, we want to investigate experimentally two-phase turbulence in a controlled air-water flow, with a focus on the formation of liquid water droplets from vapor under varying thermodynamic conditions.

The experiment will use a swirling flow driven by the counter-rotation of two disks in a closed cylinder, see fig. 1. Different properties can be measured such as the pressure fluctuations or the droplet size, velocity and number [2].

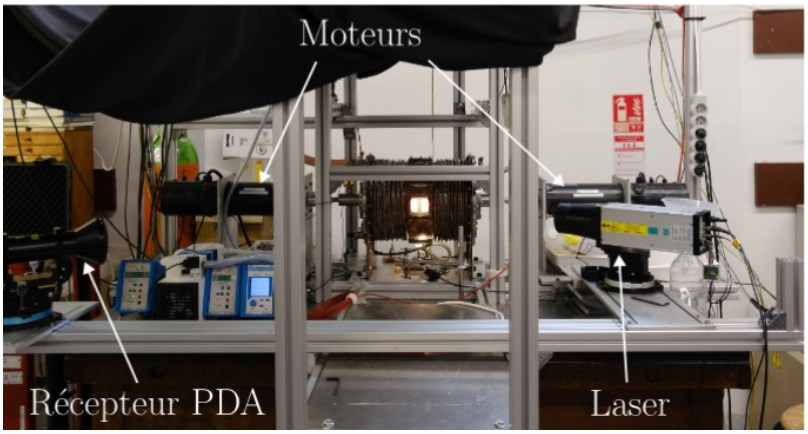


Fig 1 : Picture of the experiment. Two motors drive a turbulent flow in the cooper cylinder.

The central question is: How do the turbulent dynamics of the gas flow influence the nucleation, growth, and size distribution of water droplets, and how do these droplets, in turn, modify the flow's statistical properties (e.g., pressure fluctuations, velocity spectra)?

We will first perform measurement of the droplet size properties, analyse the results and then model their evolution using statistical approaches.

The topics covered by this project range from turbulence and hydrodynamics to thermodynamics and non-linear physics.

We are looking for a candidate interested in both experimental physics and theoretical modeling of the results. The internship can be continued as a Ph.D. project.

[1] R. Shaw Particle-Turbulence Interactions in Atmospheric Clouds. Annual Review of Fluid Mechanics (2003).
[2] Dynamique et transferts dans les écoulements turbulents liquide-gaz, V. Mouet, thèse de doctorat de l'université PSL 2024.