Karlsruhe Institute of Technology

UNIVERSITY OF LEEDS

Institute of Fluid Mechanics istm

May 3, 2024

Master-Thesis – numerical

Droplet impact dynamics on heterogeneously wetting surfaces

Background & Motivation

Knowledge of the wetting and impact of liquid droplets on solid substrates is key to the reliable and efficient operation of various industrial processes, such as spray cooling, application of pesticides and printing. To date, scientific investigations have mainly focused on the rich dynamics of droplet impact analyses on smooth or homogeneously patterned surfaces (figure 1). However, natural and manufactured materials often exhibit non-uniform surface roughness and chemical properties, which influences the impact dynamics with significant consequences in performance of applications such as inkjet printing and spray cooling that are yet to be uncovered (figure 2). Among other, the following questions remain to be answered: How does the wetting gradient impact the droplet contact and departure? What is the influence of the wetting heterogeneity length scale relative to the droplet size? What hydrodynamic regimes of impact, encourage or damp asymmetric effects in droplet behavoiur during impact?

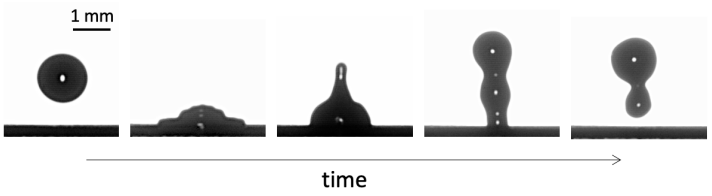

Figure 1: High-speed images of droplet impact on a homogensougly rough surface.

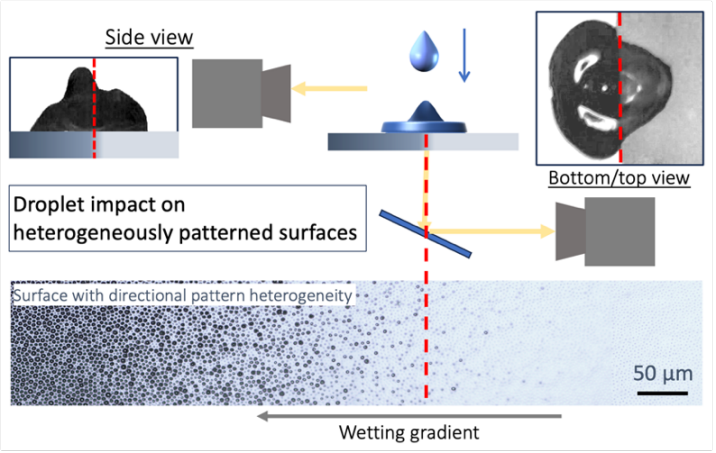

Figure 2: Asymmetric droplet impact on surfaces with heterogeneous wetting properties at the location of impact.

Content of the Thesis
This PhD project aims to build a prediction model linking the wetting heterogeneity of the surface with the dynamics of impacting droplets, using a combination of numerical approaches. The student will perform three-dimensional (3D) spatio-temporal numerical simulations using the phase-field method and validated the data against the two-dimensional (2D) experimental data. The student will investigate the influence of wetting gradient with respect to the diameter of the impacting droplet. The student will also perform simulations of droplet impact at different velocities to identify conditions where wetting gradients are most influential.

This project will be carried out in cooperation with Prof. M Wilson and Dr. S Khodaparast from the University of Leeds.

Start date:

Submission date:

Student:
Matrikel-Nr:

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Signature

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