

Evaporating drops: From coffee stains to inkjet printing.

Description

At first, a drying drop might seem boring and irrelevant to study. However, evaporating drops enable a wide range of applications [4], such as:

- Transparent conductive coatings are used in everyday devices such as touch screens, LCD displays, OLED and many others. Droplet evaporation techniques offer an inexpensive and simple process to create these coatings.
- Another important application is in medical diagnosis, by inspecting the residues of dried drops of body fluids. The technique provides a cheap and easy method for a preliminary diagnosis in remote and inaccessible areas with little or no infrastructure.
- And finally, for inkjet printing technology it is crucial to thoroughly understand the physics involved in drop evaporation. An example of an industrial printer is shown in fig 1.

What is surprising, is that although coffee has been around since the 15th century, the coffee stain effect was only scientifically accurately described in 1997 [1]. (The coffee stain effect refers to the dark edges of a dried drop of coffee). Since then, much more works have been dedicated to evaporating drops. It turns out that the physics involved are so rich and far from trivial, that many aspects are still unknown.

For example: What happens when two drops, composed of water and glycerol, evaporate in close proximity? We know that a flow will develop for a single drop [2]. But it is unclear how these drops will affect each other. This is just an example of the many mysteries waiting to be uncovered!

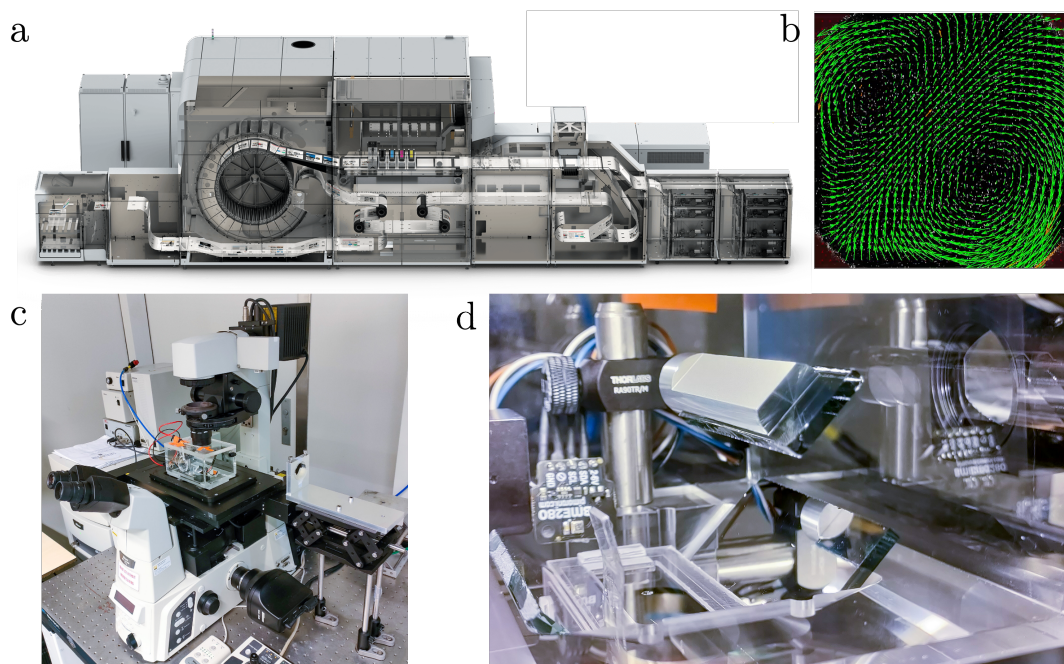


Figure 1: (a) An inkjet printer designed by Canon Production Printing. The printer is 9 m long and weighs over 8500 kg. Image: <https://cpp.canon> (b) Visualization of the flow inside the drop using μ -PIV, made with the confocal. (c) The setup: Confocal microscope with the humidity-controlled chamber. (d) A close-up look inside the humidity chamber. The mirrors allow us to view the drops from the side.

Assignment

As drops are typically tiny, we need to use a confocal microscope, see fig 1. This is an advanced device which allows us to see the flow or concentration inside an evaporating drop using a method known as μ -PIV [3]. The experiments and processing of the experimental data will be the most challenging part of this assignment, since the techniques are complex to master and the drops will be very sensitive to contaminants. In this assignment, you will learn all about the fascinating intricacies of evaporating drops and you will combine all these beautiful techniques with state-of-the-art equipment to do science! If you are interested, please contact me (Pim) for more information!

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