School of Mathematics and Statistics
Faculty of Science, Technology, Engineering and Mathematics

2022 PhD Projects

Project title	Evaporation of multiple droplets on patterned solids
Principal supervisor	Marc Pradas
Second supervisor	Paul Upton
Discipline	Applied mathematics
Keywords	Droplet dynamics, wetting phenomena, bifurcation analysis
Suitable for	Full time applicants

Project background and description

The ability to manipulate and control how a droplet interacts with a solid surface is important for many technological applications in which droplet dynamics plays a fundamental role. Examples include cooling processes for applications in microelectronics, inkjet micro-printing, and more generally, droplet-based microfluidic systems that are used for industrial, chemical, and biological applications, such as diagnostics and DNA sequencing. At the core of these systems is the understanding and mathematical modelling of interfacial dynamics driven by capillary forces.

During the past decades, several advances have been made in the study of controlling the motion of a droplet on a solid surface, with examples ranging from imposing chemical, thermal or electrical gradients to the use of well-designed surface topographies (see Figure 1 and references [1–3] below); and there has been an increased interest on droplets evaporating on solid surfaces. However, despite such significant progress, there are still many aspects of this problem that are not fully understood. For example, little is known on how a group of evaporating droplets interact with each and how such interaction is affected by the properties of the solid surface.

This project will focus on the interaction of droplets that are evaporating on a solid surface with a well defined geometrical pattern. One of the aims will be to understand cooperative phenomena in the multi-droplet system and how the surface pattern can be designed to induce droplet directed motion and coalescence phenomena. These questions will be addressed through a combination of analytical/asymptotic mathematical techniques and computational/numerical methods. Suitable

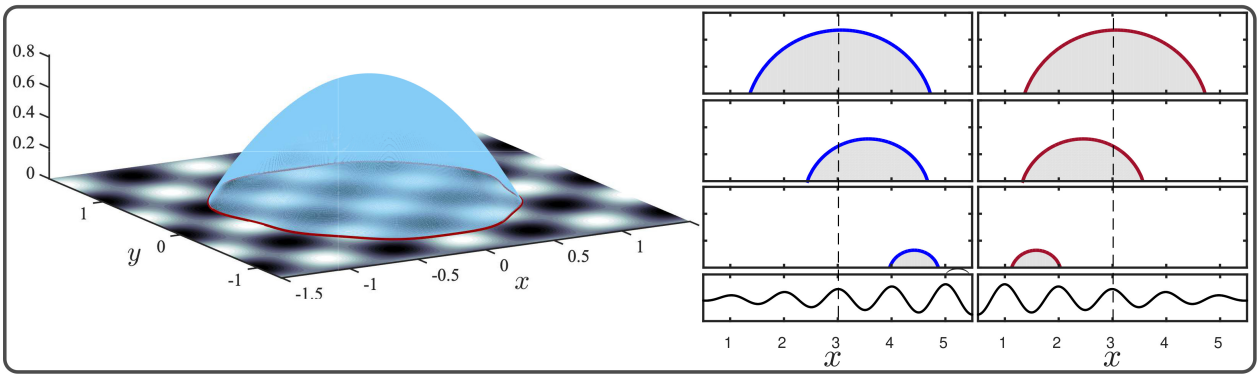

Figure 1: Example of a 3D droplet resting on periodic and symmetric wetting pattern and snapshots of 2D droplets evaporating on asymmetric patterns.

students will have a strong background on applied mathematics and some basic knowledge on fluid mechanics. If you are interested, contact Marc Pradas (marc.pradas@open.ac.uk).

Background reading/references

(1) “Control of droplet evaporation on smooth chemical patterns”, M. Ewetola, R. Ledesma-Aguilar, M. Pradas *Physical Review Fluids* 6, 033904 (2021).

(2) “Snap evaporation of droplets on smooth topographies”, G. Wells, E. Ruiz-Gutierrez, Y Le Lirzin, A Nourry, B Orme, M. Pradas, R. Ledesma-Aguilar. *Nature Communications* 9, 1380 (2018).

(3) “Dynamics of Fattening and Thinning 2D Sessile Droplets”, M. Pradas, N. Savva, J. Benziger, I.G. Kevrekidis, S. Kalliadasis. *Langmuir*, 32, 4736 (2016).