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THE BURGERS PROGRAM FOR FLUID DYNAMICS
FLUID DYNAMICS REVIEWS SEMINAR SERIES

RESPONSE OF HYPERSONIC BOUNDARY-LAYER DISTURBANCES TO COMPRESSION AND EXPANSION CORNERS

Friday, April 9, 2021 | 11am - 12pm

Zoom link: https://umd.zoom.us/j/96193107619?pwd=-SUxpZVRrSGxaRUNaNFE2NzIwMXhKZz09

Meeting ID: 961 9310 7619
Password: 591368

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ABSTRACT

Hypersonic vehicle design is constrained by the increased thermo-mechanical surface loading which accompanies laminar-turbulent boundary-layer transition. In the low-disturbance environments typical of hypersonic flight, the path to transition on slender, smooth bodies is characterized by linear growth of instabilities within the boundary layer leading up to nonlinear modal interactions and breakdown, with a dominant instability mechanism being the Mack or second-mode. The outer mold line of true flight vehicles does not always consist of smoothly varying surfaces, however, and may exhibit sudden changes in geometry, e.g. at a control surface or intake.

To examine the impact of such abrupt surface changes on incoming laminar boundary-layer disturbances, an experimental investigation was conducted in the UMD Mach-6 HyperTERP shock tunnel. The test article consisted of a 5-degree half-angle, conical forebody with interchangeable afterbodies corresponding to flow deflections of -5 degrees (expansion) to +15 degrees (compression). Ultra-high-speed schlieren (440-822kHz) was employed as the primary means of flow interrogation, supplemented by high-speed surface pressure measurements. In all cases, second-mode energy from disturbances was observed radiating along the mean corner flow structure (shock or expansion). For large compression angles, where the flow separated upstream of the corner, shear-generated disturbances were observed distinct from the second-mode instabilities. The high frame rate enabled the use of a variety of spectral analysis techniques to provide a global view of the instability development. Spectral proper orthogonal decomposition was demonstrated as a powerful tool for resolving coherent flow structures related to the transition process. Finally, important nonlinear energy exchange mechanisms were identified through bispectral analysis.

BIO

Cameron Butler joined the High-speed Aerodynamics and Propulsion Lab at UMD in 2015 after obtaining his B.S. in Mechanical Engineering from the University of Virginia. The first few years of his graduate research were spent on the design and construction of HyperTERP, a reflected-shock tunnel operated by UMD. It is within this facility that his dissertation research was performed. Although predominantly an experimentalist, Cam is versed in CFD tools and interested in hybrid research approaches. Cam is broadly interested in hypersonic phenomena and supported by a National Defense Science and Engineering Fellowship.

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