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Ph.D. DISSERTATION DEFENSE

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Date: Monday, April 17th, 2023
Time/Location: 1:00 p.m. / Gateway North, Corcoran Room 103
Title: Spectral Analysis of Hypersonic Boundary-Layer Instability

Chairperson: Dr. Nicholaus J. Parziale, Department of Mechanical Engineering, School of Engineering and Science

Committee Members: Dr. Hamid Hadim, Department of Mechanical Engineering, School of Engineering and Science
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ABSTRACT

Accurate prediction of the transition location from laminar to turbulent flow over hypersonic vehicles is necessary for the optimization of the vehicle's thermal protective systems. There are several instability phenomena that may affect the transition of a hypersonic boundary layer. In this work, the mechanisms that cause transition are experimentally investigated using focused laser differential interferometry (FLDI). Advancements to this flow diagnostic technique are made and the analytical results are validated with benchtop experiments. FLDI is used in low-enthalpy and high-enthalpy facilities to investigate the effects of wall-cooling on disturbance evolution. In the low-enthalpy facility, a multi-beam pair FLDI system is used to successfully measure the disturbance phase speed. The second-mode instability is measured and shown to have higher frequency content due to wall-cooling. In the high-enthalpy facility, bicoherence analysis is used to investigate the nonlinear interactions between spatially separated FLDI signals located inside and outside of the boundary-layer. Throughout this work, experimental results are supported with stability computations.