THE BURGERS PROGRAM FOR FLUID DYNAMICS PRESENTS THE JOINT FLUID DYNAMICS REVIEW AND AEROSPACE ENGINEERING SEMINAR

THE RESTRICTED NONLINEAR MODEL: A MINIMAL MODEL FOR SELF-SUSTAINING TURBULENCE IN WALL BOUNDED SHEAR FLOWS

Thursday, March 8, 2018 | 3:00pm
2164 Martin Hall, DeWALT Seminar Room

Guest Speaker
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ABSTRACT
Understanding wall-turbulence is crucial to enabling technological advances in a wide range of applications. However, attaining the requisite knowledge has been hindered by the complexity of its mathematical description, the Navier Stokes equations. This talk describes one of a growing number of dynamical systems based models that have been proposed to address this challenge by studying important aspects of wall-turbulence in a simplified setting. The restricted nonlinear (RNL) model for wall-bounded turbulent flows is a quasi-linearization of the Navier-Stokes equations with a streamwise averaged mean flow; a choice motivated by experimental and analytical evidence of the central role of streamwise elongated coherent structures in these flows. Simulations of the RNL model at a range of Reynolds numbers are shown to support self-sustaining turbulence that naturally collapses to a minimal system supported by a small number of streamwise varying perturbations. We discuss the fact that RNL turbulence with accurate statistical features can be sustained even when the model is further restricted to a small number of appropriately selected streamwise varying modes interacting with the streamwise constant mean flow. The resulting ‘band-limited’ RNL system therefore constitutes an analytically and computationally attractive reduced order model for studying some of the key underlying mechanisms wall-turbulence. In particular, its study can inform mechanistic and control oriented models for engineering applications such as wind farm design.

BIO
Dennice F. Gayme is an Assistant Professor in Mechanical Engineering and the Carol Croft Linde Faculty Scholar at the Johns Hopkins University. She earned her B. Eng. & Society from McMaster University in 1997 and an M.S. from the University of California at Berkeley in 1998, both in Mechanical Engineering. She received her Ph.D. in Control and Dynamical Systems in 2010 from the California Institute of Technology. Her research interests are in modeling, analysis and control for spatially distributed and large-scale networked systems in applications such as wall-bounded turbulent flows, wind farms, power grids and vehicular networks. She was a recipient of the JHU Catalyst Award in 2015, a 2017 ONR Young Investigator award, and an NSF CAREER award in 2017.