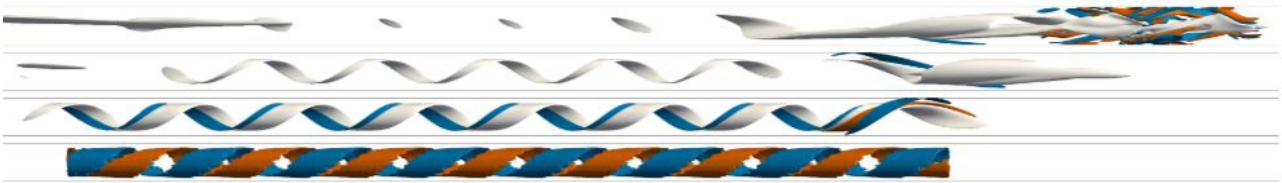
Bachelor-Thesis

How does shear-thinning affect transition in pulsating pipe flows?

Background

Cardiovascular diseases represent one, if not the major, cause of death worldwide. With its ever increasing danger in mind, the scientific community is interested on determining its causes and prevent them. One of these causes appears to be the presence of **turbulence** in our **cardiovascular system**. The only solid understanding regarding transition to turbulence in our arteries or veins comes from the analogy between cardiovascular flow and the elementary Newtonian fluid flow in rigid circular pipes [4]. It comes with no surprise that, with such a simplified model, many characteristics of blood flow in our flexible vessels are ignored. Most recently we have started to learn what effects a pulsating driving, instead of a steady driving, has on the transition scenario [3] . As further steps we want to check what effects other previously ignored characteristics of cardiovascular flow may have on transition.



From Helix to Turbulent puff. In grey low velocity streaks, and in colors positive/negative axial vorticity. The figure presents the transition to turbulence in a pulsating pipe flow from a helix like disturbance. Obtained from DNS [1].

Your project

We want to investigate what effect **shear-thinning** has on **turbulence transition**. For a pulsating driven pipe flow you will select a shear thinning model that approximates our blood characteristics and then study transition in such scenario. To that end you will modify one of our **MATLAB** tools [2] to introduce shear thinning and obtain the corresponding laminar flow. Then, using this tool, you will investigate the perturbations that optimally disturb this flow for different flow parameters. Is the most dangerous perturbation similar to the helix we have observed in some pulsating flows of Newtonian fluids? Or on the contrary, do our blood characteristics counteract the instabilities found in some pulsating flows?

We are looking for a motivated student who

- ✓ is interested in working with **Matlab** and **Fortran** in a **Linux** development environment
- ✓ is interested in **CFD** and performing numerical simulations of turbulent fluid flow
- ✓ has a strong theoretical inclination for fluid **turbulence**

We offer

- ✓ integration in a research group expert in high-performance computing and fluid dynamics
- ✓ working in a DFG funded project with the possibility to attend meetings and visit collaborators in Germany
- ✓ possibility to publish in international journals

Literature

[1] J.M. Lopez et al., SoftwareX (2020), https://doi.org/10.1016/j.softx.2019.100395
[2] Barkley, Numerical Mehtods in Fluids(2008), https://doi.org/10.1002/fld.1824
[3] Xu, PNAS(2020), https://doi.org/10.1073/pnas.1913716117
[4] Avila, Science(2011), https://science.sciencemag.org/content/333/6039/192

Contact

Daniel Morón Montesdeoca, FB4 (ZARM)
Email: daniel.moron@zarm.uni-bremen.de