Weekly CEAFM Seminar: Fall 2016

JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

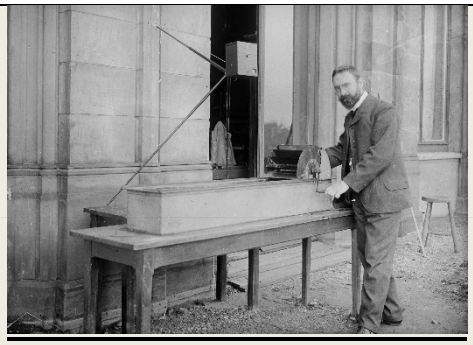
Date: **Friday, October 14, 2016**

Time: 11:00 AM

Location: Gilman Hall # 50

Speaker: **Prof. Gabriel G. Katul** (Duke University)

Title: ***"Co-Spectral Budgets Link Energy Distributions in Eddies to Bulk Flow Properties"***



Ludwig Prandtl (1904) with his fluid test channel (*left*).
Center for International Cooperation in Long Pipe Experiments (*right*).

Abstract: Connections are explored between spectral descriptions of turbulence and the mean velocity profile in wall-bounded flows using a budget for the co-spectral density. The co-spectrum is derived using a standard model for the wall normal velocity variance and a linear Rotta-like return-to-isotropy closure modified to include the isotropozition of the production for the pressure-strain effects. The approach establishes a relation between well-established constants such as the von Karṁan and Kolmogorov constants, and the Rotta constant known to vary with the flow configuration. Depending on the choices made about small-scale intermittency corrections, the logarithmic mean velocity profile or a power-law profile with an exponent that depends on the intermittency correction are derived thereby offering a new perspective on a long standing debate about the shape of the mean velocity profile in the equilibrium region[1]. The twice-integrated co-spectral budget with respect to scale and depth is then used to explain the variation in the friction factor with Reynolds number in smooth pipes[2] with attention to the switch from power-law (Blasius scaling) to log-law (Colebrook's formula).

References:

[1]Katul, G.G., A. Porporato, C. Manes, and C. Meneveau, 2013, Co-spectrum and mean velocity in turbulent boundary layers, *Physics of Fluids*, 25, 091702;
[2]Katul, G.G. and C. Manes, 2014, Cospectral budget of turbulence explains the bulk properties of smooth pipe flow, *Physical Review E*, 90, 063008