

# Self-similar relaxation of a confined non-wetting droplet

Margaux Kerdraon<sup>a</sup>, Joshua D. McGraw<sup>a</sup>, Stéphanie Descroix<sup>b</sup>, Marie-Caroline Jullien<sup>a</sup>

<sup>a</sup>*Gulliver, ESPCI 10 rue Vanquelin, 75005 PARIS*

<sup>b</sup>*MMBM, Institut Curie, 6 rue Jean Calvin, 75005 PARIS*

---

*Key words: Relaxation, non-wetting confined droplet, self-similarity*

---

Despite the growing field of droplet-based microfluidics, few theoretical tools are available to describe 3D flows in confined droplets in square or rectangular channels. Furthermore, few model experiments for such flow situations have been realized. In this study, we experimentally observe the relaxation of a mineral oil droplet in water. The droplet is confined in the rectangular channel of a PDMS microfluidic system. The droplet deformation is induced by the heating of a localized micro-patterned resistance. This heating induces a spontaneous flow such that a neck is formed in the region near the resistance. For the purposes of this study, such a deformation process allows us to prepare a well-defined initial condition for the observed relaxations. These relaxations are driven by Laplace pressure gradients and are mediated by viscous dissipation. We observe that the profile of the neck is self-similar at the late stages and we propose a drainage model that recovers the experimentally observed scaling exponents. The model is based on scaling arguments that take into account both the Laplace pressure generated by the neck and viscous dissipation in the gutters through which the fluid escapes to the unconfined regions of the microfluidic chip. We show that theoretical tools that are classically used such as lubrication equations have to be amended due to the complexity of both the interface shape and the 3D velocity profile.

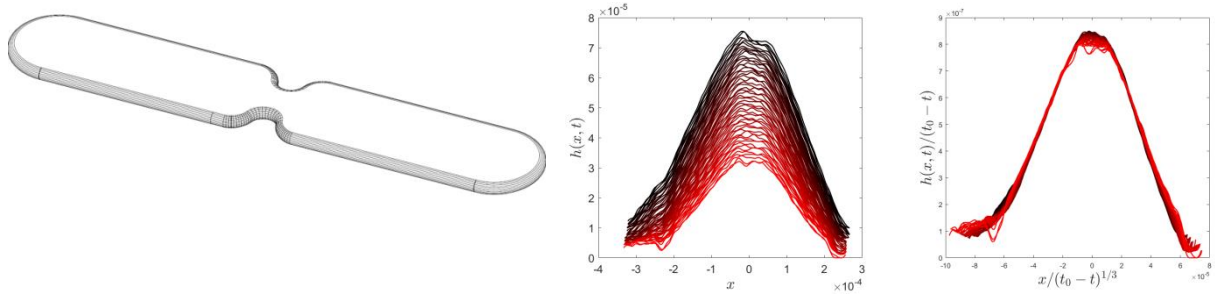


Figure 1: 1) Configuration of the confined non-wetting droplet, 2) Profile of the interface of the droplet during relaxation, 3) Self-similarity of the interface profile.