Aerospace and Mechanical Engineering Seminar

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Unsteady Features of Canonical Turbulent Shock-Boundary Layer Interactions

Shock-boundary layer interactions, or SBLIs, are complex flow features commonly experienced in high-speed flows, yet they remain poorly understood. In certain conditions, low-frequency unsteadiness observed in the separation shock is known to induce significant fluctuations in pressure and temperature. These perturbations can be detrimental to vehicle performance or even promote self-sustaining oscillatory mechanisms that may lead to vehicle failure. Various mechanisms have been proposed in literature to explain the origin of this low-frequency unsteadiness. These can be broadly grouped into either an upstream influence related to the incoming boundary layer being amplified within the SBLI, or an inherent instability in the downstream flow of the SBLI. The endeavor for a consensus across literature is limited by the fact that experimental studies typically focus on a specific configuration of SBLI (of which there are many) meaning comparisons across SBLI configurations are contaminated by inevitable influences of the test facility.

The work presented here represents a detailed experimental survey of SBLIs with various strengths and configuration types, all tested within the same supersonic blow-down wind tunnel facility at Imperial College London. The SBLIs are induced by either a compression ramp or an impinging oblique shock, and interact with the incoming Mach 2 turbulent boundary layer. Observations of the resultant SBLI are obtained using particle image velocimetry, fast-response pressure transducers and Schlieren photography. Results show commonality in high-frequency unsteadiness within the SBLI seemingly independent of the inducing mechanism, an observation reminiscent of Free Interaction Theory which observed a similar behavior in mean wall-pressure results. The low-frequency energy peak associated with the shock motion scales with the interaction strength and appears to be related to a local stability mechanism within the interaction that does not appear to be associated with unsteadiness of the incoming boundary layer or the separated region. Using an inviscid model based upon experimental data, the nature of the low-frequency shock dynamics is proposed, in agreement with indirect observations in literature.

Bio:

James Threadgill is a postdoctoral researcher in the University of Arizona Department of Aerospace and Mechanical Engineering. In 2009 he obtained his MEng degree in aeronautical engineering from the University of Bristol (United Kingdom), then proceeded to work in industry for three years at Lockheed Martin in the United Kingdom. Threadgill returned to academia in 2012 to pursue a PhD at Imperial College London (United Kingdom) under the supervision of Paul Bruce. His research interests focus upon experimental investigation of complex flow features experienced in high-speed compressible flows, specifically those within shock-boundary layer interactions. He came to the University of Arizona in April 2016 to work with Jesse Little investigating the influence of three-dimensionality in SBLIs.

AME Lecture Hall, Room S212
Thursday, Feb. 23, 2017
4 p.m.
Refreshments and socializing 3:45 p.m. at the east end of the AME Courtyard