THOMAS S. EAVES

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Appointments

- **University of Dundee, School of Science and Engineering** — Dundee, UK
  Lecturer in Environmental Fluid Mechanics and Renewables: Jan. 2020–Present
- **University of Oxford, Department of Physics** — Oxford, UK
  Visiting Researcher: Sept. 2019–Dec. 2019
  - with Dr. Andrew Wells
- **University of British Columbia, Department of Mathematics** — Vancouver, Canada
  Postdoctoral Research Fellow: Sept. 2016–Aug. 2019
  - with Prof. Neil Balmforth and Prof. Mark Martinez

Education

- **University of Cambridge, U.K.**
  - 2013–2016: **Ph.D. Applied Mathematics & Theoretical Physics**
    Supervisor: Prof. Colm-cille Caulfield
    Thesis title: Generalised nonlinear stability of stratified shear flows: adjoint-based optimisation, Koopman modes, and reduced models.
  - 2012–2013: **M.Math. (Part III) (with Distinction)**
    Thesis title: Instability and perturbation growth in stratified shear flows.
  - 2009–2012: **B.A. Mathematics (First Class)**
- **University of Dundee, U.K.**
  - 2021–2022: **Associate Module, PGCert Academic Practice in Higher Education** (expected 2022)

Research Focus

- **Simulation and categorisation of oceanographic mixing**
  - Developing a nonlinear diagnostic to analyse oceanographic observations of mixing.
  - Developing a linear diagnostic for distinguishing stratified shear flow instabilities.
  - Direct and contour simulation of the nonlinear dynamics of shear flow instabilities.
- **Dynamical systems interpretation of transition and turbulence in fluid flows**
  - Designing control schemes to guide turbulent flows towards low-drag states.
  - Investigating the effect of density stratification on nonlinear steady vortex solutions.
  - Analysing critical trajectories in state space that transition to turbulence.
- **Rheology of compressible and reactive porous media and application to wood-fibre paper-making**
  - Determining the compressional dewatering rheology of wood-fibre suspensions.
  - Working with industrial partners to model and design wood-fibre presses.
  - Migration of salt through sea-ice into overlying snow, for sea-ice thickness calibration.

Teaching and Mentoring

- **Lecturer** — University of Dundee, UK
  2020–Present
  Learning and Teaching Awards Finalist (Innovation), 2020
  Learning and Teaching Awards Nominee (Innovation), 2021
  - **EG11003 Science and Engineering Mathematics 1A (BEng Year 1)**: 2021/22.
    Introductory Mathematics (Algebra; Functions; Trigonometry; Vectors; Calculus).
  - **ME22002 Mechanics of Machines (BEng Year 2)**: 2019/20, 2020/21, 2021/22.
    Mathematics of Fundamental Mechanics (Rotation; Energy; Momentum; etc.); Applications to Machinery (Dynamic Balancing; Vibration; Mathematical Models of Gear Trains & Belt Drives).
  - **EG22010 Solid Mechanics (BEng Year 2)**: 2020/21, 2021/22.
    Introductory Solid Mechanics (Restraints; Stress and Strain; Shear Force; Bending Moments; Moments of Area; Bending Stresses; Torsion; Mohr's Circle; FMEA).
  - **ME30001 Engineering Design (BEng Year 3)**: Project Supervisor 2020/21, 2021/22.
    Designing a cheaper Lazy Susan. (Foodmek Ltd.)
    Tank design for growing algae on a production scale. (Foodmek Ltd.)
  - **CE40001 Civil Engineering Honours Project (BEng Year 4)**: Project Supervisor 2020/21.
    Power grids: identifying weak points likely to cause blackouts.
  - **CE40003/EV40001 Water Resources and Treatment (BEng/BSc Year 4)**: 2019/20, 2020/21.
    Water Treatment (Water Treatment Plants; Softening; Flocculation; Settling; Filtration).
  - **GA40001 Graduate Apprenticeship Civil Engineering Honours Project (BEng Year 4)**: Project Supervisor 2021/22.
    A comparison between offshore wind farm and tidal energy arrays.
  - **ME40005 Mechanical Engineering Honours Project (BEng Year 4)**:
    Project Supervisor 2020/21, 2021/22.
    Review of modern paper pressing technology and its modelling.
    Aerodynamics of a truck in a cross-wind.
    Unsteady flow effects on tidal turbine efficiency.
    Close approach of a tidal turbine blade to the seafloor.
  - **CE50007 Civil Engineering Research Project (MSc)**:
    Project Supervisor 2020/21.
    Assessment of the settling and deposition properties of organic wastes from fish farming.
  - **CE50033 Coastal Processes and Engineering Applications (MSc)**: 2019/20.
    Surface-wave Processes (Shoaling; Refraction; Diffraction; Reflection; Coastal Structures).
  - **ME53001 Industrial Placement Engineering Project (MSc)**:
    Project Supervisor 2019/20, 2020/21.
    Modelling the cooking time of steam-jacketed cooking vessels. (Foodmek Ltd.)
    Optimisation of electroplating to reduce thickness non-uniformity (Interplex PMP Ltd.)
    Selection and implementation of a Cobot for automotive manufacturing. (Interplex PMP Ltd.)

- **PhD Supervisor** — University of Dundee, UK
  2020–Present
  - Filip Jovanovic (matric. 2021) EPSRC DTP
    Primary Supervisor. Periodic forcing of chaotic dynamical systems: effect on unstable periodic orbits and statistics.
  - Saranraj Gururaj (matric. 2020) U. Dundee Scholarship
    Secondary Supervisor. Instabilities and mixing in partially stratified estuaries.

- **Advisor of Studies** — University of Dundee, UK
  Pastoral Advisor
  - BEng Mechanical Engineering: matric. 2020 – 1 student
  - BEng Mechanical Engineering with Renewables: matric. 2020 – 1 student
- **Lecturer** — University of British Columbia, Canada
  Postdoctoral Lecturer: 2017–2018
  Special commendation from the Dean, Faculty of Science, 2017, 2018
  - **MATH 256 Differential Equations (Engineering Mathematics Year 2)**: 2016/17, 2017/18. Differential Equations (First-order ODEs; Second-order ODEs; Systems of first-order ODEs; Laplace transforms; Fourier series; Separation of variables for PDEs).
- **Research Student Mentoring** — University of British Columbia, Canada
  Postdoctoral mentoring of graduate and undergraduate research
  - Daniel Paterson, PhD Candidate, Department of Chemical Engineering (now at AFT-Global)
  - Romain Mary, Undergraduate Research Visitor from ENSTA Paris (now at AVNIR Engineering)
- **College Teaching Assistant (Tutorials)** — St. John's College, University of Cambridge, UK
  2014–2016
  - **Methods (Mathematics Year 2)**:
    Further Differential Equations (Fourier series; Sturm–Liouville theory; Wave, heat and Laplace equations; Separable solutions of PDEs; Green's functions for ODEs and PDEs; Fourier transforms; Method of images).
- **Undergraduate Supervisor (Small-group teaching)** — St John's College, Churchill College, Fitzwilliam College, Emmanuel College, Murray Edwards College, University of Cambridge, UK
  2013–2016
  - **Methods (Mathematics Year 2)**
  - **Dynamical Systems (Mathematics Year 3)** :
    Essentials of Dynamical Systems (Phase portraits; Stability of fixed points and periodic orbits; Near-Hamiltonian flows; Stationary bifurcations; Hopf bifurcations; Bifurcations of maps; Definitions of chaos; Horseshoes).
  - **Asymptotic Methods (Mathematics Year 3)**:
    Introduction to Asymptotic Methods (Asymptotic sequences; Laplace's method; Stationary phase; Steepest descent; WKB and Liouville–Green).
  - **Mathematical Biology (Mathematics Year 3)**:
    Topics in Mathematical Biology (Discrete or continuous dynamical systems; Fixed points and stability; Master equations; Fokker–Planck equations; Similarity solutions; Travelling wave solutions; Turing instability).

Additional Research Experience

- **Woods Hole Oceanographic Institution** — Woods Hole, Massachusetts, USA
  Geophysical Fluid Dynamics Program Fellow: Jun.–Aug. 2015
  - Collaborator: Prof. Neil Balmforth
- **University of Cambridge, DAMTP** — Cambridge, UK
  Research Assistant: Jun.–Aug. 2012
  - Supervisor: Prof. John Lister

- **University of Cambridge, DAMTP** — Cambridge, UK
  Research Assistant: Jun.–Sep. 2011
  - Supervisors: Dr. Nathalie Vriend, Prof. Jim McElwaine, Prof. Stuart Dalziel

Publications

- **Published Manuscripts**

1. Paterson, D., Eaves, T. S., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2022: One-dimensional compression of a saturated elasto-visco-plastic medium. *Phys. Rev. Fluids* 7, 054303 (2022).
2. Pershin, A., Beaume, C., Eaves, T. S., and Tobias, S. M. 2022: Optimizing the control of transition to turbulence using a Bayesian method. *J. Fluid Mech.* 941, A25 (2022).
3. Paterson, D., Eaves, T. S., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2021: On two-phase modelling of dewatering of pulp suspensions. *AIChE J.* 67, e17277 (2021).
4. Eaves, T. S., Paterson, D., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2020: Dewatering saturated, networked suspensions with a screw press. *J. Eng. Math.* 120, 1-28 (2020).
5. Langham, J., Eaves, T. S. and Kerswell, R. R. 2020: Stably stratified exact coherent structures in shear flow: the effect of Prandtl number. *J. Fluid Mech.* 882, A10 (2020).
6. Paterson, D., Eaves, T. S., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2019: Flow-induced compaction of a fibrous porous medium. *Phys. Rev. Fluids* 4, 074306 (2019).
7. Eaves, T. S. and Balmforth, N. J. 2019: Instability of sheared density interfaces. *J. Fluid Mech.* 860, 145-171 (2019).
8. Ponetti, G., Balmforth, N. J. and Eaves, T. S. 2018: Instabilities in a staircase stratified shear flow. *Geophys. Astrophys. Fluid Dyn.* 112, 1-19 (2018).
9. Eaves, T. S. and Caulfield, C. P. 2017: Multiple instability of layered stratified plane Couette flow. *J. Fluid Mech.* 813, 250-278 (2017).
10. Eaves, T. S. and Balmforth, N. J. 2016: Noisy homoclinic pulse dynamics. *Chaos* 26, 043104 (2016).
11. Eaves, T. S. and Caulfield, C. P. 2015: Disruption of SSP/VWI states by a stable stratification. *J. Fluid Mech.* 784, 548-564 (2015).
12. Brun, P.-T., Audoly, B., Ribe, N. M., Eaves, T. S. and Lister, J. R. 2015: Liquid ropes: A geometrical model for thin viscous jet instabilities. *Phys. Rev. Lett.* 114, 174501 (2015).

Presentations

- **Conference Presentations**

1. Eaves, T. S., Paterson, D., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2020: A poro-elasto-visco-plastic model of the dewatering of a two-phase suspension, Interpore, *31-4 Jun. 2021*.
2. Eaves, T. S. 2020: Towards a categorisation of ocean mixing data sets, MASTS Marine Climate Change Forum, *1-10 Dec. 2020*. **Plenary.**
3. Eaves, T. S., Paterson, D., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2020: A poro-elasto-visco-plastic model of the dewatering of a two-phase suspension, APS DFD, *22-24 Nov. 2020*. **Invited.**
4. Eaves, T. S. and Salehipour, H. 2019: Flavours of stratified shear flows: algorithmic detection, APS DFD, *23-26 Nov. 2019*.

5. Eaves, T. S., Paterson, D., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2019: Dewatering saturated, networked suspensions with a screw press, APS DFD, *23-26 Nov. 2019*.
6. Eaves, T. S., Paterson, D., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2019: Compaction of fibrous porous media. Oxford Fluids Network Workshop: Large-Deformation Mechanics of Fluids with Complex Rheology, *22-23 Oct. 2019*.
7. Eaves, T. S. and Balmforth, N. J. 2019: Instability of sheared density interfaces. Bifurcations and Instabilities in Fluid Dynamics, *16-19 Jul. 2019*.
8. Eaves, T. S., Caulfield, C. P. and Mezić, I. 2019: Koopman operator theory for turbulence transition in plane Couette flow. SIAM Dynamical Systems, *19-23 May 2019*. **Invited.**
9. Paterson, D., Hewitt, D. R., Eaves, T. S., Balmforth, N. J. and Martinez, D. M. 2018: Flow-induced compaction of a fibrous porous medium I: from the coffee press to industrial machinery. APS DFD, *18-20 Nov. 2018*.
10. Eaves, T. S., Paterson, D., Hewitt, D. R., Balmforth, N. J. and Martinez, D. M. 2018: Flow-induced compaction of a fibrous porous medium II: gelling and Freeness. APS DFD, *18-20 Nov. 2018*.
11. Langham, J., Eaves, T. S. and Kerswell, R. R. 2018: Density homogenization of a stratified exact coherent structure at high Prandtl number. APS DFD, *18-20 Nov. 2018*.
12. Eaves, T. S. and Balmforth, N. J. 2017: Effect of Prandtl number and bulk Richardson number on the secondary nonlinear dynamics of the Taylor–Caulfield instability. APS DFD, *19-21 Nov. 2017*.
13. Eaves, T. S. and Balmforth, N. J. 2017: Secondary nonlinear dynamics of the Taylor–Caulfield instability. SIAM Pacific NW Conference, *27-29 Oct. 2017*. **Invited.**
14. Eaves, T. S., Caulfield, C. P. and Mezić, I. 2016: Transition to turbulence: highway through the edge of chaos is charted by Koopman modes. APS DFD, *20-22 Nov. 2016*.
15. Eaves, T. S. and Caulfield, C. P. 2016: Disruption of the vortex-wave interaction self-sustaining process in stratified plane Couette flow. Fields Institute Workshop on Extreme Events and Criticality in Fluid Mechanics, *25-29 Jan. 2016*.
16. Eaves, T. S. and Caulfield, C. P. 2015: Disruption of the vortex-wave interaction self-sustaining process in stratified plane Couette flow. APS DFD, *22-24 Nov. 2015*.
17. Eaves, T. S. and Caulfield, C. P. 2015: Minimal seeds for turbulence in stratified plane Couette flow. EUROMECH Colloquium 567: Turbulent mixing in stratified flows, U. Cambridge, Cambridge, UK, *22-25 Mar. 22-25*.
18. Eaves, T. S. and Caulfield, C. P. 2014: Nonlinear optimal perturbations of stratified plane Couette flow. APS DFD, *23-25 Nov. 2014*.
19. Caulfield, C. P. and Eaves, T. S. 2014: Multiple instabilities in layered stratified plane Couette flow. APS DFD, *23-25 Nov. 2014*.

- **Conference Posters**

1. Jovanovic, F. A. and Eaves, T. S. 2022: Periodic forcing of chaotic fluid systems. Scottish Fluid Mechanics Meeting, *26 May 2022*.
2. Eaves, T. S. and Caulfield, C. P. 2014: Nonlinear optimal perturbations of stratified plane Couette flow. IPAM Workshop, Mathematics of Turbulence IV: Turbulence in Engineering Applications, *17-21 Nov. 2014*.

- **Seminars**
  1. University of Bristol, Fluids and Materials Seminar Series, *17 Jun. 2021*.
  2. Marine Alliance for Science and Technology for Scotland (MASTS) **Public Webinar Series**, *3 Mar. 2021*. YouTube
  3. University of Strathclyde, Continuum Mechanics and Industrial Mathematics Seminar Series, *20 Oct. 2020*.
  4. Imperial College London, Aerodynamics and Control Seminar Series, *14 Oct. 2020*. Vimeo
  5. University of St Andrews, Applied Mathematics Seminar Series, *25 Sept. 2020*.
  6. University of Oxford, Mathematical Geoscience Seminar Series, *25 Oct. 2019*.
  7. Woods Hole Oceanographic Institution, Geophysical Fluid Dynamics Program, *24 Jul. 2019*.
  8. Philipps-Universität Marburg, Complex Systems Seminar Series, *30 Apr. 2019*.
  9. Woods Hole Oceanographic Institution, Geophysical Fluid Dynamics Program, *3 Aug. 2018*.
  10. University of British Columbia, Scientific Computing, Applied and Industrial Mathematics Seminar Series, *31 Oct. 2017*.
  11. University of British Columbia, Fluid Dynamics Seminar Series, *9 Mar. 2017*.
  12. University of Cambridge, G.K. Batchelor Laboratory Seminar Series, *30 May 2014*.

Service

- **Committee Membership**
  - School Internationalisation Committee (2020–Present)
    School planning committee for international student recruitment and conversion.
    Feedback of committee actions to Civil and Mechanical Engineering staff.
  - Short Life Working Group on Usage of Space (2021)
    Information gathering on office space requirements with the School.
    Designed a survey to gather staff opinions on office space and working post-Covid.
    Developed the survey using feedback from the group – survey used by the Dean.

- **PhD Examiner**
  - Internal Examiner: Lorna Dennison-Wilkins
    A study of human body movement in inland waterways

- **Peer Review**
  - Journal of Fluid Mechanics (18 manuscripts, plus revisions)
  - Physical Review Fluids (1)
  - Proceedings of the Royal Society A (1)
  - SIAM Journal on Applied Mathematics (1)
  - Physics Letters A (1)
  - ASME Offshore Mechanics and Arctic Engineering (1)
  - Applied Mathematical Modelling (1)
  - Journal of Waterway, Port, Coastal, and Ocean Engineering (1)

- **Seminar Organisation**
  - Organiser, G. K. Batchelor Laboratory Seminar Series, *2014.*
    Scheduled speakers, organised end-of-year event.

- **Outreach**
  - Math Mania Volunteer, University of British Columbia, *2018*.
    Interactive mathematics demonstrations, puzzles, and games, for primary-age children.
  - Fluid Dynamics Laboratory Demonstrator, Cambridge Science Festival, *2014*.
    Demonstration of vortex stretching and other fluids experiments.

- **Extended Research Visits**
  - Staff member, Geophysical Fluid Dynamics Program, Woods Hole Oceanographic Institution, *Summer 2018, 2019.*
  - Industrial collaboration, VTT Technical Research Centre of Finland, *Apr., Aug. 2019.*
  - Industrial seminars, Valmet Ltd (Montreal Canada, Sundsvall Sweden), *Multiple, 2016–2019*.

Academic Awards

- **Geophysical Fluid Dynamics Fellowship** at the GFD Program, Woods Hole Oceanographic Institution, USA, *Jun.–Aug. 2015*
- **Sims Scholarship for PhD** University of Cambridge, UK, *Oct. 2013 – Sept. 2016*
- **Dirac Prize for High Performance in Part III (Master's Degree)** St John's College, University of Cambridge, UK, *Oct. 2013*
- **Ian Hall Prize for High Performance in Part II (Bachelor's Degree)** St John's College, University of Cambridge, UK, *Oct. 2012*
- **Horne Scholarship for High Performance** St John's College, University of Cambridge, UK, *Oct. 2010 – Sept. 2016*

Additional Information

- Proficient in programming in Fortran and Matlab.
- Professional affiliations: member of the American Physical Society (APS), member of the Society for Industrial and Applied Mathematics (SIAM), member of the British Society of Rheology (BSR).
- Citizenship: United Kingdom.

References

- **Prof. Jonathan A. Knappett** — U. Dundee (Civil Engineering)

  Mailing address: School of Science & Engineering
  Fulton Building
  Dundee DD1 4HN
  United Kingdom

  Telephone: +44 (0)1382 384345

  Email: J.A.Knappett@dundee.ac.uk

- **Prof. Neil J. Balmforth** — U. British Columbia (Mathematics)

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  Room 121, 1984 Mathematics Road
  Vancouver, BC V6T 1Z2
  Canada

  Telephone: +1 (604) 822 3034

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- **Prof. Colm-cille P. Caulfield** — U. Cambridge (Applied Mathematics)

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