Elastic turbulence in homogeneous and shear flows

Marco Edoardo Rosti*, Giulio Foggi Rota*, Christian Amor*,
Giovanni Soligo*, and Rahul Kumar Singh*

The addition of polymers to a fluid can result in chaotic motion even at vanishing inertia. Such a turbulence-like state arises due to elasticity of dissolved polymers, and is commonly referred to as Elastic Turbulence (ET)[1]. Studies on ET have been driven majorly by experiments, with direct numerical simulations only recently being used to reveal its more surprising features.

Here, we perform fully resolved 3D numerical simulations with the Oldroyd-B model in three different configurations with increasing level of complexity: a triperiodic flow with three homogeneous directions[2], a planar channel flow with two homogeneous directions[3,4], and a planar jet with one homogeneous direction[5,6], as shown in Figure 1. For all these cases, we consider a Reynolds number $Re = Uh/\nu$ (where U and h are the characteristic velocity and length scales of the problem, and ν the fluid total kinematic viscosity) sufficiently low such that the corresponding Newtonian flow is laminar, and a Deborah number $De = \lambda/\tau_f$ (where λ is the polymer relaxation time, and $\tau_f = h/U$ the typical large time scale of the flow) sufficiently high to sustain a fully developed turbulent state. At the conference, we will describe ET in these cases, highlighting their similaties and differences.

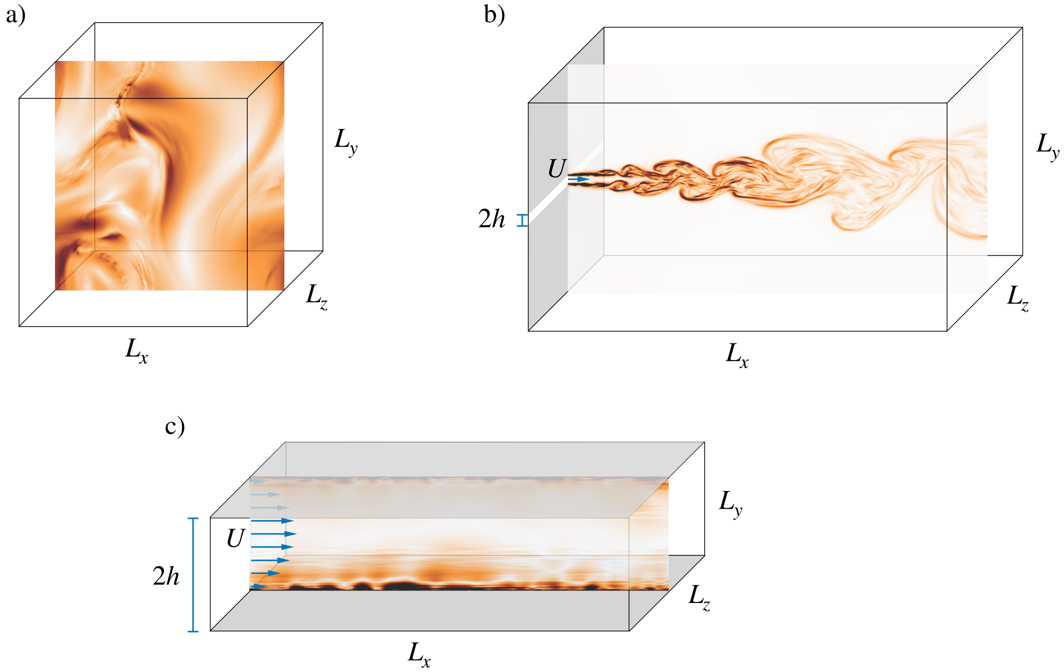

Figure 1: Sketch of the numerical simulations. The colour contours represent the magnitude of instantaneous vorticity fluctuations. **a)** Forced triperiodic homogeneous flow; **b)** planar jet; **c)** planar channel flow. The grey planes in **b)** and **c)** represent solid walls.

*Complex Fluids and Flows Unit, Okinawa Institute of Science and Technology Graduate University, Japan.

[1] Steinberg, *Annual Review of Fluid Mechanics* **53** (2021).
[2] Singh et al., *arXiv:2308.06997* (2023).
[3] Foggi Rota et al., *arXiv:2310.05340* (2023).
[4] Lellep, Linkmann and Morozov, *arXiv:2312.08091* (2023).
[5] Yamani et al., *Physical Review Letters* **127** (2021).
[6] Soligo and Rosti, *International Journal of Multiphase Flow* **167** (2023).