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Role of Elasto-Inertial Turbulence in Polymer Drag Reduction[1]
YVES DUBIEF, University of Vermont, SAMIR SID, VINCENT TERRAPON, University of Liege — Elasto-Inertial Turbulence (EIT) is a peculiar state of turbulence found in dilute polymer solutions flowing in parallel wall flows over a wide range of Reynolds numbers. At subcritical Reynolds numbers, appropriate boundary conditions trigger EIT, a self-sustaining cycle of energy transfers between thin sheets of stretched polymers and velocity perturbations, which translates into an increase of friction drag. For critical and supercritical Reynolds numbers, polymer additives may lead to significant drag reduction, bounded by the asymptotic state known as Maximum Drag Reduction (MDR). The present research investigates the role of EIT in the dynamics of critical and supercritical Reynolds number wall flows. Using high-fidelity direct numerical simulations of channel flows and the FENE-P model, we establish that (i) EIT is two-dimensional, (ii) the scales essential to the existence of EIT are sub-Kolmogorov, and (iii) EIT drives MDR at low and possibly moderate Reynolds number turbulent flows. These findings were validated in two different codes and using unprecedented resolutions for polymer flows.

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