Internship

Soft Valves Under Pressure: When Flow Triggers Failure

Context. In nature, liquid transport often relies on soft structures, such as valves, cilia, or porous walls, that deform under flow to passively regulate circulation. These structures have inspired the design of microfluidic devices and soft-robotic systems [1].
However, sometimes these soft structures fail. For instance, soft valves are meant to close gently to prevent backflow, but under certain conditions, they can instead undergo snap-through instabilities: instead of sealing properly, the leaflet suddenly bends in an unintended direction. Such failures disrupt normal flow and can lead to pathological conditions. A well-known example is mitral valve prolapse in the human heart, where the valve leaflets buckle into the left atrium, impairing blood circulation. Similar buckling-related malfunctions are also reported in venous valves and lymphatic valves, leading to venous insufficiency or lymphatic disorders.
In this internship, we will explore these mechanisms using a simplified, upscaled experimental model of a soft valve in a flow at low Reynolds numbers. By studying the conditions under which a leaflet buckles, how it depends on flow rate, geometry, and material properties, we aim to build the first steps toward a physical understanding of valve buckling. The student will work together with PhD students and postdocs. He/She will use experimental facilities to measure flow rates as a function of externally imposed pressure and characterize soft valves buckling. He/She will develop models inspired by previous studies on flow-induced buckling [2]. This fundamental knowledge will not only shed light on biological failures but also inform the design of robust, bio-inspired fluidic devices. **The internship can be followed by a PhD grant.**

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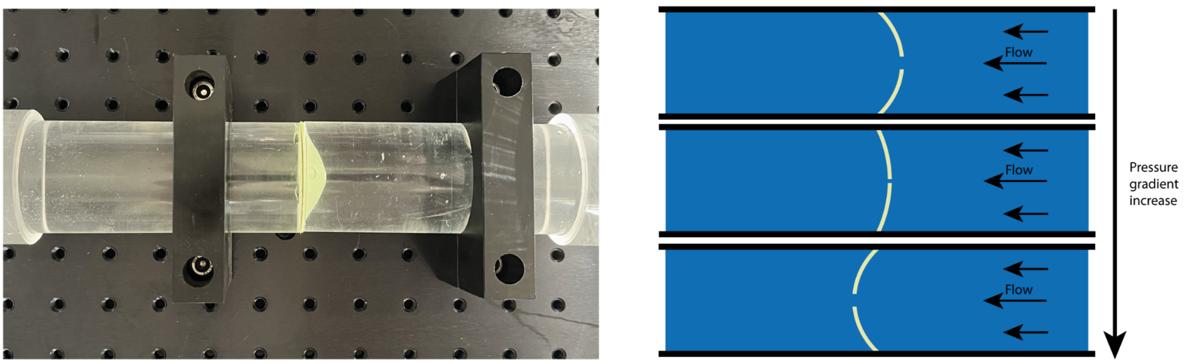

Figure 1 (a) Picture of the experimental setup with the buckling valve (in green) in the center of the fluidic channel. (a) Schematic of the valve suddenly deforming at a critical pressure gradient.

<u>Duration:</u> 5-6 months
<u>Grant:</u> 600 euros per month
<u>Degree:</u> M2, Starting from February 2026.
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References:
[1] Chen, S., Qiao, Z., Niu, Y., Yeo, J. C., Liu, Y., Qi, J., ... & Lim, C. T. (2023). Wearable flexible microfluidic sensing technologies. *Nature Reviews Bioengineering*, *1*(12), 950-971.
[2] Gomez, M., Moulton, D. E., & Vella, D. (2017). Passive control of viscous flow via elastic snap-through. Physical review letters, 119(14), 144502.