NEW EXPERIMENT IN TRANSITION TO TURBULENCE IN PLANE COUETTE-POISEUILLE FLOW

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We present a new experimental set-up which enables us to create two dimensional shear flow with zero mean advection velocity. Our concept ([1]) is a generalization of classical plane Couette experimental set-up (see [2], [3]), where the base flow is generated by imposing the velocity of opposite sign at each wall of the test section.

We investigate a plane Couette-Poiseuille configuration, completing the first experimental results for this flow which had only been studied theoretically to-date ([4]). This configuration consists of a single loop of plastic belt, which imposes the speed at one wall (the second one remains stationary) and generates the pressure gradient in the streamwise direction.

The resulting plane Couette-Poiseuille flow can be considered as two subregions. The first one is parabolic (Poiseuille like) and occupies approximately two-thirds of the gap. In the second region the velocity profile can be approximated by a straight line, like in plane Couette flow. In addition the shear in the Couette region is much higher than that of the Poiseuille region.

Using flow visualizations we characterize subcritical transition to turbulence. For low Reynolds numbers the flow is globally laminar in the test section. When we increase the Reynolds numbers we observe a nearly stationary v-shaped turbulent spot which is very slowly advected through the test section. The coexistence of laminar and turbulent phases is observed. Finally for high enough Reynolds numbers the turbulent region occupies most of the test section.

To our knowledge this is the first time when turbulent spots in plane Couette-Poiseuille flow are observed and when the advection velocity of turbulent structures in a flow with non-zero pressure gradient is so drastically reduced.

Building on this, we also introduce a finite-size perturbation to investigate a forced transition to turbulence. We observe two different scales which are associated with the plane Couette and Poiseuille regions respectively. We also determine the evolution of streamwise and spanwise dimensions of turbulent spot as a function of Reynolds number.

Références

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