Mechanical & Aerospace Engineering

seminar

Multiscale Dynamics and Coherent Structures in Turbulent Flow

September 26, 2014 at 1:30pm in SCOB 210

abstract

Despite an enormous range of applications and centuries of scientific study, understanding and predicting the flow of fluids remains a tremendous challenge, particularly when the flow is chaotic or turbulent. Turbulent flows tend to be characterized by violent fluctuations, enormous numbers of strongly coupled degrees of freedom, and significant variability in space and time. But despite all this complexity, turbulence is not random. Rather, it tends to self-organize into striking but transient patterns and features that arise from nonlinear interactions. Some of these "coherent structures," such as strong vortices, are readily apparent; others are more subtle. But how much can we learn or predict about the flow from studying coherent structures? The answer may lie in the energetics of the flow, since these same nonlinearities couple dynamics on different scales and, in turbulence, drive a net transfer of energy from the scales at which it is injected into the flow to the scales at which it is dissipated. To begin to make quantitative links between the nonlinear dynamics of the flow and the spontaneous generation of spatiotemporal order, I will discuss experimental results from a quasi-two-dimensional turbulent flow. Using a filtering technique, we extract the spatially localized scale-to-scale flux of energy, and show that it is linked to suitably defined coherent structures.

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biosketch

Dr. Nicholas Ouellette is an Associate Professor in the Department of Mechanical Engineering & Materials Science at Yale University. His research focuses on understanding the behavior of complex systems far from equilibrium, and has included work on turbulent fluid flows, collective animal behavior, the erosion of granular materials, and active matter. He graduated from Swarthmore College in 2002 with majors in Physics and Computer Science, and earned his Ph.D. in Physics from Cornell University in 2006. Before coming to Yale, he did postdoctoral research at the Max Planck Institute for Dynamics and Self-Organization in 2006 and in the Physics Department at Haverford College from 2007-2008.