Master internship and PhD proposal

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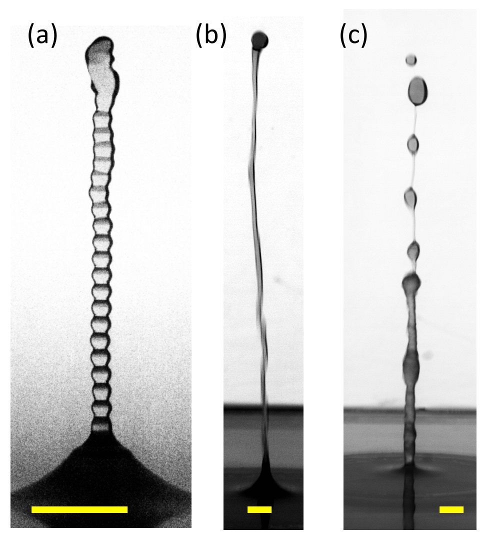
Acoustic fountains in viscoelastic fluids

When ultrasound propagates upwards across water and is reflected at the surface, a constant force, referred to as the "acoustic radiation force," is exerted on the air-water interface. For high enough acoustic intensities, the interface deforms and a liquid jet is formed that breaks up into droplets. Such "acoustic fountains" are known for almost a century [1] and have been extensively studied in simple, *viscous* liquids like water with emphasis on atomization and cavitation [2-4]. However, it has not been studied in non-Newtonian *viscoelastic* fluids, although these have important practical applications in ink-jet or 3D printing.

The aim of the internship is to explore experimentally the effects of viscoelasticity on the formation, on the shape and on the dynamical features of acoustic fountains. We will start by investigating polymer solutions and ask how the early stages of fountain growth (Figure a) and the subsequent jets (Figure b) are modified as a function of polymer concentration. Preliminary measurements on polyethylene oxide (PEO) solutions (Figure c) show that the fountain destabilizes in droplets connected by liquid bridges, an instability known as "beads on string" in viscoelastic fluids. We will study quantitatively the impact of such instability on the acoustic fountain thanks to fast imaging and particle imaging velocimetry (PIV).



Acoustic fountains generated by focused ultrasound (a,b) in a viscous solution (mixture of UCON oil and water) and (c) in a PEO solution in water. The scale bar is 5 mm.

Both global observables such as the maximal height of the jet and local quantities such as velocity gradients will be systematically compared to the case of a Newtonian fluid.

Duration – 3 to 6 months at Master 1 or Master 2 level between February and August 2020 with a possibility of follow-up with a PhD thesis.

Keywords – High-intensity focused ultrasound, viscoelastic fluids, particle imaging velocimetry

References

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[4] J. C. Simon *et al.*, Journal of Fluid Mechanics **766**, 129-146 (2015)