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The computation of 2D unstable manifolds in models of turbulent shear flow

The publication of a landmark paper by Kawahara and Kida (2001) on the relevance of unstable periodic orbits to the dynamics of shear flow has initiated intense efforts to explain such phenomena as bursting and subcritical transition in terms of dynamical systems theory. Results similar to and stronger then those of Kawahara and Kida were since found in a variety of geometries, such as flow through pipes, ducts and channels. In all these geometries there exists a laminar flow profile which remains asymptotically stable up to high, sometimes infinite, Reynolds number. Thus, the onset of turbulence cannot be explained in terms of a straightforward bifurcation scenario as is often found in rotating or differentially heated flows. Instead, the relevant dynamical structures seem to be periodic orbits which live on the boundary of the domain of attraction of the laminar flow profile in phase space.

We can study the geometry of the basin boundary through the stable and unstable manifolds of such orbits. However, the computation of manifolds embedded in a high-dimensional phase space is a hard task. In this presentation I will show some recent results obtained with a low-order model of shear flow and, if time allows, with a full-fledged simulation of plane Couette flow.