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Master internship: Oscillations of a micro hydraulic jump

Abstract:

Circular hydraulic jump

Everyone has likely observed a hydraulic jump at some point (if not, see Figure): Simply open a tap, and you'll see a vertical stream of water striking the bottom of the sink. You'll notice a circular liquid wall surrounding the jet which separates an inner, shallow, fast-flowing region from an outer, slower, and deeper one. This wall is the circular hydraulic jump. But how many have ever witnessed this liquid wall regularly vanishing and reappearing multiple times each second, and continuously if undisturbed?

In a recent study [1], it has been showed that the occurrence of this remarkable phenomenon stem from small waves emitted by the hydraulic jump itself, trapped and amplified by the layer of water on top of the disk, in a resonant cavity system. As a result, the depth of the water layer oscillates, causing the hydraulic jump to repeatedly close and open.

The primary goal of this internship is to delve into the various cavity modes achievable within this system. By altering the plate's shape, adjusting the number of jets, and exploring the interactions between the liquid and the substrate, we can investigate the conditions that trigger the oscillations in the hydraulic jump, unlock the various cavity modes it offers and build a liquid equivalent to Chladni figures.

This internship also offers the opportunity for continuation into a Ph.D. thesis, which will further address the questions previously mentioned, as well as explore other aspects of microjets impacts.

The internship will take place at the Institute of Electronics, Microelectronics and Nanotechnology (IEMN) on the scientific campus of the University of Lille. Access to the institute's state-of-the-art microfabrication facility, one of the largest in France, will enable the construction of specialized devices. Additionally, you will gain expertise in controlling the wetting properties and surface conditions of the affected substrates.

References

[1] A. Goerlinger, M. Baudoin, F. Zoueshtiagh and A. Duchesne, Oscillations and cavity modes in the circular hydraulic jump, accepted for publication in Phys. Rev. Lett. (2023)