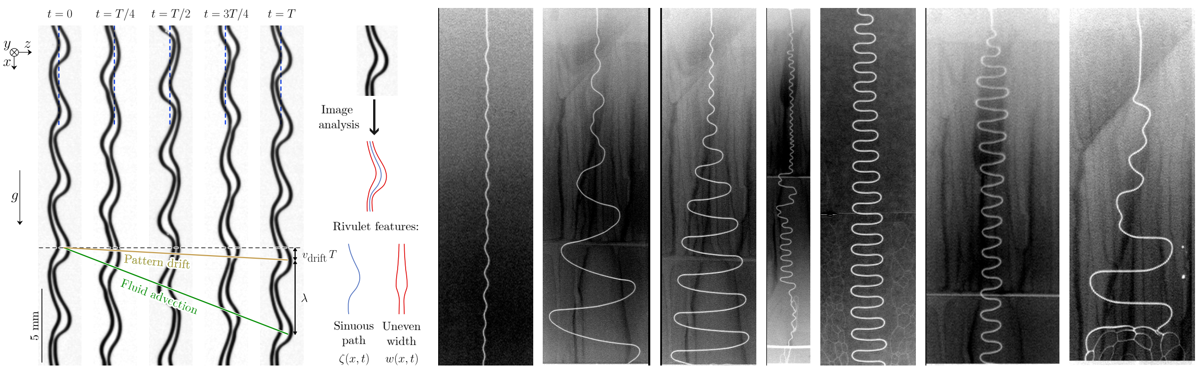
Triadic wave instability on a liquid rivulet

Laboratory: Matière & Systèmes Complexes (MSC), UMR 7057 CNRS & Univ. Paris Cité
Internship director: Adrian DAERR (bureau 771A, bât Condorcet) tél.: 01 57 27 62 73
adrian.daerr@u-paris.fr `https://labo.msc.u-paris.fr/~daerr/`

Thesis possibility after internship: yes *Thesis funding already secured:* no



(left) *Pattern instability on a shaken PTFE oil filament in air. The oil-air interfaces appear black. Longitudinal and transverse waves (width modulations, red, and sinuous modulations, blue) are phase-locked.* ***(right)*** *Rich spontaneous meandering dynamics of a water rivulet with surfactants (here dish washing liquid). Depending on the flow rate the dynamics is regular or irregular, and exhibits amplitude saturation or diverging growth up to breaking.*

When a liquid filament flowing under gravity between vertical walls is shaken horizontally, we observe the spontaneous emergence of a periodic pattern (figure left).This instability can be seen as resulting from the parametric coupling of longitudinal and transverse waves on the filament, and wavelength is then understood as a triadic resonance condition where the shaking enters as the third “wave” with zero wavenumber and non-zero frequency.

We have so far characterised this instability for a simple Newtonian liquid [1]. During the internship, we would like to explore the dynamics in the presence of surfactants. We already know that surfactants strongly modify the spontaneous meandering patterns that arise at high flow rates from a distinct inertial instability (figure right), so it seems natural to ask whether the parametric instability described above is also affected.

As the parametric instability is observed for a large interval of forcing frequencies, this opens the perspective, and potential avenue of research for a PhD, of probing surfactant dynamics, notably surface rheological properties, at different time scales.

The internship and PhD are of particular interest to students who like to go back and forth between experiment and theoretical or numerical modeling. 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.

[1] Le Lay, G. & Daerr, A. (2024), "Phase-locking melody: a parametric instability coupling longitudinal and transversewaves on rivulets in a Hele-Shaw cell", Phys. Rev. Lett. 134 , 014001.