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Title: Theory for turbulent-laminar patterns in Couette flow

Abstract: Turbulence in wall-bounded shear flows exhibits a remarkable phenomenon:
spatially periodic patterns of alternating turbulent and laminar flow emerge spontaneously from uniform turbulence as the Reynolds number is decreased. These patterns are ubiquitous in subcritical shear flows and explaining them has been a long-standing challenge for understanding the route to turbulence. From a dynamical systems viewpoint, these patterns are fascinating because they appear in a highly fluctuating, highly nonlinear state. Here we report on a model obtained from projecting the Navier-Stokes equations onto a few vertical modes, with closure coming from modelling Reynolds stresses and dissipation. The resulting two-dimensional PDE model is expressed in 4 fields describing the large-scale flow, and 1 or 2 fields describing the turbulent kinetic energy. The model can be viewed as a generalized and more fully justified version of the Barkley model for pipe flow. The model captures the transition to periodic turbulent-laminar patterns, as well as other spatiotemporal dynamics found in transitional turbulence. This work is joint with Santiago Benavides.

Speaker: Dwight Barkley