Chair: Physics of Fluids group

Understanding viscous effects in bouncing drops (Part II: Numerics)

Description

Recently, during one of his trips to the International Space Station, astronaut Scott Kelly demonstrated that one could play ping-pong in space using water drops (link here). This demonstration follows from a long history of research on bouncing drops on superhydrophobic surfaces (see the discussions related to bouncing off superhydrophobic surfaces in Josserand and Thoroddsen (2016)).
In this study, we would like to understand this process of bouncing droplets. Figure 1 shows a typical sequence of a drop bouncing off a dry substrate. A similar process occurs if a thin film of a different more viscous oil is present on the (wet) substrate. In our simulation, we will use an in-house developed read-to-use code to solve the problem of the liquid drop impact on both dry and wet substrates.
We will focus on the hydrodynamics of the process. In particular, we wish to understand various mechanisms through which the initial kinetic energy of the drop is dissipated in the system. Drawing analogy with the impact of rigid balls, we will also calculate the coefficient of restitution as a function of the viscosities of drop and thin liquid film.

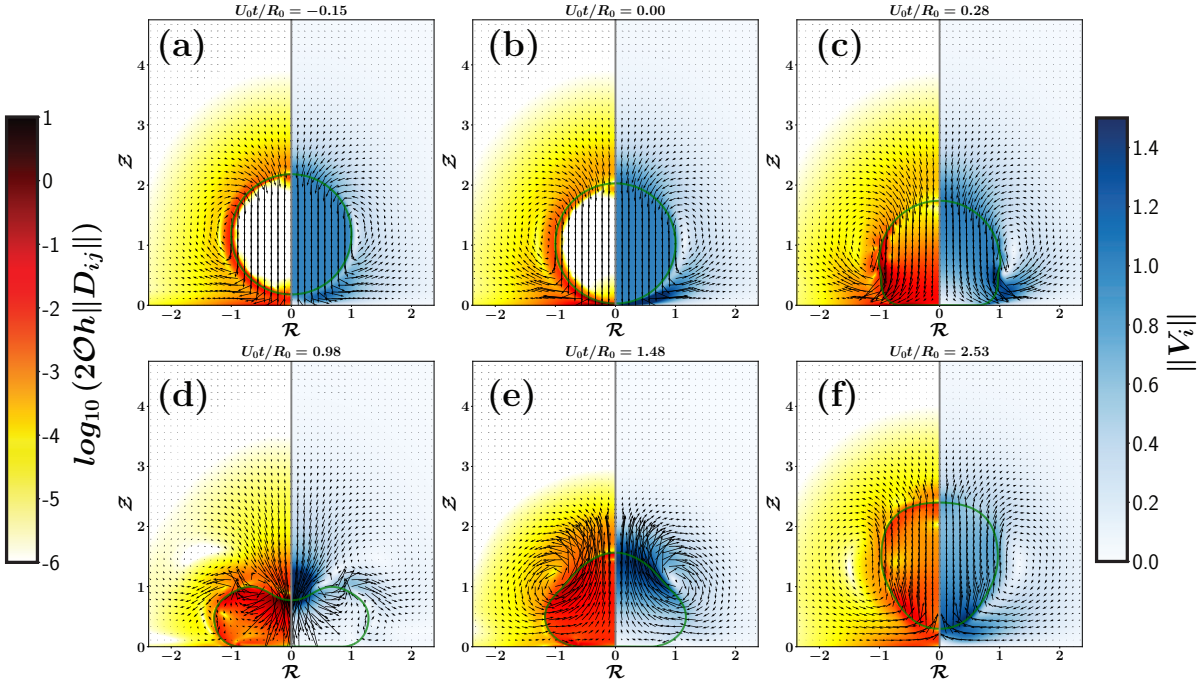

Figure 1: A typical simulation of a drop bouncing off a superhydrophobic substrate: (a) The drop approaches the substrate, (b) Air is squeezed out of the thin gap between the drop and the substrate, leading to lubrication flow in the gap, (c) The drop spreads on the substrate (see Wildeman et al. (2016)), (d) - (e) The drop changes the direction of motion because of the substrate, and (f) The drop bounces back.

What you will do and what you will 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 advance data analysis.
4. You will work closely with experimentalists in trying to undertand the physical process, and for validation of the numerical code.

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

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References

Josserand, Christophe and Sigurdur T Thoroddsen (2016). "Drop impact on a solid surface". In: *Annual review of fluid mechanics* 48, pp. 365–391.

Wildeman, Sander, Claas Willem Visser, Chao Sun, and Detlef Lohse (2016). "On the spreading of impacting drops". In: *Journal of fluid mechanics* 805, pp. 636–655.