JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Weekly CEAFM Seminar: Fall 2012

100 YEARS
JOHNS HOPKINS ENGINEERING

Date: **Friday, December 7, 2012**

Time: 11:00 AM

Location: Gilman 50 (Marjorie M. Fisher Hall)

Speaker: **Dr. Xiaofeng Liu** (JHU | Mechanical Engineering)

Title: ***"Vortex-Corner Interactions in a Cavity Shear Layer Elucidated by Time Resolved Measurements of the Pressure Field"***

Abstract

The flow structure and turbulence in an open cavity shear layer at a Reynolds number of 4.0 x 10^4 is experimentally investigated using time resolved PIV, with an emphasis on interactions of the unsteady pressure field with the cavity corners. The pressure is obtained by spatially integrating the in-plane components of the measured material acceleration. (Liu, X., and Katz, J., 2006)

Conditional sampling, low-pass filtering and time correlations among variables enable us to elucidate two processes with distinctly different frequency ranges, which dominate the shear layer interactions with the corners. The first process, with Strouhal number range of 0.5-3.2, involves the traveling Kelvin-Helmholtz shear layer eddies. Their interactions with the trailing corner introduce two sources of vorticity fluctuations above the corner, i.e., the advected shear layer vorticity and the locally generated vorticity, with the latter one intrinsically associated with the local streamwise pressure gradients. The local vorticity production is strongly affected by the streamwise location of the large scale shear layer vortices, periodically creating a lingering region with peak vorticity and pressure minima just above the trailing corner, making the place there most prone to cavitation inception.

The second distinct unsteady flow process, with characteristic Strouhal numbers of ~0.05, is characterized by the low frequency flapping of the shear layer and the boundary layer upstream of the leading corner, periodically strengthening or weakening all of the flow and turbulence quantities around both the leading and the trailing corners. Time dependent correlations of the shear layer elevation show that the flapping starts from the boundary layer upstream of the leading corner and propagates downstream at the freestream speed. The high negative correlations of shear/boundary layer elevation with the streamwise pressure gradient above the leading corner introduce a plausible mechanism that sustains the flapping: When the shear layer is low, the boundary layer is subjected to high streamwise adverse pressure gradients that force it to widen, and when the shear layer is high, the boundary layer is subjected to favorable pressure gradients, causing it thin down. Flow mechanisms that would cause these pressure changes and their relation to the flow within the cavity will be discussed.