Aerospace and Mechanical Engineering Seminar

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A Theoretical Prediction Method for Trapped Mode Flow-Acoustic Resonances in a Wind Tunnel with a Side Cavity

Cavity flow-acoustic resonances may occur when a fluid stream flows past a recessed cavity in a wall. These resonances may lead to high unsteady pressure levels. The resonance involves a coupling between the instability wave which propagates downstream on the shear-layer that spans the open face of the cavity, and acoustic waves that propagate back upstream inside and outside the cavity. These waves are coupled by the scattering processes at the ends of the cavity.

Previous theoretical research considered cavities in a wall that bounds an infinite stream. In many of the experiments on cavity resonances, however, the cavity is placed in a side wall of a wind tunnel. When the surrounding wind tunnel walls are not acoustically treated, the resonances can be very strong. Fang's research is a theoretical investigation of the case of a cavity in a side wall of a wind tunnel.

Recently, a mode trapping phenomenon has been proposed as an explanation for the very strong cavity resonances in the wind tunnel case. The mode trapping occurs when the critical frequency of a mode in the tunnel-cavity region is slightly lower than the critical frequency of the corresponding mode in the tunnel region. The region between these two critical frequencies is defined as a frequency window. Experiments show that very high pressure levels are observed in these frequency windows.

The goal of this research is to develop a global theory of cavity resonances in the wind tunnel geometry. The global theory couples solutions for the instability wave and the acoustic waves through scattering analyses at the ends of the cavity. Resonance frequencies, spatial mode shapes and linear growth rates are predicted. The theoretical predictions are consistent with experimental measurements and demonstrate that the mode trapping phenomenon explains the experimentally observed behavior.

Bio:

Ying Fang received a bachelor's degree from Nanjing Normal University in thermal energy and power engineering in 2003 and a master's degree from Nanjing University of Aeronautics and Astronautics in engineering thermophysics in 2007. She is pursuing a PhD at the University of Arizona under the supervision of professor Edward Kerschen.

AME Lecture Hall, Room S212
Thursday, March 2, 2017
4 p.m.
Refreshments and socializing 3:45 p.m. at the east end of the AME Courtyard