

Transient Growth in Developing Plane and Hagen Poiseuille Flow

Peter W. Duck

Department of Mathematics, University of Manchester, UK

The problem of the stability of developing entry flow in both two-dimensional channels and circular pipes is investigated. The basic flow is generated by uniform flow entering a channel/pipe, which then provokes the growth of boundary layers on the walls, until (far downstream) fully developed (Poiseuille) flow is attained; the length for this development to be $O(\text{Reynolds number}) \times$ the channel/pipe width/diameter. This enables the use of high-Reynolds-number theory, leading to boundary-layer-type equations; as such there is no need to impose heuristic parallel-flow approximations. The resulting flow is shown to be susceptible to significant, three-dimensional transient (initially algebraic) growth in the streamwise direction, and as such large amplifications to flow disturbances are shown to occur (followed by ultimate decay far downstream). It is suggested that this initial amplification of disturbances is a possible mechanism for flow transition, with steady disturbances being the most 'dangerous'.

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