UNIVERSITY OF MARYLAND

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CONVECTIVE AND GLOBAL INSTABILITIES OVER HYPERSONIC CONFIGURATIONS WITH FLOW SEPARATION

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Speaker

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ABSTRACT

Computations are performed to investigate the convective and global boundary-layer instabilities over cone-cylinder-flare at zero degrees angle of attack. The geometry model and flow conditions are selected to match the experiments conducted at the Boeing/AFOSR Mach 6 Quiet Tunnel (BAM6QT) at Purdue University. The BAM6QT maintains a laminar nozzle wall boundary layer, greatly reducing the freestream noise levels in comparison with conventional facilities and approximating those in the flight conditions. The cone-cylinder-flare experimental model consists of a nominally sharp 5 degrees half-angle cone, followed by a cylindrical segment and then a 10 degrees half-angle flare. Additionally, the flare half angles and the nosetip radii are varied to study their effects on the instability characteristics. An axisymmetric separation bubble is generated as a result of the laminar shock/boundary-layer interaction in the cylinder-flare region. The laminar flow solution and the amplification of disturbances are compared with the heat transfer, schlieren images, and surface pressure measurements, which helped to explain the appearance of low-frequency disturbances over the separation region. The global stability analysis (GSA) shows that the laminar flow becomes supercritical for flare half angles larger than 9 degrees. The unstable global mode for the experimental configuration of a 10 degrees flare corresponds to a stationary three-dimensional disturbances that is concentrated in the recirculation region and achieves its maximum growth rate for an azimuthal wavenumber between 5 and 6, which is well below the wavenumber of 36 measured by infrared thermography. However, the nonlinear evolution of the global mode reaches a saturated, three-dimensional solution, which azimuthal spectrum of the wall heat transfer shows dominance of the wavenumber 36 along the flare.

BIO

Dr. Pedro Paredes is a National Institute of Aerospace (NIA) Senior Research Engineer. He works in the Computational AeroSciences Branch at the NASA Langley Research Center in Hampton, VA. Dr. Paredes received his Ph.D. and M.Sc. in Aerospace Engineering from the Polytechnic University of Madrid. The research activities of Dr. Paredes are related to boundary layer transition (BLT) prediction and physics-based development of technology concepts for BLT control across the flight speed regimes.

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