Weekly CEAFM Seminar: Fall 2017

JOHNS HOPKINS
Center for Environmental & Applied Fluid Mechanics

Date: **Friday, September 15, 2017**

Time: 11:00 AM

Location: Hodson Hall # 210

Speaker: **Prof. Joseph Klewicki** (University of New Hampshire)

Title: ***"Mean Equation Based Scaling Analysis of Fully Developed Turbulent Channel Flow with Uniform Heat Generation"***

Abstract

Multi-scale analysis of the mean equation for passive scalar transport is used to investigate the asymptotic scaling structure of fully developed turbulent channel flow subjected to uniform heat generation. Unlike previous studies of channel flow heat transport, the present configuration has a constant outward wall flux that accommodates for volumetrically uniform heat generation. This has distinct analytical advantages relative to precisely elucidating the underlying self-similar structure admitted by the mean transport equation. The present analyses are advanced using direct numerical simulations (Pirozzoli et al. 2016 *J. Fluid Mech.*, **788**) that cover friction Reynolds numbers up to 4088 and Prandtl numbers ranging from $Pr = 0.2$ to 1.0. The leading balances of terms in the mean equation are determined empirically and then analytically described. Consistent with its asymptotic universality, the logarithmic mean temperature profile is shown analytically to arise as a similarity solution to the mean scalar equation, with this solution emerging at large Reynolds number on an interior domain where molecular diffusion effects are negligible. In addition to clarifying the Reynolds and Prandtl number influences on the von Karman constant for temperature, k_θ, the present theory also provides a couple of self-consistent ways to estimate k_θ. As with previous empirical observations, the present analytical predictions for k_θ indicate values that are larger than found for the mean velocity von Karman constant. The origin of this is briefly described via examination of the $Pr = 1$ case.