Deformation of a flexible fiber settling against obstacles in a viscous fluid

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The motion of flexible fibers often happens in complex media that are structured by obstacles, examples range from delivering drugs to tumor regions to papermaking process [1]. For large number of such problems, the dynamic of the fibers results from complex interplay between internal elastic stresses, contact forces and hydrodynamic interactions with the walls and obstacles. Understanding how flexible fibers behave in a viscous flow embedded with obstacles is essential for the study of biological mechanisms and the design of industrial systems. Using a combination of numerical simulations and macroscopic experiments, we analyze the dynamic of a flexible fiber settling in a viscous flow embedded with an obstacle. We identify different effects of the obstacle shape on the deformation of the fiber that involve different wrapping configurations, prolonged periods of trapping around the obstacle, and dispersion of the center of mass, which we quantify in terms of a lateral drift.

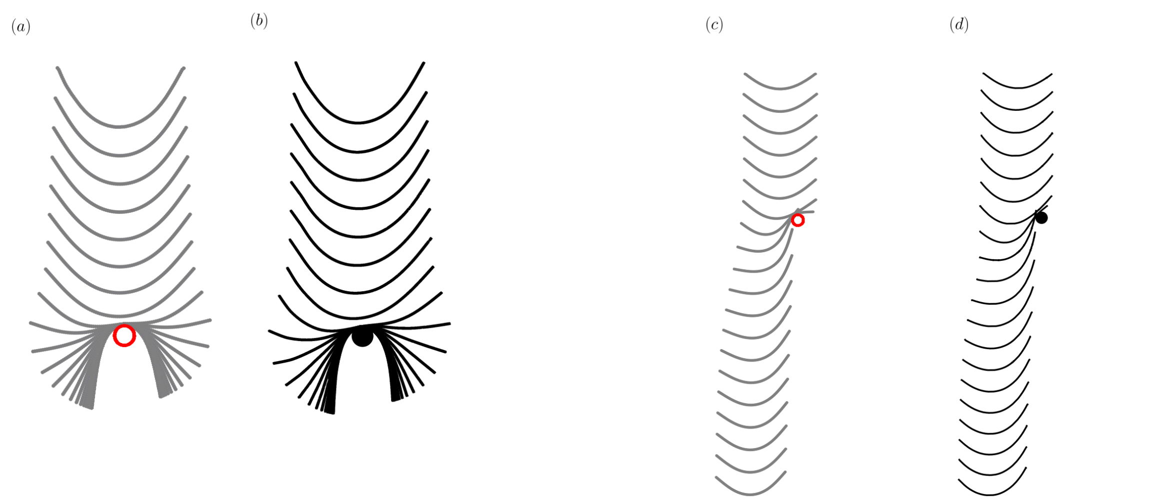

Figure 1. Numerical and experimental chronophotographies of a flexible fiber settling against an obstacle in a viscous fluid. The gray fibers (*a*) and (*c*) denote the numerical simulations and the black ones (*b*) and (*d*), the experiments. We define two characteristic numbers : the elasto-gravitational number $Be = WL^3/EI$ and the length-to-width ratio $\xi = L/\omega$, where W is the weight per unit length, L the fiber length, ω the obstacle width, E the Young's modulus and I the second moment of inertia. $(a-b)$ "Trapping event" with $Be = 210$ and $\xi = 9.35$, characterized by a prolonged trapping period of the fiber around the obstacle. $(c-d)$ "Gliding event" with $Be = 200$ and $\xi = 7.71$, characterized by a short trapping period around the obstacle followed by a drift motion.

Références

1. F. Lundell, D. Söderberg & H. Alfredsson, Fluid Mechanics of Papermaking, *Annual Review of Fluid Mechanics*, **43**, 195-217, (2011)

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