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aerospace engineering
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GRADUATE SEMINAR

A Computational Aeroacoustics Approach to Multi-Scale Problems: The Case of Jet Engine Acoustic Liner Simulation

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Place:	755 Baldwin Hall

ABSTRACT
Most aeroacoustics problems involve multiple length and time scales. In many of these problems, the intrinsic size and length scale of the noise sources are an order of magnitude smaller than the acoustic wavelength. This large disparity in length scales immediately leads to a classical multiple-scales problem. In other acoustic problems, they become multiple-scales because of a change in the dominant physics in different regions of the problem domain. The difference in dominant physics leads to a large difference in the pertinent length scales. An effective way to treat multiple-scales problems using the Multi-size-mesh Multi-time-step Dispersion-Relation-Preserving (DRP) scheme is discussed. This method uses different size mesh, appropriate for the local requirement, in different parts of the computation domain. The time step also changes accordingly. The use of multiple time steps concentrates most of the computation in the domains with the smallest time steps. This makes the computation very efficient. To illustrate the usefulness of the method, direct numerical simulation (DNS) of the flow and acoustic fields inside a normal incident impedance tube is considered. An impedance tube is used to measure the resistance and reactance of an acoustic liner. The acoustic liner problem is a multiple scales problem. DNS results at high sound intensity reveals that vortex shedding, whereby acoustic energy is converted into kinetic energy of the shed vortices which are subsequently dissipated by molecular viscosity, is a dominant mechanism of dissipation. Computed liner impedance over a wide range of frequencies and slit widths are found to compare well with experimental measurements.

BIOGRAPHICAL SKETCH
Dr. Tam is a Robert O. Lawton Distinguished Professor of Mathematics at the Florida State University. He is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA), the American Physical Society (APS) and the Acoustical Society of America (ASA). Dr. Tam has extensive research experience in aeroacoustics. He has published over 100 research papers in archival journals. For his many contributions to aeroacoustics, he was conferred the AIAA Aeroacoustics Award in 1987. Dr. Tam was a founding pioneer of Computational Aeroacoustics. He developed the Dispersion-Relation-Preserving (DRP) scheme, the Tam & Webb radiation and outflow boundary conditions, the artificial selective damping and numerous other CAA methods and algorithms.