Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Global stability analysis of oblique shock/boundary layer interactions at Mach 5.92[1] NATHANIEL HILDEBRAND, ANUBHAV DWIVEDI, PRAKASH SHRESTHA, JOSEPH W. NICHOLS, MIHAILO R. JOVANOVIC, GRAHAM V. CANDLER, University of Minnesota - Twin Cities — We investigate the mechanisms by which an oblique shock impinging on a hypersonic, laminar boundary layer can transition to turbulence. As the shock angle increases, the initially stable flow undergoes a three-dimensional bifurcation to instability. We apply Direct Numerical Simulation (DNS) and global stability analysis to characterize the frequency and spanwise wavenumber selected by this bifurcation. The compressible flow solver US3D was used to perform DNS as well as to construct steady, two-dimensional base flows. Direct and adjoint global modes were extracted about each base flow with the shift-and-invert Arnoldi method. Linear stability analysis was repeated for various shock angles to identify when the bifurcation occurs. An angle of 14 degrees resulted in unstable eigenvalues for spanwise wavenumbers around 0.32. The most unstable mode resides in the shear layer and creates streaks downstream. Multiplying this direct mode by its corresponding adjoint, we find the wave maker for this instability and show it's sensitive to changes near the reattachment point. We also use the adjoint modes to project DNS data on the direct modes to see their physical relevance.

[1]We are grateful to the Office of Naval Research for supporting this study through grant number N00014-15-1-2522.

Nathaniel Hildebrand
University of Minnesota - Twin Cities

Date submitted: 01 Aug 2016 Electronic form version 1.4