



Department of Mechanical and Aerospace Engineering

MAE SEMINAR SERIES

Low Order Flow Models: Mean Field Models, Finite Time Thermodynamics and Traveling Waves Too

Gilead Tadmor
Northeastern University

October 17, 2007, 2:00-3:30p.m., Phillips Hall, 7th Floor Conference Room #736

Abstract:

We shall review enablers for low order fluid flow models, motivated primarily by the needs for models accessible for feedback flow control design. In such models one aims at capturing key large scale features of flow dynamics, that may be relevant to actuation decisions, but is far less concerned with fine details than when the direct investigation of fluid mechanics is concerned. We shall review three examples of modeling frameworks: Mean field models capture the two way interactions between fast fluctuations and slow base flow variations in the Galerkin framework. The mean field model serves as a Galerkin model counterpart of the Reynolds stresses, it captures natural and actuated energy balance over attractors, and acts as a nonlinear mediator between high frequency actuation and lower frequency instabilities. Finite time thermodynamics (FTT) is a dynamic framework for the statistical physics closure for the first and second moments of the flow field based on reduced order Galerkin models. The FTT enables a statistical energy dynamics resolution, even where detailed instantaneous flow field representation is difficult, or unnecessary. Finally, the simplest framework consists of auxiliary traveling wave models that enable a robust coding of phase and amplitude relations between the sensor readings and periodic actuation. Auxiliary models provide an easy and robust implementation of feedback flow control. Simulation and experimental examples range from wake flows, the flow over airfoils and a backwards facing step to the free mixing layer and homogeneous shear turbulence.

Bio: Gilead Tadmor received his B.Sc. (1977) from Tel Aviv University and the M.Sc. (1979) and Ph.D. in (1984) degrees from the Weizmann Institute of Science, Israel, all in mathematics. In 1989 he joined Northeastern University where he is a professor at the departments of Electrical & Computer Engineering and Mathematics, and the Director of the Communications & Digital Signal Processing Center for Research and Graduate Studies. He has also held research, faculty and visiting positions at Tel Aviv University, Brown University, the University of Texas (Dallas), the Laboratory for Information and Decision Systems at M.I.T., SatCon Technology Corp., the Air Force Research Laboratory and the Technion. Dr. Tadmor's background is in the areas of robust and optimal control, distributed parameter systems, and mathematical systems theory. His recent active interests include robust and nonlinear control with applications in modeling and control of mechanical and fluid flow systems, dynamic imaging and neural systems.

Hosted by Professor R. Mittal: mittal@gwu.edu