DEPARTMENT OF MECHANICAL ENGINEERING WILLIAM MAXWELL REED SEMINAR SERIES

"Effect of transport property variation on high-speed flow transition"

Bijaylakshmi Saikia, Ph.D.
Indian Institute of Technology, Bombay

Abstract: Hypersonic vehicles fly at an extreme range of stagnation enthalpy, and the aero-thermodynamics associated with them involve strong shock waves, viscous shock layers and non-equilibrium thermo-chemistry. These multiple processes can influence laminar to turbulent transition in different ways. A turbulent boundary layer generates much higher friction and heat transfer, by factors of four or higher to the vehicle surface compared to a laminar boundary layer. The prediction of laminar to turbulent transition is an important concern since it decides the amount of aero-heating and skin friction drag, which in turn affect the vehicle weight and material, range, and payload capacity. For avoiding an overly conservative design margin for the thermal protection system it is crucial to predict the location and stream-wise extent of transition accurately.

Accurate prediction of laminar to turbulent transition in high-speed flows is a challenging task. Large changes in pressure, density, temperature, and gas composition, in the presence of chemical reactions can lead to significant non-monotonic variations in the transport properties of compressible flows. In the context of drag reduction, the role of transport property variation, mainly that of viscosity stratification, has been studied widely for incompressible as well as non-Newtonian flows. Changes in these properties can affect the stability characteristics of a high-Mach number flow differently due to the presence of additional instability modes compared to incompressible flows. Further, the variation of transport properties and the resulting effect on flow instabilities are dependent on the specific transport model used. The problem is exacerbated by the fact that stability results are often very sensitive to minute changes in the flow properties. This is a major disadvantage in studying the stability characteristics of high-speed flows, especially in the absence of a universally accepted transport model. In this talk, I will briefly discuss how the variations in the transport properties can affect the stability of wall-bounded and boundary layer flows at high-Mach numbers.

Bio: Bijaylakshmi Saikia received her Ph.D. from Indian Institute of Technology, Bombay in 2019 from the Department of Aerospace Engineering. During that period, she worked extensively in the areas of hypersonic boundary layer transition, computation of reacting non-equilibrium flows, shock-turbulence interaction in scramjet intakes, in addition to the studies associated with multi-jet interaction exhausting from under-expanded rocket nozzles. Her Ph.D. thesis deals with the stability analysis of wall-bounded and boundary layer flows at high Mach numbers and how these flows are affected by a minor variation in the transport properties in the flow. After graduation, she joined the Department of Mechanical Engineering at the University of Kentucky as a Postdoctoral Research Fellow. Currently, she is working with Dr. Christoph Brehm and Dr. Alexandre Martin in an ongoing NASA funded a research project, which conducts fluid-ablation interaction (FAI) simulations for Venus atmospheric entry.

Date: Friday, Sep. 6th
Place: CB 106

Time: 3PM
Contact: Dr. Alexandre Martin 257-4462

Meet the speaker and have refreshments
Attendance open to all interested persons

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