Research Topic for the ParisTech/CSC PhD Program

Subfield: Physics and mechanical engineering

ParisTech School: ESPCI

Title: **Transition to turbulence in shear flows**

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Short description of possible research topics for a PhD:

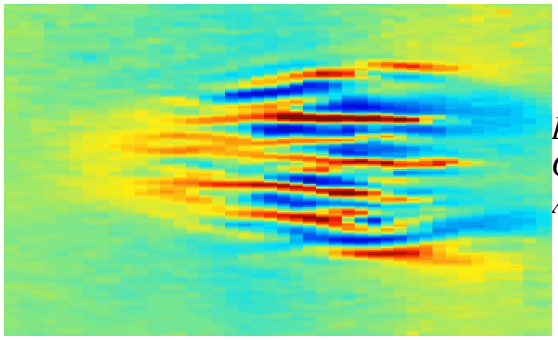
Confined shear flows are flows between two parallel plates or in a tube. There are ubiquitous in industrial processes. The transition to turbulence is particularly complex: the flow may be laminar or turbulent for the same Reynolds number, depending on an initial perturbation. In the transition regime, turbulence is localized in turbulent spots.

The objective of this project is to determine how the turbulence is sustained in these spots, and how these spots evolve in time.

We have recently setup a unique experiment to study these turbulent spots [2-3], which consists of a Couette-Poiseuille flow. The next step will be to improve the velocity measurements, using stereo-PIV and 3D PIV (particle image velocimetry) and other sensors (pressure, hot wire).

Image analysis will include extracting the sub-structures of the spots, using for instance dynamic mode decomposition, and comparing their dynamics to nonlinear dynamical model.

This PhD thesis will benefit from strong collaborations with theoreticians, in particular within the laboratory.



Experimental streamwise velocity measured in a Couette-Poiseuille setup.
A turbulent spot is surrounded by laminar flow.

Required background of the student: physics or mechanical engineering, knowledge in fluid mechanics or in non-linear dynamics, experience in experimental science

List of representative publications of the group:

[1] G. Lemoult, K. Gumowski, J.-L. Aider, and J.E. Wesfreid, Turbulent spots in channel flow: An experimental study, *Eur. Phys. J. E* (2014), **37**: 25
[2] L. Klotz, G. Lemoult, I. Frontczak, L.S. Tuckerman, J.E. Wesfreid, New experiment in Couette-Poiseuille flow with zero mean advection velocity: subcritical transition to turbulence, *Phys. Rev. Fluids* (2017) 2.043904
[3] Klotz, L. and Wesfreid, J. E. ; Experiments on transient growth of turbulent spots ; *Journal of Fluid Mechanics* (2017) ; **829** ; R4.