Transition to turbulence in Couette-Poiseuille flow

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The transition to turbulence in confined shear flow, like plane Couette flow and circular Poiseuille flow, is sub-critical. It is characterized by the coexistence of laminar and turbulent regions. The flow is organised in the form of turbulent spots in the transition regime. In order to study this scenario, an experimental setup has recently been constructed by combining plane Couette and plane Poiseuille flow to generate a zero mean flux flow in the channel [1]. The turbulent spots are advected with a velocity close to the mean velocity which is near zero in this setup. This allows us to measure the evolution of the spots for a long time with one single camera.

By using Particle Image Velocimetry (PIV), we characterize the flow inside turbulent spots, where streamwise streaks and rolls can be observed. We obtain experimental evidence of transient growth of turbulent spots introduced by external forcing localized in time and space. Experimental results for the maximal gain and the time when it occurs are compared to theoretical prediction [2]. At moderate Reynolds number, we observe large scale flows and oblique turbulent bands with an angle around 44° which is close to the numerical prediction in plane Poiseuille flow at $Re = 700$ [3].

We are currently employing a stereo-PIV system to measure 3D velocity fields and investigate quantitatively the traveling waves that have been observed in plane Poiseuille flow experiments [4].

Références

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