SMU Department of Mechanical Engineering

SEMINAR

"Experimental Investigation of Three-Dimensional Flows Induced by Vortex Ring Interactions with Oblique Boundaries"

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Location: Huitt-Zollars Pavilion

Abstract: Turbulent boundary layers have been widely studied due to the applicability of turbulent flows in engineering and related fields, and coherent structures in these boundary layers are of particular interest because of their role in generating and sustaining turbulence. Numerous studies have suggested a correlation between such coherent structures and vortex rings impinging on inclined surfaces, and though studies have examined vortex ring interactions with normal boundaries and with a limited number of oblique boundaries, the particular angles of collisions that lead to similarities with coherent structures in turbulent boundary layers have been largely neglected.

Here vortex ring interactions with oblique boundaries are studied experimentally to determine the effects of plate angle on the evolution of structures similar to those in turbulent boundary layers. Vortex rings were generated using a mechanical piston-cylinder vortex ring generator at jet Reynolds number 4000 and stroke length to piston diameter ratios of 0.75. The plate angle relative to the path of the vortex ring ranged from 3 to 75 degrees. Flow analysis was performed using planar laser induced fluorescence (PLIF), digital particle image velocimetry (DPIV), and defocusing digital particle tracking velocimetry (DDPTV).
To enhance three-dimensional analysis, a radial basis function (RBF) algorithm was developed to interpolated unstructured velocity data obtained using DDPTV onto a structured grid. To test the accuracy of this method, a study was conducted using data generated from a known analytical solution, to which the interpolation was compared. The beneficial properties of RBF interpolation, namely the suppression of noise amplification in gradients when compared to differencing methods, are illustrated by applying vortex identification criteria to unbounded vortex ring flows.

Bio: Lauren D. Couch is currently a Master's student in Mechanical Engineering at the Bobby B. Lyle School of Engineering at Southern Methodist University. She received a Bachelor of Science in Mechanical Engineering and a Bachelor of Science in mathematics from SMU in 2009. This presentation will be given as part of her Master's thesis defense, and upon completing her MSME, Lauren plans to pursue a Ph.D. focusing in biological applications of fluid dynamics.