Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Global mode decomposition of supersonic impinging jet noise[1]

NATHANIEL HILDEBRAND, JOSEPH W. NICHOLS, University of Minnesota - Twin Cities — We apply global stability analysis to an ideally expanded, Mach 1.5, turbulent jet that impinges on a flat surface. The analysis extracts axisymmetric and helical instability modes, involving coherent vortices, shocks, and acoustic feedback, which we use to help explain and predict the effectiveness of microjet control. High-fidelity large eddy simulations (LES) were performed at nozzle-to-wall distances of 4 and 4.5 throat diameters with and without sixteen microjets positioned uniformly around the nozzle lip. These flow configurations conform exactly to experiments performed at Florida State University. Stability analysis about LES mean fields predicted the least stable global mode with a frequency that matched the impingement tone observed in experiments at a nozzle-to-wall distance of 4 throat diameters. The Reynolds-averaged Navier-Stokes (RANS) equations were solved at five nozzle-to-wall distances to create base flows that were used to investigate the influence of this parameter. A comparison of the eigenvalue spectra computed from the stability analysis about LES and RANS base flows resulted in good agreement. We also investigate the effect of the boundary layer state as it emerges from the nozzle using a multi-block global mode solver.

[1]Computational resources were provided by the Argonne Leadership Computing Facility.

Nathaniel Hildebrand
University of Minnesota - Twin Cities

Date submitted: 31 Jul 2015 Electronic form version 1.4