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SEMINAR

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February 13, 2003
304 Whitehead Hall
Refreshments: 3:30 p.m.
Seminar: 4:00 p.m.

WHAT'S SO SURPRISING ABOUT TURBULENT FLOW?

Abstract

In this talk I'll tell you about a weird phenomenon in classical fluids, e.g., air and water, when they become turbulent. The partial differential equation which describes such fluids is called the incompressible Navier–Stokes equation. As the viscosity of a Navier–Stokes fluid drops (relative to its mean velocity and the diameter of the flow domain), smooth laminar flow becomes unstable and the fluid motion instead becomes chaotic. Everyone has seen such turbulent flow in a pot of boiling water on the stove, or felt its effects now and then on airline flights. Unpleasant, to be sure, but what's so surprising? In fact, even though the energy dissipation term in the Navier–Stokes equation is proportional to viscosity, many experiments have shown that the mean dissipation in turbulent flow does not vanish even as viscosity tends to zero! Aside from posing a remarkable scientific puzzle, this enormous enhancement of energy loss by turbulent dissipation has big economic impacts, and one would like to understand it in order to control and eliminate it. I'll discuss here some attempts to explain this weird behavior on the basis of the zero-viscosity limit of the Navier–Stokes equation, the incompressible Euler equations, and "multifractal singularities" in its turbulent solutions. In particular, I'll review some rigorous mathematical work of the speaker and others on the anomalous conservation laws of singular Euler solutions.