Jovanović, Mihailo R.; **Bamieh, Bassam**
Componentwise energy amplification in channel flows. (English) Zbl 1074.76016
J. Fluid Mech. 534, 145-183 (2005).

Summary: We study the linearized Navier-Stokes equations in channel flows from an input-output point of view by analysing their spatio-temporal frequency responses. Spatially distributed and temporally varying body force fields are considered as inputs, and components of the resulting velocity fields are considered as outputs of these equations. We show how the roles of Tollmien-Schlichting waves, oblique waves, and streamwise vortices and streaks in subcritical transition can be explained as input-output resonances of the spatio-temporal frequency responses. On the one hand, we demonstrate the effectiveness of input field components, and on the other, the energy content of velocity perturbation components. We establish that wall-normal and spanwise forces have much stronger influence on the velocity field than streamwise force, and that the impact of these forces is most powerful on the streamwise velocity component. We show this using the relative scaling of the different input-output system components with the Reynolds number. We further demonstrate that for the streamwise constant perturbations, the spanwise force localized near the lower wall has, by far, the strongest effect on the evolution of the velocity field.

MSC:

76E05 Parallel shear flows in hydrodynamic stability
76D05 Navier-Stokes equations for incompressible viscous fluids
76F06 Transition to turbulence

Keywords:

linearized Navier-Stokes equations; Tollmien-Schlichting waves; velocity perturbation

Full Text: DOI