JOHNS HOPKINS
Center for Environmental & Applied Fluid Mechanics

FALL 2020 CEAFM VIRTUAL SEMINAR

"Learned Low-Dimensional Representations of Turbulence and Connections to Simple Invariant Solutions"

Presented by Prof. Jacob Page

School of Mathematics at the University of Edinburgh
Hosted by Tamer Zaki (JHU - MechE)

A long-standing challenge in low-order modelling is to design reduced representations of turbulent flows which are connected to the underlying dynamical system. In this talk I will describe how deep convolutional neural networks in a simple "autoencoder" configuration decompose snapshots of monochromatically forced, two-dimensional turbulence into a finite set of recurrent patterns which resemble the simple invariant solutions embedded in the turbulent attractor. The interpretation of the neural network embeddings is made possible by the application of "latent Fourier analysis", a decomposition of the low-dimensional latent representation of vorticity into a set of orthogonal modes parameterised by latent wavenumbers. Projections onto individual latent Fourier wavenumbers reveal the simple invariant solutions organising both the quiescent and bursting dynamics in a systematic way inaccessible to previous approaches. I will also discuss the use of latent Fourier analysis in an ongoing hunt for unstable periodic orbits.

Jacob Page obtained his PhD in fluid dynamics from Imperial College London in 2016, where he studied the dynamics of viscoelastic liquids under the supervision of Prof Tamer Zaki. He was awarded the ERCOFTAC Osborne Reynolds Prize and an EPSRC Doctoral Prize Fellowship for his doctoral work. He left Imperial to work as a postdoc with Prof Rich Kerswell on a variety of problems in the dynamical systems approach to turbulence, before being appointed the Sultan Qaboos Research Fellow in Mathematics at the University of Cambridge in 2019. He is now a new faculty member in the School of Mathematics at the University of Edinburgh. His interests include applications of machine learning to turbulence as well as the various types of chaotic motion that can be sustained when the working fluid is viscoelastic, and the implications for mixing.

Friday, September 25, 2020 at 12:00 PM (Noon)
https://wse.zoom.us/j/93762992307