Sujet de stage de Master 2

Laboratoire : Laboratoire de Mecanique des Fluides de Lille Kampé de Fériet

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Stage rémunéré : ☑Oui ☐ non

Elastic turbulence in curvilinear geometries

Présentation du sujet : One of the most remarkable effects of highly viscous polymer solutions that has been recently observed in experiments is the development of an *elastic turbulence* regime in the limit of strong elasticity. The flow of polymer solution in this regime displays irregularities typical of turbulent flows even at low velocity and high viscosity (i.e., for vanishing Reynolds number). As a consequence of turbulent motion at small scales, elastic turbulence can reveal as an efficient technique for mixing in very low Reynolds flows (e.g., in microchannels). Despite its great technological interest, elastic turbulence is still only partially understood from a fundamental point of view.
During this internship, we will explore the possibility to numerically generate elastic turbulence in curvilinear geometries (Fig. 1) that are relevant for applications. In particular, we will consider a 2D Taylor-Couette viscoelastic flow, either with or without a steady concentric cylinder, and an improvement of this setup that can better mimic the swirling flows employed in experiments. The analysis will focus on the statistical behavior of velocity fluctuations as a function of the flow elasticity and the polymer concentration.

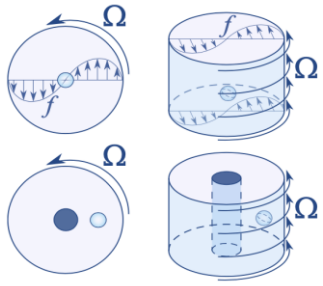

Figure 1: Schematics of the setup for numerical simulations. The geometry considered corresponds to 2D Taylor-Couette flow (bottom) or a generalisation of it, including a volume force (top), with imposed external wall rotation rate Ω.
Depending on the advancement of the work, it will be possible to extend the study to more realistic 3D flows.

This project is conceived as a first step towards the investigation of the phenomenon of *emulsification* in elastic turbulence. It is inscribed within a new collaboration between the laboratories LMFL and UML (Lille), in the broader framework of a joint work with experimental researchers in an international team. The simulations will be carried out using the open-source code OpenFoam in the laboratories in Lille, whose activities are centered on the topics of turbulence and computational fluid dynamics. The cutting-edge parallel numerical simulations required for this project will make use of the local servers and national clusters, and the master student will be granted access to such numerical resources by LMFL and UML. The database resulting from such simulations will be stocked on backup servers at LMFL and UML. The in-depth analysis of such data will provide a theoretical and numerical counterpart to the experimental work conducted by the research partners in Nantes and Liverpool, who are leading scientists in the fields of multiphase flows and complex fluids. The collaboration between the numerical and experimental groups will benefit from regular exchanges and meetings. A proposal for an ANR project is being submitted, to assure funding to pursue the research work during a PhD thesis.

Mots-clés : Fluid mechanics, Turbulence, Complex fluids, Numerical simulation.

Prérequis : Education in Fluid mechanics, Physics, Applied Mathematics. Good knowledge of fluid mechanics and an interest for numerical methods. Good knowledge of oral and written English is required. Knowing a programming language (Python, C, Fortran) would be a plus.