JOHNS HOPKINS
Center for Environmental & Applied Fluid Mechanics

SPRING 2022 CEAFM SEMINAR SERIES

"Structured Input-Output Analysis of Transitional Wall-Bounded Flows"

Presented by Dr. Chang Liu

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Hosted by Prof. Dennice Gayme (JHU - MechE)

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Input-output analysis of transitional channel flows has proven to be a valuable analytical tool for identifying important flow structures and energetic motions. The traditional approach abstracts the nonlinear terms as forcing that is unstructured, in the sense that this forcing is not directly tied to the underlying nonlinearity in the dynamics. This work develops a structured input-output analysis to predict the structural features of transition-inducing perturbations in plane Couette flow (PCF) and plane Poiseuille flow (PPF). The results closely match those obtained from direct numerical simulation and nonlinear optimal perturbation analysis but are achieved using a linear analytical framework with vastly reduced computational costs. The proposed approach also captures the recently observed oblique turbulent bands that have been linked to transition in experiments and DNS with very large channel size. We then demonstrate the application of the structured input-output approach to stably stratified PCF and rotating PCF. Our analysis uncovers a relationship between the classical Miles-Howard stability criterion and a change in the most amplified flow structures when the Prandtl number is close to one. At higher Prandtl numbers they identify another quasi-horizontal flow structure that is shown to be principally associated with density perturbations. The results demonstrate the applicability of structured input-output analysis as a framework for analyzing a wide range of transitional wall-bounded shear flows.

Friday, April 22, 2022 at 3:00 PM (ET)
https://wse.zoom.us/j/93762992307