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Visualizing the geometry of state space in plane Couette flow

JOHN GIBSON, PREDRAG CVITANOVIĆ, JONATHAN HALCROW, Georgia Institute of Technology — Motivated by recent experimental and numerical studies of recurrent coherent structures in wall-bounded shear flows, we initiate a systematic exploration of the hierarchy of unstable invariant solutions of the Navier-Stokes equations. We construct a dynamical, 10^5-dimensional state-space representation of plane Couette flow at $Re = 400$ in a small, periodic cell and offer a new method of visualizing invariant manifolds embedded in such high dimensions. We compute the leading linearized stability exponents and eigenfunctions of known equilibria at this Reynolds number and cell size. What emerges from global continuations of their unstable manifolds is a surprisingly simple and elegant dynamical-systems visualization of low-Re turbulence. The invariant manifolds tessellate the region of state space explored by transiently turbulent dynamics with a rigid web of heteroclinic connections induced by the continuous and discrete symmetries.

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