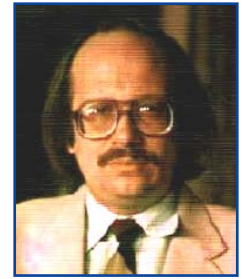


“Deterministic Turbulence – a Breakthrough in Fluid Mechanics and Philosophy”



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**Friday, May 1, 2:30 pm
Pickard Hall, Room 304**

Abstract:

Summary. The problem of existence of the deterministic wall turbulence is analyzed based on new experimental results. First, the definition of the deterministic turbulence is given. Second, a hypothesis on existence of such turbulence is made and substantiated. Third, the experimental results are presented, which show directly that the deterministic wall turbulence exists in nature and can be produced experimentally. Finally, it is shown that the deterministic-turbulence method provides unique possibilities for experimental and numerical turbulence research.

Definitions. Microscopic structure of the flow is an instantaneous spatial velocity field of fluid particles. Stochastic turbulence is the turbulence, which microscopic structure can not be reproduced repeatedly (although the average structure – can be reproduced). Deterministic (causal) turbulence is the turbulence, which microscopic structure can be reproduced repeatedly from one realization to another at reproduction of the same initial conditions for perturbations incoming into the boundary layer.

Hypotheses. Let assume that there are some fluid flows in which: (a) laws of flow evolution are fully deterministic (in particular, the molecular chaos does not play any significant role) and (b) stochastic flow properties result entirely from external perturbations amplified by various instabilities. Let also assume that if all instabilities in these flows are convective than the stochastic external perturbations may not have enough time to be amplified and the flow may remain deterministic even if it has become turbulent.

Results. Our experiments have shown that the post-transitional turbulent flow produced by controlled broadband perturbations remains mainly deterministic even when it becomes fully turbulent. Such flow can be simulated (modeled) experimentally and represents one of possible microscopic realizations of the turbulent flow (among infinite number of such instantaneous realizations), which possess all main average properties, characteristic of the wall turbulence. At the same time, the microscopic (instantaneous) structure of this turbulence remains basically deterministic and reproducible as many times as you want.

Conclusions.

1. Famous ancient Greek philosopher Heraclitus says (in modern interpretation): “..you could not step twice into the same river...”. (In other words, though the river stays the same the water in it is always changing.) Now we have shown that sometimes you can... This means that the same instantaneous turbulent “river” can be reproduced repeatedly. Thus, the deterministic wall turbulence does exist.

2. Such reproducibility of the discovered deterministic turbulence can be used extremely efficiently in turbulence research. Two examples of its application, devoted to turbulence structure and its control (for turbulent drag reduction), are presented in the lecture.

The Math Department will provide refreshments 30 min. prior to the presentation.