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Creating Turbulence with Polymers: Elastoinertia Turbulence in Taylor Couette flow

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Abstract

The addition of small amounts of polymers to turbulent flows has long been associated with drag reduction. More recently, polymer additives have been shown to give rise to new forms of turbulent-like flows, namely Elastic Turbulence and Elastoinertial Turbulence (EIT), which occur at Reynolds numbers significantly lower than those required for classical Newtonian turbulence. EIT arises from the interplay between fluid inertia and polymer-induced elastic stresses, resulting in complex transition pathways, intermittent flow states, and distinctive coherent structures that have attracted considerable research interest.

In this talk I will present our experimental studies on elastoinertial transitions in viscoelastic Taylor Couette flow. We employ solutions of polymers with different molecular weights and concentrations to probe the role of viscoelasticity on flow transitions. We characterise these flow transitions by means of flow visualisation and Particle Image Velocimetry (PIV). We show that viscoelasticity destabilises the flow, gradually leading to elastoinertial turbulence (EIT) through a series of flow transitions, and suppresses it above certain elasticity values. Shear thinning rheologies and suspended particles are found to modulate elastoinertial transitions. The work demonstrates the potential of polymeric flows to control and optimise industrial processes.