ETH zürich

Institute of Fluid Dynamics
Institute of Energy and Process Engineering

Colloquium Thermo- and Fluid Dynamics

Understanding flow instability in swirl flows: stability and information network analysis

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Jets with swirl are technologically important flows occurring in combustors of aircraft and rocket engines, gas turbine power generation systems, Delta wing aircraft etc. Vortex breakdown in these flows can lead to self-excited instability that can critically impact system operation. The most common type of instability in these flows is the precessing vortex core (PVC). In the first part of my talk, I will discuss the mechanism that creates the PVC its passively through flow geometry changes. This is an overview of key outcomes from collaborative work with the groups of Jacqueline O' Connor (Penn. State) and Ahmed Ghoniem (MIT), that combine experiments, stability analysis and large eddy simulation (LES) to identify the "wavemaker" region responsible for the PVC. In the second part of the talk, I will show recent results that combine ideas from graph and information theory to construct network representations of the dynamics in the same LES dataset. Using these novel information networks I will show that the PVC wavemaker can be identified, without resorting to traditional stability analysis. Therefore, these results suggest new analysis methods to understand large-scale coherent unsteadiness in complex practical flows where traditional stability analysis methods are typically intractable.

I'm an associate professor in the Department of Aerospace Engineering, Indian Institute of Science (IISc), Bangalore, India. I earned my Ph. D. in 2009 from the Lieuwen group in the department of aerospace engineering at Georgia Tech. and have been on the faculty at IISc since 2012. I serve as associate editor for the Proceedings of the combustion institute and as vanguard chair of the combustion, fuels and emissions committee of the ASME/IGTI (international gas turbine institute). I was a visiting fellow at Trinity College, Cambridge university, UK in 2022.
My research group's focus is broadly on uncovering new physical insights into reacting and non-reacting flows that are of relevance to space and aircraft propulsion. This work funded mainly by key industry OEMs in these areas. Our research combine stability analysis, large eddy simulations, data driven methods of various kinds along with experimental studies, to gain insight into the origins of large scale flow unsteadiness in industrially relevant turbulent flows and how it may be controlled.

Date: Wednesday, 12 June 2024
Time: 16:15 - 17:15h
Place: ETH Zurich, LEE E 101
Host: Prof. Nicolas Noiray

Further information: https://ifd.ethz.ch/events/ktf.html

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