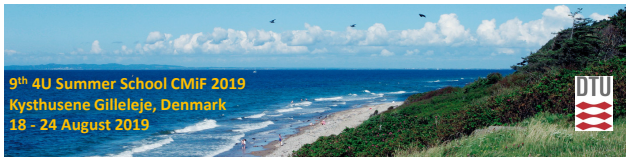

Fluid dynamic instabilities and pattern formation

François Gallaire

Laboratory of fluid mechanics and instabilities, EPFL, Lausanne, Switzerland
E-mail: francois.gallaire@epfl.ch, URL: http:/lfmi.epfl.ch/

In these two lectures, I will introduce the concept of hydrodynamic instabilities [1] and exemplify its use to rationalize pattern formation in thin layers of liquid coating overhanging surfaces [2]. This instability is referred to as the Rayleigh-Taylor instability, in which gravity acts to pull down the fluid while capillary forces oppose the interface deformation.
I will discuss the role of advection when the surface is tilted with respect to the horizontal [3] as well as that of drainage when the liquid film coats a curved substrate [4].
Specifically, I will show how the exponential destabilization of their interface revealed from a linear stability analysis often sets the blueprint of the patterns they eventually form and thereby link linear instability theory to nonlinear pattern formation.

Figure 1: A thin film coating the underside of an inclined plate is fed at constant flux. Despite the isotropy of the linear growth-rate of the instability, longitudinal structures, called rivulets, which are aligned with the flow emerge through a nonlinear selection mechanism. Once saturated, their secondary instability with respect to travelling lenses is also studied.

References

[1] F. Gallaire, and P.-T. Brun, Phil. Trans. R. Soc. A **375** 20160155 (2017).
[2] M. Fermigier, L. Limat, J. E. Wesfreid, P. Boudinet, and C. Quilliet, J. Fluid Mech. **236**, 349-383 (1992)
[3] P.-T. Brun, A. Damiano, P. Rieu, G. Balestra, F. Gallaire, Phys. Fluids **27**(8), 084107 (2015)
[4] G. Balestra, N. Kofman, P.-T. Brun, B. Scheid, and F. Gallaire, J. Fluid Mech. **837**, 19-47 (2018)