Chair: Physics of Fluids group

Drops and bubbles spreading on lubricant infused surfaces

Description

The spreading of liquid drops and air bubbles on solid surfaces is a complex phenomenon with various natural and industrial applications. Recently, a new class of surfaces, called liquid infused surfaces (LIS), has been developed that allows for unprecedented control over the spreading behavior of liquids and gases on solid surfaces. In this proposal, we aim to investigate the spreading behavior of liquid drops and air bubbles on LIS and explore its potential applications in different fields.

Figure 1 illustrates a typical scenario when an air bubble in water comes in contact with LIS. Due to change in topology at the point of contact, a train of capillary waves travel across the bubble-water interface (figure 1a,b,c). These traveling capillary waves converge at the top of the bubble (figure 1d,e) leading to entrainment of a smaller air bubble (figure 1f,g). We will study this process in detail to understand the influence of various control parameters on this spreading dynamics.

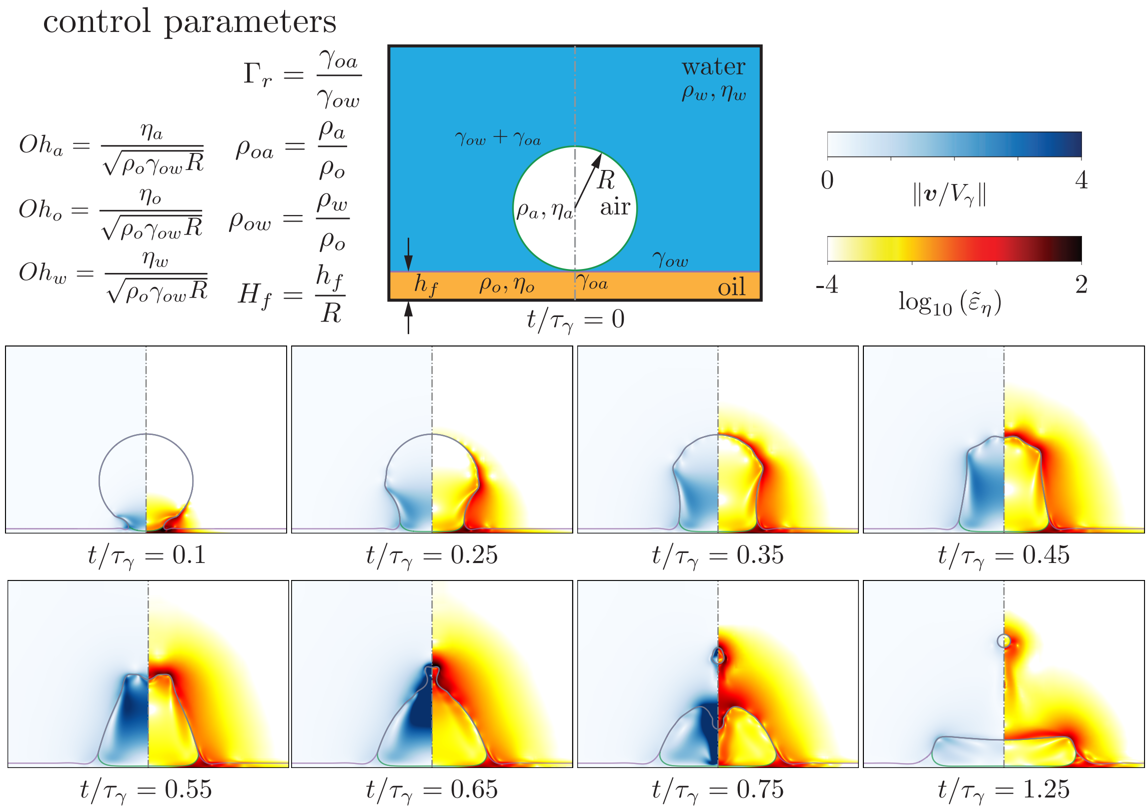

Figure 1: A typical scenario of an air bubble in water spreading on liquid infused surfaces (LIS). In each snapshot, left-hand side contains information about the velocity field magnitude normalized with the inertio-capillary velocity and the right-hand side shows viscous dissipation function ($\varepsilon_\eta = 2\eta\,(\boldsymbol{\mathcal{D}} : \boldsymbol{\mathcal{D}})$). The latter is plotted on a log scale to identify regions of high viscous dissipation. Also see the video of this process at: https://www.youtube.com/watch?v=crRoP9udk9M.

The main objectives of this study are:

1. To investigate the spreading behavior of liquid drops and air bubbles on LIS under different conditions, such as liquid and geometric properties (see figure 1).

2. To understand the underlying mechanisms that govern the spreading behavior of liquid drops and air bubbles on LIS.
3. To identify and explore the different timescales relevant for this process (see the introduction of Sanjay (2022d)).

What will you do and what will you learn?

In the Physics of Fluids group, we are looking for enthusiastic students to work on this topic.

1. You will learn about fundamental fluid dynamics.
2. You will get hands-on experience with Computational Fluid Dynamics (CFD).
3. You will learn how to do basic and advanced data analysis.
4. You will learn modeling of complex multiphase systems contact lines.
5. You will learn how to document and publish ready-to-use codes and share them with the community, similar to Sanjay (2022a,b,c).

If you have any questions, fell free to contact Vatsal (details below).

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References

Sanjay, V. (2022a). *Code repository: Drop impact on viscous liquid films.* https://github.com/VatsalSy/Drop-impact-on-viscous-liquid-films (Last accessed: April 1, 2022).

Sanjay, V. (2022b). *Code repository: Impact forces of water drops falling on superhydrophobic surfaces.* https://github.com/VatsalSy/Impact-forces-of-water-drops-falling-on-superhydrophobic-surfaces.git (Last accessed: February 4, 2022).

Sanjay, V. (2022c). *Code repository: When does a drop stop bouncing?* https://github.com/VatsalSy/When-does-a-drop-stop-bouncing (Last accessed: April 20, 2022).

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