2012-2013

Special Seminar

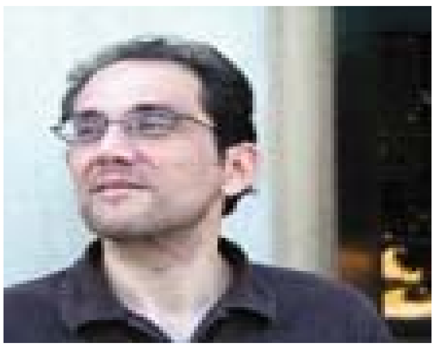
The Department of Mechanical Engineering – Engineering Mechanics

Proudly Presents

Gustavo Gioia

Okinawa Institute of Science and Technology Graduate University

Okinawa, Japan



Professor Gioia has lead a diverse research program in solid and fluid mechanics at University of Illinois for several years. He uses theory, experiments and computations to research problems related to the delamination and folding of thin solid films, configurational phase transitions in cellular materials and granular aggregates, the scaling of mechanical failure across disparate length scales, localized deformation in thermoviscoplastic solids, dense granular flows, shock-like effects in thin liquid films, turbulent friction, and the turbulent scouring of granular beds. Although these problems are often closely associated with engineering applications, Gioia is most interested in their fundamental rather than technological aspects. He has recently been hired by the highly prestigious Okinawa Institute of Science and Technology Graduate University, in Okinawa, Japan.

Thursday, Aug. 23, 2012 2:00 – 3:00 p.m. Room 112, ME-EM Bldg.

"Linking energy spectra and mean-velocity profiles in wall-bounded turbulent flows"

Two aspects of wall-bounded turbulent flows have been the subject of extensive, disjunct research efforts: average properties such as the frictional drag and the mean-velocity profile (MVP), and the energy spectrum of the turbulent fluctuations. In this talk we seek to establish a link between the MVP of a turbulent pipe flow and the energy spectrum of the turbulent fluctuations in the flow. The idea is to use this hitherto missing ``spectral link'' to help us shed new light on the MVP by building on the well-known structure of the energy spectrum. We start with a brief review of the energy spectrum. Next, we carry out a spectral analysis to identify the eddies that dominate the production of shear stress via momentum transfer. This analysis allows us to express the MVP as a functional of the spectrum. Each part of the MVP turns out to be related to a specific spectral range: the buffer layer to the dissipative range, the log layer to the inertial range, and the wake to the energetic range. The parameters of the spectrum set the thickness of the viscous layer, the amplitude of the buffer layer, and the amplitude of the wake. In the last part of the talk, we compare the three canonical wall--bounded flows: pipe flow, channel flow, and boundary layer flow. We show that the disparities among the MVPs of the three canonical flows can be traced to corresponding disparities among the attendant energy spectra. I will try to explain all the salient concepts from scratch; even if you are an undergraduate student, do not be intimidated! This research was carried out in collaboration with Pinaki Chakraborty, Carlo Zuniga, Nigel Goldenfeld, and Nicholas Guttenberg.

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