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Dynamics of inertialess flows of viscoelastic fluids: the role of uncertainty MIHAILO JOVANOVIC, BINH LIEU, SATISH KUMAR, University of Minnesota — We use techniques from control theory to demonstrate high sensitivity of inertialess channel flows of viscoelastic fluids. To counter this sensitivity we explicitly account for modeling imperfections, such as the approximate nature of polymer constitutive equations, by quantifying their influence on transient and asymptotic dynamics. Our approach has strong connections to the analysis of pseudospectra of linear operators, and it exhibits the importance of streamwise-elongated flow patterns in viscoelastic fluids. For streamwise-independent flows with high elasticity numbers and finite Weissenberg numbers, We, we establish that the energy of velocity and polymer stress fluctuations scale as $O(We^2)$ and $O(We^4)$, respectively. This suggests that small amount of modeling uncertainty can destabilize nominally stable dynamics and promote transition to elastic turbulence. The underlying physical mechanism involves polymer stretching that introduces a lift-up of flow fluctuations similar to vortex tilting in inertia- dominated flows. The phenomenon examined here provides a possible route for the early stages of a bypass transition to elastic turbulence and might be exploited to enhance mixing in microfluidic devices.

Mihailo Jovanovic
University of Minnesota

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