RECURRENT FLOWS EMBEDDED IN 2D TURBULENCE

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Ideas from dynamical systems have recently provided fresh insight into transitional and weakly turbulent flows where the system size is smaller than the spatial correlation length. Viewing such flows as a trajectory through a phase space littered with invariant (`exact') solutions and their stable and unstable manifolds has proved a fruitful way of understanding such flows. It is therefore natural to ask whether any ideas attempting to rationalise chaos may have something to say about developed turbulence. One promising line of thinking in low-dimensional, hyperbolic dynamical systems stands out as a possibility - Periodic Orbit Theory. With this in mind, I will discuss long-time simulations of body-forced turbulence on a 2D torus with the purpose of extracting simple invariant sets or `exact recurrent flows' embedded in this turbulence. Each recurrent flow represents a sustained closed cycle of dynamical processes which underpins the turbulence. These are used to reconstruct the turbulence statistics in the spirit of Periodic OrbitTheory.

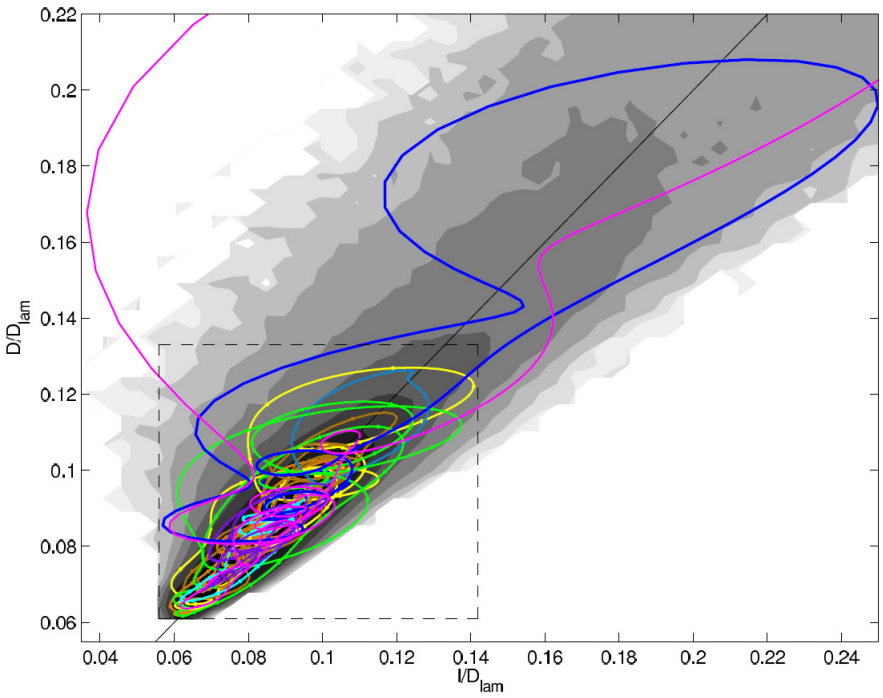

Figure 1. An example of recurrent flows buried in the turbulent attractor in 2D body-forced turbulence [1]. Dissipation D is plotted against energy input I (both normalised by the laminar value D_lam) for a small collection of the periodic orbits found (closed curves parametrised by time) with the pdf of the turbulence plotted in the background (darkest means most heavily visited).

References

[1] G. Chandler and R.R.Kerswell. Simple invariant solutions embedded in 2D Kolmogorov turbulence. *arXiv:1207.4682*