Universität Bremen

CENTER OF APPLIED SPACE TECHNOLOGY AND MICROGRAVITY

ZARM

Master thesis:
Finding precursors of turbulence proliferation in pipe flow

Turbulence remains as the most important unsolved problem of classical physics. Given the amount of energy lost in human and fluids transportation due to turbulence (about 10% worldwide), it is imperative that we understand the ways turbulence proliferates so we can better eradicate it. Transitional pipe flow is an excellent test scenario to study this. Here, turbulence takes the form of localized turbulent patches called turbulent puffs (see figure 1). At certain Reynolds numbers, these turbulent puffs tend to split or elongate, resulting in a higher turbulent fraction in the pipe. The exact flow structures/perturbations that cause these splits and elongations are still unknown. The identification of these, would help us to understand the reasons behind turbulence proliferation in otherwise laminar flows, help us to avoid them and open the door to answer fundamental questions regarding turbulence dynamics.

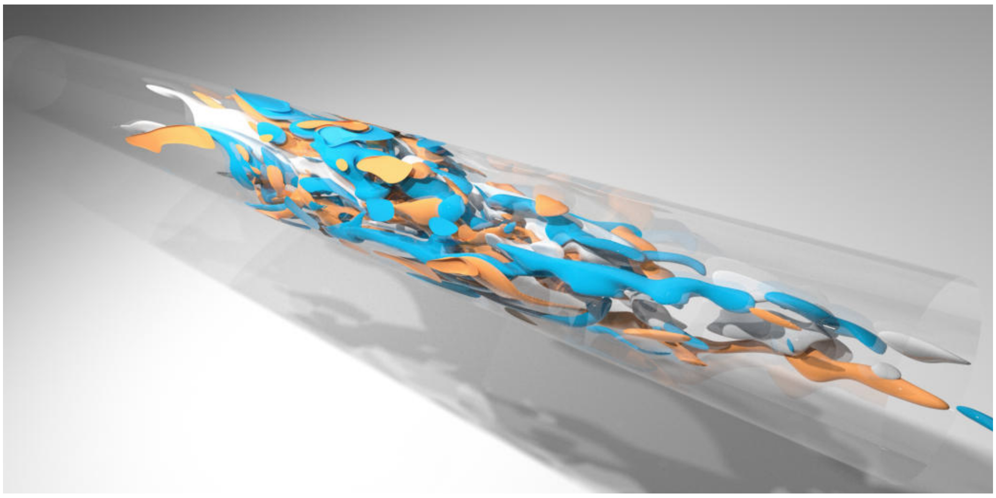

Figure 1: Visualization of a turbulent puff in pipe flow: blue/red positive/negative vorticity and in grey low axial velocity streaks.

In this thesis you will solve an optimization problem and find the flow structures (vortices, flow injections) that are optimal at triggering splitting/puff elongation. You will have access to a state of the art GPU code to perform fast optimizations of pipe flow. With the use of state of the art data driven methods, you will identify the most dangerous perturbation/actuation for turbulence growth.

Requirements:
- Basic knowledge in numerical methods and fluid mechanics.
- High interest and motivation on applied mathematics, coding and turbulence.

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