Non-linear instability of a liquid rivulet

Intership proposal

Laboratory: Matière & Systèmes Complexes (MSC), UMR 7057 CNRS & Univ. de Paris
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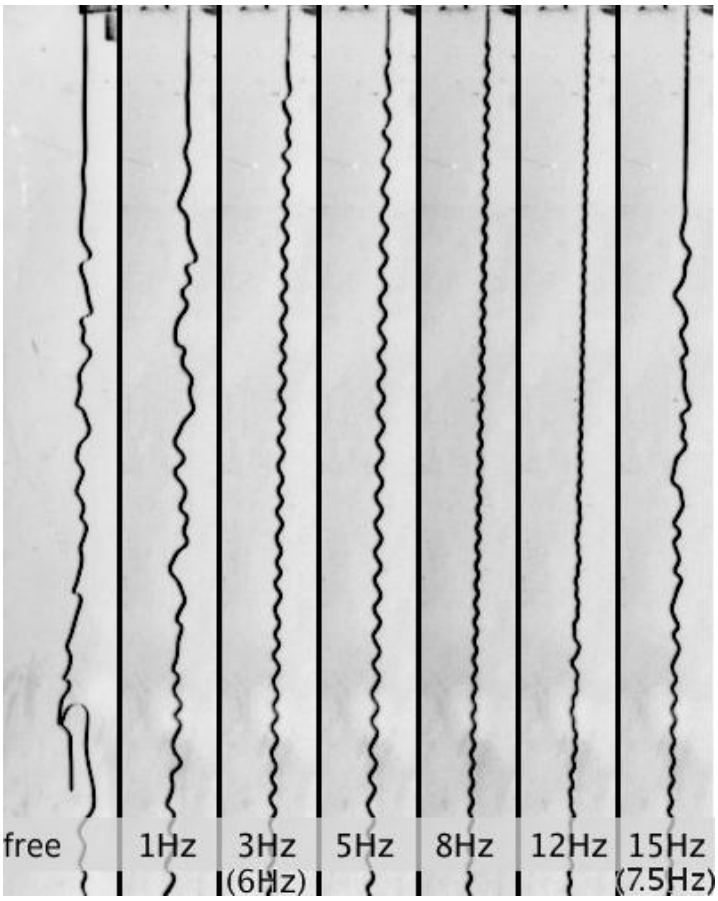
Thesis possibility after internship: oui *Thesis funding already secured:* no



Meandering instability of a liquid filament flowing in a Hele-Shaw cell. The flow rate is the same in all snapshots, but in all but the leftmost image the liquid is weakly and locally shaken by air jets near the inlet (top of image). The response is non-linéar.

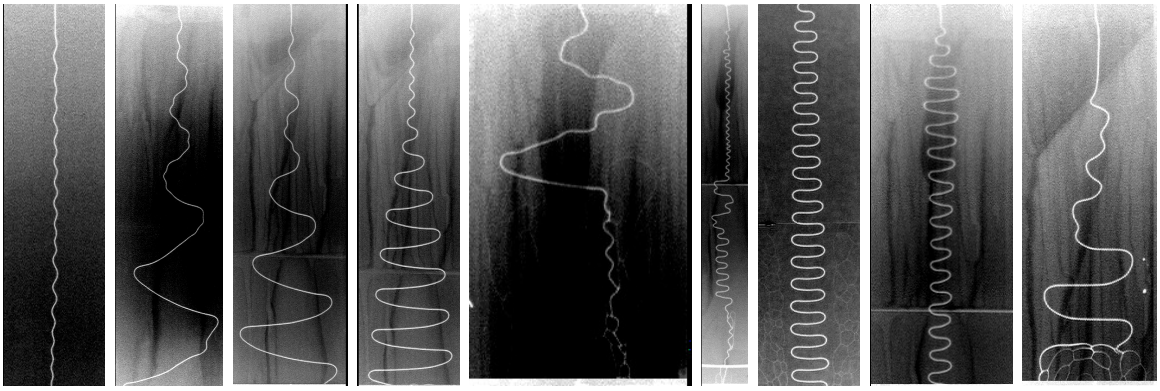
A liquid filament between vertical walls starts meandering spontaneously above a critical flow rate, instead of flowing down along a straight path (leftmost image above).

Beyond the threshold itself little is understood about the dynamics of the rivulet, such as the power spectrum of perturbations amplified above the instability threshold, the amplitude saturation, the existence of transitions from convective to absolute instability or vice-versa, and the response to an acoustic forcing (see figure above). The aim of the internship will be to constrain the possible terms of an amplitude equation, starting from the simplest that respect the system's symmetry, from an analysis of the spatio-temporal evolution of the rivulet in the experiment. This will help us guide the hydrodynamic modelling of the system from the Navier-Stokes equations.

The internship is thus of particular interest to students who like to go back and forth between

experiment, theory and possibly numerical work. Some image processing will be involved. Basic knowledge of hydrodynamics (viscosity, surface tension, Couette flow, boundary layers) and of non-linear dynamical systems is welcome but not required beforehand.

During a PhD the broader aim is to investigate the rich dynamics in the presence of surfactants, in particular to link the phase diagram to rheological and physico-chemical properties of the surfactant solution.



Dynamics of a water rivulet with surfactants (here dish washing liquid). Depending on the flow rate the system changes from regular to irregular, as well as from amplitude-saturating to regimes of diverging growth up to breaking.

Condensed matter physics: no
Soft matter and biological physics: yes
Quantum physics: no
Theoretical physics: no