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Subcritical shear-induced instabilities and turbulence of visco-elastic fluids

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While instabilities in normal Newtonian fluids are usually due to inertial effects, most visco-elastic instabilities are noninertial, i.e. happen at small Reynolds numbers. In polymeric fluids the viscoelastic instabilities and turbulence are due to shear-induced anisotropic elastic forces: when the so-called Weissenberg number is larger than about 1, a polymer fluid is very non-Newtonian: in this regime the fluid is anisotropic and elastic, and relaxation effects are important. After reviewing some recent experiments, I will discuss the recent progress on understanding the viscoelastic instabilities in parallel shear flows (planar Couette and Poiseuille flow). Contrary to common belief that such flows are absolutely stable in the small Reynolds number limit, our recent nonlinear amplitude analysis predicts that the transitions are subcritical. The critical Weissenberg number our analysis predicts is close to the values where in practice such flows are found to exhibit instabilities. The scenario suggested by these results shows strong resemblance to the transition to (weak) turbulence scenario in Newtonian shear flows.

A. N. Morozov and W. van Saarloos, *Subcritical finite-amplitude solutions in plane Couette flow of visco-elastic fluids*, Phys. Rev. Lett. **95**, 024501 (2005)