Time-dependent dynamics of 3D states in viscoelastic pressure-driven channel flow

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Dilute polymer solutions do not flow like Newtonian fluids. Their flows exhibit instabilities at very low Reynolds numbers that are driven not by inertia, but rather by anisotropic elastic stresses. Further increase of the flow rate results in a chaotic flow, often referred to as purely elastic turbulence. The mechanism of this new type of chaotic motion is poorly understood.

In this talk we present the first coherent state in purely elastic parallel shear flows. We consider a model shear-thinning viscoelastic fluid driven by an applied pressure gradient through two- and three-dimensional channels. By starting from a linearly unstable mode recently discovered by Khalid et al.[1] at very large flow rates and very low polymer dilution, we demonstrate that this instability sub-critically connects to significantly higher values of polymer concentration and lower flow rates[2], rendering these structures experimentally relevant The dynamics becomes unsteady upon embedding the 2D coherent state in a 3D domain, see Fig. 1 for an instantaneous snapshot, and the time-dependent dynamics is discussed. The characterisation of those 3D states suggests their strong connection to purely elastic turbulence.

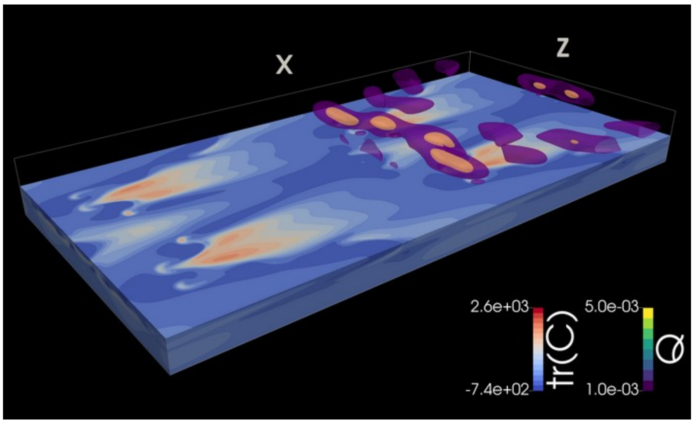

Figure 1: Instantaneous snapshot of 3D dynamics showing trace of conformational tensor and Q criterion (only shown partially).

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[1] Khalid et al., *Phys. Rev. Lett.* **127**, 134502 (2021)

[2] Morozov, *Phys. Rev. Lett.* **129**, 017801 (2022)