Attraction-repulsion of elastic structures that are withdrawn from a viscous bath

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Dipping structures made of an assembly of slender elastic appendices is a common strategy to capture and manipulate small quantities of fluid. It is used by nectarivores to feed and by painters, decorators and calligraphers to perform their art. However, the physical mechanisms that govern the capture remain poorly understood. In this work, we carry laboratory experiments where model structures made of an assembly of two parallel elastic plates are withdrawn from a viscous bath at constant speed. Interestingly, at small retraction speed, the two plates tend to attract each others thereby forming a single aggregate at the end of the retraction (Fig. 1 left panel) whereas at higher retraction speed they tend to repel each others instead (Fig. 1 right panel). At small speed the configuration of the structure results from a competition between the attractive capillary forces and the elastic forces associated with the deformation of the plates [1]. At higher speed, the viscous forces associated with the flow taking place in-between the plates come into play and radically change the behavior of the system [2]. The fluid capture resulting from this elastohydrodynamic interactions is complex and depend on the elastic properties of the structure, the distance between the plates, the viscosity of the fluid, the retraction speed and capillary effects. The model we develop describes quantitatively all our experimental observations. It allows to identify the physical parameters that govern the fluid capture and provides tools to exploit these strategies for fluid manipulation at small scale.

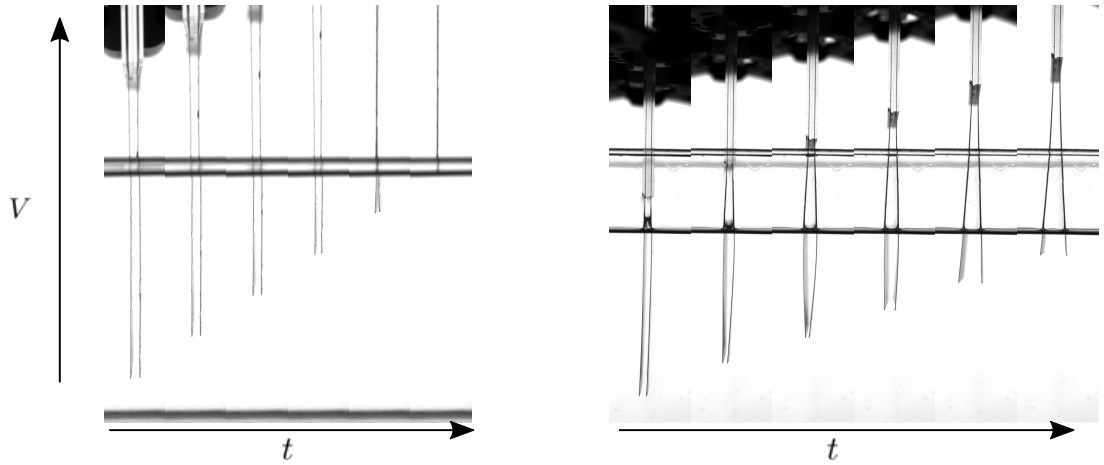

Figure 1. Withdrawing of two parallel elastic plates from a viscous bath. **Left panel :** at small retraction speed, the two plates tend to attract each others and ultimately collapse. **Right panel :** at higher speed the two plates repel each others instead.

Références

1. Siéfert E., Hua H. A. B., & Brau F, *Extreme Mechanics Letters*, **vol. 55**, p. 101823 (2022).
2. Radisson B., Bense H., Siéfert E., Domino L., Hua H. A. B., & Brau F., *arXiv*, 2411.15970 (2024).