Weekly CEAFM Seminar: Spring 2017

JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Date: **Friday, March 3, 2017**

Time: 11:00 AM

Location: Gilman Hall # 132

Speaker: **Prof. Stanislav Gordeyev** (University of Notre Dame)

Title: ***"The Use of Aero-Optical Effects to Investigate Boundary Layers"***

Abstract

Lasers provide an efficient way to focus light energy on a target and to provide very high rates of data transmission. Placing them on an airborne platform would give additional benefits of establishing fast free-space and secure communication links and other important applications. However, spatial-temporal density variations inside turbulent flow around an aircraft introduce distortions on the outgoing laser beam. These distortions, termed aero-optical effects, often result in unsteady beam motion and breaking of the beam potentially leading to significant losses of laser intensity on the target. Although aero-optical effects had been studied since the 1960s, only recently has the development of high-speed and accurate sensors allowed the direct collection of reliable spatially-temporally-resolved distortions (wavefronts). Knowing the distorted wavefronts, it is possible to calculate the far-field intensity pattern. On the other hand, a great deal of information about the flow itself is "imprinted" on these wavefronts. Also, the non-intrusive nature of the optical measurements makes it very attractive for studying high-speed flows where the number of useful sensors is limited, or for transitional flows where surface-mounted sensors might disrupt the natural evolution or the flow. In this presentation, I will briefly discuss wavefront sensors to study aero-optical effects and then discuss the relation between flow properties and the resulting aero-optical distortions. I will primarily focus on aero-optical distortions caused by both subsonic and supersonic turbulent boundary layers (TBL), and demonstrate the ability of optical measurements to extract important boundary layer characteristics (e.g. thickness, speed, etc). A physics-based model for aero-optical distortions will be presented and compared with experimental data. Finally, I will discuss recent studies of TBL large-scale structures using simultaneous velocity/wavefront measurements, which suggest a re-thinking of the importance of localized pressure variations and their connection to the large-scale structure in the TBL.