Elasto-inertial instabilities in a two-phase Taylor-Couette flow

It has been over 100 years since Osborne Reynolds discovered that turbulence in fluid flow is controlled by the inertia or momentum of the fluid. Indeed, Newtonian fluids are known to exhibit hydrodynamic instabilities and the transition to turbulence at large enough Reynolds numbers in which the influence of inertia becomes more important. In 2000, the seminal paper by Groisman and Steinberg reported for the first time a purely-elastic turbulence-like behaviour of polymer solution flows at negligible inertia and high relaxation-time-to-strain-rate ratios. Since then, the so-called elastic turbulence has attracted the attention of several research groups, who focused on unravelling the intricate mechanisms at the core of such a mixing-enhancing phenomenon at micro- and millimetric scale. Recently, a new state of chaotic flow, relying on the viscoelastic behavior of polymer solutions in inertial flows, has been uncovered. In this state, which has been called Elasto-Inertial Turbulence (EIT), the competition between elastic instabilities and flow's inertia can be conducted the dynamic and flow structure of such system. The goal of this project is to understand the physics at the core of such complex fluids, focusing on the EIT generated at the two-fluids interface emerging in a two-phase Taylor–Couette set-up (see fig. 1).

The objectives of this study include :

- Characterizing the elasto-inertial instabilities in a two-phase Taylor-Couette flow ;
- Characterizing the transition to different unstable regimes and the emergence of EIT.

The methods of investigations consist of :

- Experimental rheological and optical measurements ;
- Numerical simulations to modeling the whole process.

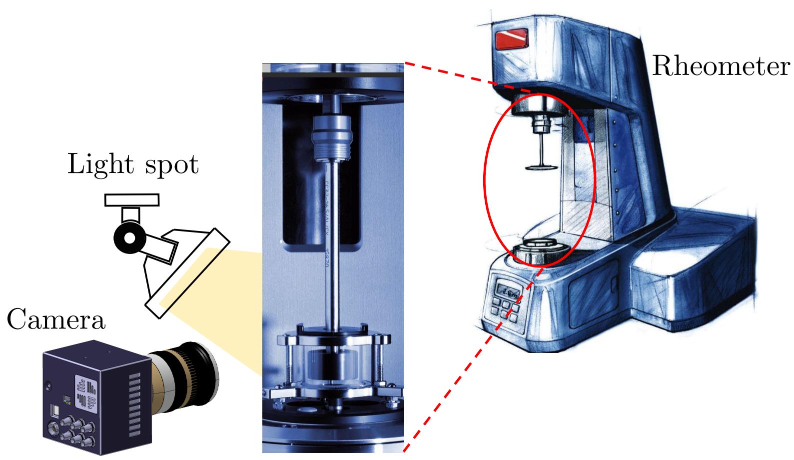

FIGURE 1 – *Two-phase Taylor–Couette flow. The viscoelastic liquid is at the bottom, while the Newtonian fluid is at the top. By rotating the inner cylinder, the flow becomes unstable and EIT emerges as dominant regime in the viscoelastic phase at the bottom.*

Project organisation, desired skills and applications

- The project will take place at ENSAM, Lille (Numerical approach, Francesco ROMANO) and IMT Nord Europe, Douai (Experiment approach, S. Amir BAHRANI), in close collaboration with University of Vermont, USA (Yves DUBIEF).
- Candidates having a background in Physics, Fluid Mechanics, Soft Matter, Process Engineering and Energetic and with an interest in both experiments and theoretical approach are invited to apply : (CV + Motivation letter + contact information of the references).
- Candidates are invited to contact :
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  S. Amir BAHRANI (associate professor, IMT Nord Europe, amir.bahrani@imt-nord-europe.fr).