Thesis subject 2021

Laboratory : Institut d’Alembert
University: Sorbonne Université
Title of the thesis: Ultrasonic Atomization
Thesis supervisor: Régis Wunenburger
Email contact: regis.wunenburger@sorbonne-universite.fr
Number of phd student: 1
Co supervisor: 
Collaborations within the thesis: 
Program affiliation: 
Cotutelle: 
University :

This subject can be published on the doctoral school’s web site:

Thesis’s summary (abstract):
The thesis is dedicated to the experimental study of ultrasonic atomization, which is the generation of micro-droplets at the surface of a liquid irradiated by an intense acoustic beam. The goals of the thesis are the elucidation of (i) the mechanisms of droplet ejection, (ii) the impact of visco-elastic properties and of the irradiation conditions on the ejection mechanism.
Subject

Ultrasonic atomization is the production of micro-droplets at the surface of a liquid irradiated by an intense acoustic beam, see the picture below. Atomization is commonly used for aerosol production for perfume diffusion or injection of vaccines via respiratory path [1].

In the case of simple fluids, droplet generation seems to be correctly described by Faraday instability [2]. But several characteristic features of ultrasonic atomization are unexplained:

- The ejection and propulsion mechanism remains unexplained. Possible mechanisms are the acoustic radiation pressure exerted on the droplets in the air or an acoustic streaming flow generated in the air.
- In the case of liquids having a visco-elastic behavior, like silicone oil at megahertz frequencies frequently encountered in acoustics, we do not know how visco-elasticity affects ultrasonic atomization [3].
- The instability mechanism may be affected by the incidence angle of the acoustic beam on the interface [4]. The objectives of this thesis will be to answer the three questions by performing controlled experiments of ultrasonic atomization and combining the characterization of the acoustic field in the liquid and in the air, high-speed imaging, and control of the composition of the atmosphere in which the droplets are suspended.

This thesis is at the interface between hydrodynamics and acoustics and is mainly experimental. Complementary numerical investigations could be performed for predicting the motion of the droplets in the atmosphere.