Internship/PhD proposal: Clogging in hairy channels

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Profile: Soft matter physicist or mechanical engineer with an affinity with experiments

Keywords: fluid-structure interactions, biomimetics, filtering

Context: From hairs on our skin to the microscopic cilia inside our respiratory tract, large aggregates of thin deformable structures in contact with fluids are ubiquitous. While the fluid structure interactions of single hair-like structures are known for simple Newtonian fluids, the collective effects emerging from a dense collection of these hair-like structures and their interaction with the complex fluids often encountered in biology is much less explored.

Goal: In this project, using model experiments we aim at understanding how a channel filled with deformable hairs affect fluid flow and can trap small particles carried by the flow (see Figure 1). It is well known that clogs can occur in porous medias when particles have a size comparable to the pores. However, these hairy channels constitute a very peculiar porous media where the pore size can vary as the hairs are bent by the fluid flow which should impact the clogging process.

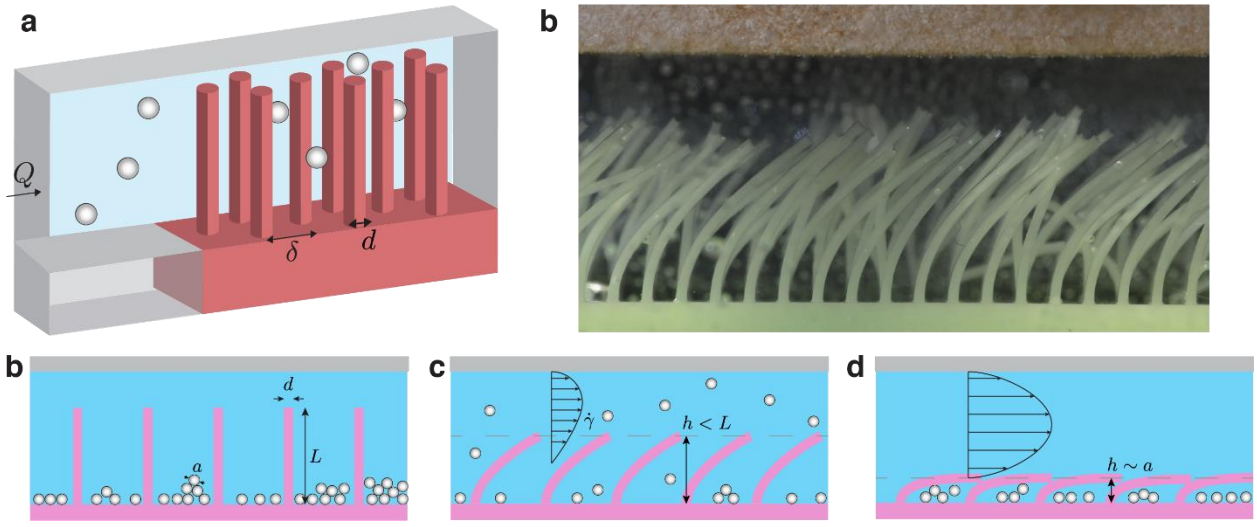

Figure 1: Schematic of the proposed experiments and image of preliminary experiments

Experimental techniques: The student will build the hairy channels using fast prototyping and molding techniques. They will generate and monitor flows with syringe pumps, pressure sensors, and measure the hair deformations with image analysis techniques. They will model these deformations combining flow analysis with beam mechanics. Finally, they will add particles to the fluid and measure the clogging rate as a function of the parameters of the problem: flow rate, hair rigidity, particle size …