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Flow of Polymeric Solutions: Instabilities Microstructure

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Solutions of long and flexible polymer molecules do not flow like water. These fluids exhibit hydrodynamic instabilities and a new type of turbulence – the so-called *elastic turbulence* – even at low Reynolds numbers (Re). These phenomena, driven by the anisotropic elasticity of the fluid, are experimentally observed only in geometries with sufficient curvature. In this talk, I will discuss recent results on the flow of polymeric solutions in parallel shear geometries. I will present experimental evidence that parallel shear flows of polymer solutions, like flow in a straight pipe or channel, can be in fact non-linearly unstable even at low Re. We perform particle-tracking velocimetry in a long, straight microfluidic channel where we perturb the flow by placing a variable number of obstacles at the channel entrance. Above a critical flow rate and a critical size of the perturbation, a sudden onset of large velocity fluctuations indicates presence of a subcritical instability. Furthermore, Velocimetry measurements show non-periodic fluctuations in the wake of curved cylinders as well as in a parallel shear flow region. The flow in these two locations of the channel is excited over a broad range of frequencies and wavelengths, consistent with the main features of elastic turbulence. Together with the previous observations of hydrodynamic instabilities in curved geometries, our results suggest that any flow of polymer solutions becomes unstable at sufficiently high flow rates.