Air film dynamics

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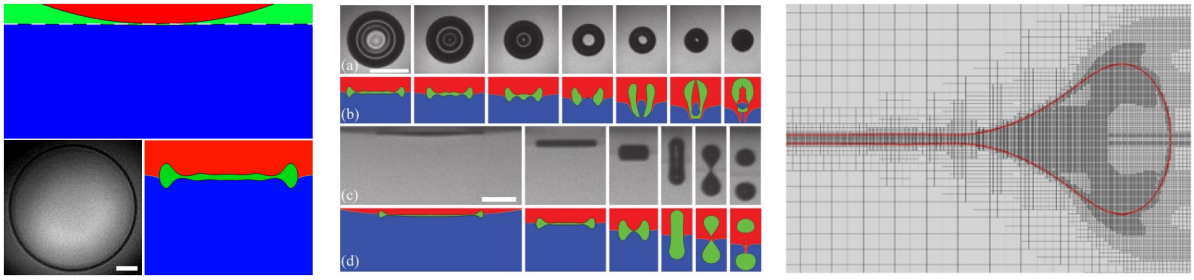
Context: Gas transfer at the ocean surface has a critical importance for climate, as it captures around 30% of the CO_2 released into the atmosphere, and for marine biological activity, as it provides the necessary O_2 [1]. This transfer can be promoted by the entrapment of bubbles, produced through impacting rain drops or breaking waves. The shape and dynamics of the bubbles are important to model these transfers.



Contraction of an air film below an impacting drop, comparing high-speed imaging experiments with simulations with the open-source code Basilisk [2, 3].

Goals: We propose in this project to study the contraction dynamics of an air film into a fluid. We will systematically vary the gas and fluid properties in different geometries to understand their contraction velocity and rupture mechanisms. This project will combine numerical simulations (using the open-source code Basilisk) with theoretical analysis to uncover the physical processes involved in the gas transfer into the ocean.

Profile: Candidates should have a good training in Fluid Mechanics and Computational Fluid Dynamics.

Environment: The project will take place at LadHyX in École Polytechnique, in the South of Paris.

References:

[1] Deike, L. (2022). Mass Transfer at the Ocean–Atmosphere Interface: The Role of Wave Breaking, Droplets, and Bubbles. *Annual Review of Fluid Mechanics*, 54, 191–224.
[2] Jian, Z., Channa, M. A., Kherbeche, A., Chizari, H., Thoroddsen, S. T., & Thoraval, M.-J. (2020). To Split or Not to Split: Dynamics of an Air Disk Formed under a Drop Impacting on a Pool. *Physical Review Letters*, 124(18), 184501.
[3] Jian, Z., Deng, P., & Thoraval, M.-J. (2020). Air sheet contraction. *Journal of Fluid Mechanics*, 899, A7.