

Dr Jonathan J. Healey

Results in time series analysis:

In Healey et al (1991) phase portraits are reconstructed from data measured from an electronic oscillator with nonlinear impedances. Nearly homoclinic orbits were found in which the trajectory passes close to a saddle fixed-point. A method was presented for estimating the eigenvalues of the saddle points. These eigenvalues control the behaviour of nearly homoclinic trajectories and explain the appearance of multiple periodic solutions, period doubling bifurcations and chaos, and so their measurement allowed a quantitative connection to be made between the abstract theory of homoclinic orbits and this particular physical system. Several features predicted by theory were observed that had not been seen in experiments before.

The eigenvalue methods were extended in Healey (1995a) and applied to data from a Taylor-Couette experiment (fluid flow between rotating cylinders), and it was found that there is a bi-focal saddle point, which sits in four dimensions and has two pairs of complex conjugate eigenvalues. Austin & Healey (2004a) developed an eigenvalue estimation technique based on wavelet transforms and applied it to the Taylor-Couette data, and also to data from a liquid-crystal experiment.

Much of the above work used a method based on the singular value decomposition of the trajectory matrix to improve signal-to-noise ratios. In the same way that the number of peaks in a Fourier spectrum can indicate the number of modes excited in a signal, the number of singular values can indicate the number of dimensions of the phase space supported by a signal. However, just as nonlinear interaction creates additional peaks in a Fourier spectrum, Healey (1994a) shows how nonlinear interaction creates additional singular values, and a method is presented for identifying these interactions, and used on wind-tunnel data to estimate a model dimension.

- Healey J.J., Broomhead D.S., Cliffe K.A., Jones R., Mullin T. 1991, *The origins of chaos in a modified van der Pol oscillator*. Physica D **48**, 322-339.
- Healey J.J. 1994a, *Identifying finite-dimensional behaviour from broad-band spectra*. Phys. Letts. A **187**, 59-66.
- Healey J.J. 1995a, *Time-series analysis of physical systems possessing homoclinicity*. Physica D **80**, 48-60.
- Austin J.C. & Healey J.J. 2004a, *Time series analysis of homoclinic nonlinear systems using a wavelet transform method*. Fluid Dyn. Res. **34**, 401-428.