Professor Alan Champneys
B.Sc.(Birm.), D.Phil.(Oxon.)

Professor of Applied Non-linear Mathematics

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Summary

- **Applied dynamical Systems**. Understanding complicated dynamics in physical systems governed byordinary, partial or lattice dierential equations in terms of bifurcation theory, especially global bifurcations (homoclinic and heteroclinic orbits). Bifurcation analysis of piecewise-smooth systems. Application to mechanical, civil, aero and eletrical engineering including rotating machines; valve dynamics; parametric resonance. Friction and impact modelling including the Painleve paradox.
- **Nonlinear waves and coherent structures**. Localised pattern formation ('homoclinic snaking') in Swift-Hohenberg and other models of bi-stable media. Application to nonlinear elastic buckling of cylinders, rods and struts. Application to ecology and biology. Solitary waves in fuids, solids and nonlinear optics.
- **Mathematical biology**. Modelling active hearing in the mammalian inner ear; the bio-mechanics of mosquito hearing and consequent swarming. Metabolomic modelling, especially within plant cells. Cellular pattern formation and polarity formation. Mathematical modelling of neuronal dynamics including the neural control of high blood pressure.
- **Mathematical modelling and industrial mathematics** Smart energy; tidal stream energy devices, economics of energy technology and market transition, power grid stability. Rotordynamics with application to drillstrings. Ecosystem feedback models. The dynamics of industrial supply networks. Design advice for pressure-relief valve instability prevention. Biosensor design. Digital healthcare using routinely collected ward data. Mutiscale modelling of hydroponic systems. Friction and impact modelling in industrial processes and sports science.

Biography

Brief Career History

- 1985-1988 BSc. in Mathematics, University of Birmingham Graduated with first class honours.
- 1988-1991 PhD. in Mathematics, Wadham College University of Oxford. Thesis title *The nonlinear dynamics of articulated pipes conveying fluid*, supervisor **T. Brooke Benjamin FRS.**
- 1992-1993 Postdoctoral Research Assistant in the School of Mathematical Sciences, University of Bath sponsored by the EPSRC (formerly SERC) on *Numerical computation of invariant manifold bifurcations.* Jointly supervised by **John Toland** and **Alastair Spence** .
- 1993- Lecturer in Nonlinear Systems. Department of Engineering Mathematics, University of Bristol. Reader since 1998. Professor since 2001.
- 1997-2002 EPSRC Advanced Fellowship

Expertise

Nonlinear dynamics and chaos and its application, particularly to engineering systems. Bifurcation theory, i.e. understanding abrupt changes from regular to complex dynamics. Application to rotor dynamics, aircraft bridges, flow-induced oscillation, parametric resonance in general including stabilisation 'upside down'. The theory of how continuous enterties give rise to localised response. For example, solitary waves, localised buckling patterns and 'kinks' or dislocations in atomic lattices. A unifying mathematical description of such phenomena, and dedicated computational techniques. Solitary waves in nonlinear optics. Localised pulses of light, so-called 'light bullets'. The mechanics of rods, such as helical buckling of cables, pipelines and DNA strands. Dynamics of piecewise systems,

such as impacts, switches and backlash.

- chaos
- resonance
- localisation
- nonlinear dynamics
- solitary wave
- dynamics of impact
- engineering instability

Memberships

Organisations

Department of Engineering Mathematics

Other sites

- Engineering

Recent publications

- McWilliams, C, Lawson, D, Santos-Rodriguez, R, Gilchrist, I, Champneys, A, Gould, T, Thomas, M & Bourdeaux, C, 2019, 'Towards a decision support tool for intensive care discharge: Machine learning algorithm development using electronic healthcare data from MIMIC-III and Bristol, UK'. *BMJ Open*, vol 9.
- Sterne, J, Shillan, D, Champneys, A & Gibbison, B, 2019, 'Use of machine learning to analyze routinely collected intensive care unit data: a systematic review'. *Critical Care*.
- Demirel, G, MacCarthy, BL, Ritterskamp, D, Champneys, A & Gross, T, 2019, 'Identifying dynamical instabilities in supply networks using generalized modeling'. *Journal of Operations Management*, vol 65., pp. 136-159
- Webster, M, Gambaruto, A & Champneys, A, 2019, 'Applying Director Theory to the Modelling of Fluid Flow in Straight and Curved Pipes'. in: *6th International Conference on Computational and Mathematical Biomedical Engineering - CMBE2019*. CMBE Proceedings
- Fontanela, F, Grolet, A, Salles, L, Chabchoub, A, Champneys, AR, Patsias, S & Hoffmann, N, 2019, 'Dissipative solitons in forced cyclic and symmetric structures'. *Mechanical Systems and Signal Processing*, vol 117., pp. 280-292
- Shaw, AD, Champneys, AR & Friswell, MI, 2019, 'Normal form analysis of bouncing cycles in isotropic rotor stator contact problems'. *International Journal of Mechanical Sciences*, vol 155., pp. 83-97
- Champneys, A, Dodwell, T, Groh, R, Hunt, G, Neville, R, Pirrera, A, Sakhaei, A, Schenk, M & Wadee, A, 2019, 'Happy Catastrophe: Recent Progress in Analysis and Exploitation of Elastic Instability'. *Frontiers in Applied Mathematics and Statistics*, vol 5.
- Wuyts, B, Champneys, AR, Verschueren, N & House, JI, 2019, 'Tropical tree cover in a heterogeneous environment: A reaction-diffusion model'. *PLoS ONE*, vol 14., pp. e0218151
- Webster, M, Gambaruto, A & Champneys, A, 2019, 'The potential of director theory to the application of cardiovascular modelling'.
- Shaw, AD, Champneys, A & Friswell, M, 2018, 'Normal form analysis of stator rub in rotating machinery'. *MATEC Web of Conferences*, vol 148.

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