

DAVID J.W. SIMPSON

School of Fundamental Sciences
Massey University
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EDUCATION

- **Ph.D.** Applied Mathematics, University of Colorado at Boulder, December 2008
- **M.Sc.** Applied Mathematics, University of Auckland, May 2004
- **B.Sc.** Mathematics and Statistics, University of Auckland, May 2002

EMPLOYMENT

- **Senior Lecturer of Mathematics** January 2017 – present
Lecturer of Mathematics August 2012 – December 2016
School of Fundamental Sciences,
Massey University, Palmerston North, New Zealand
- **Post-Doctoral Fellow** August 2009 – August 2012
Department of Mathematics and Institute of Applied Mathematics,
University of British Columbia, Vancouver, Canada
- **Lecturer and Research Associate** January – August 2009
Department of Applied Mathematics,
University of Colorado, Boulder, Colorado, USA

AWARDS AND INVITATIONS

- NZMS Research Award December 2019
– Given to (usually) one NZ mathematician per year for excellence in research.
- Marsden Grant (MAU1809) November 2018
– Principal Investigator for NZ\$500,000 project titled: *Organised chaos: Using geometry to explain robust chaotic dynamics in switched dynamical systems.*
- ICTS Invited Lecturer June 2018
– Awarded travel, accommodation, and living costs to give a series of lectures and tutorials in the *Summer Program on Dynamics of Complex Systems* held at ICTS (International Centre for Theoretical Sciences), Bangalore, India.
- Massey University International Visitors Research Fund May 2017
– Awarded NZ\$2976 to host Prof. Paul Glendinning (University of Manchester) for collaborative research.
- Simons Visiting Researcher February–March 2016
– Awarded travel, accommodation, and living costs for five weeks by the Simon's Foundation to participate in the research program *Advances in Nonsmooth Dynamics* held at the *Centre de Recerca Matemàtica*, Barcelona, Spain.
- NZMS Early Career Award December 2014
– Given to one NZ early career mathematician per year for excellence in research.
- Massey University Early Career Researcher Award March 2013
– Awarded NZ\$5000 to visit the University of Bristol to establish an on-going collaborative research project.

BOOKS

- D.J.W. Simpson. Bifurcations in Piecewise-Smooth, Continuous Systems. Volume 70 of *Nonlinear Science*. World Scientific, Singapore, 2010.

RESEARCH PUBLICATIONS

- 1) P.A. Glendinning and D.J.W. Simpson. Robust Chaos and the Continuity of Attractors. *Transactions of Mathematics and Its Applications*, To appear.
- 2) D.J.W. Simpson. Chaotic Attractors from Border-Collision Bifurcations: Stable Border Fixed Points and Determinant-Based Lyapunov Exponent Bounds. *NZJM*, To appear.
- 3) D.J.W. Simpson. The Stability of Fixed Points on Switching Manifolds of Piecewise-Smooth Continuous Maps. *J. Dyn. Diff. Equat.*, To appear.
- 4) D.J.W. Simpson. Unfolding Codimension-Two Subsumed Homoclinic Connections in Two-Dimensional Piecewise-Linear Maps. *Int. J. Bifurcation Chaos*, 30(3):2030006, 2020.
- 5) D.J.W. Simpson. Hopf-Like Boundary Equilibrium Bifurcations involving Two Foci in Filippov Systems. *J. Diff. Eq.*, 267(11):6133–6151, 2019.
- 6) H.A. Al Fran, D.J.W. Simpson and C.P. Tuffley. Characterisation and Classification of Signatures of Spanning Trees of the n -Cube. *Australas. J. Combin.*, 75(3):259–295, 2019.
- 7) D.J.W. Simpson. A General Framework for Boundary Equilibrium Bifurcations of Filippov Systems. *Chaos*, 28(10):103114, 2018.
- 8) D.J.W. Simpson. A Compendium of Hopf-Like Bifurcations in Piecewise-Smooth Dynamical Systems. *Phys. Lett. A.*, 382(35):2439–2444, 2018.
- 9) M.R. Jeffrey, G. Kafanas and D.J.W. Simpson. Jitter in Dynamical Systems with Intersecting Discontinuity Surfaces. *Int. J. Bifurcation Chaos*, 28(6):1830020, 2018.
- 10) D.J.W. Simpson. The Structure of Mode-Locking Regions of Piecewise-Linear Continuous Maps: II. Skew Sawtooth Maps. *Nonlinearity*, 31(5):1905–1939, 2018.
- 11) D.J.W. Simpson and R. Kuske. The Influence of Localised Randomness on Regular Grazing Bifurcations with Applications to Impacting Dynamics. *J. Vib. Contr.*, 24(2):407–426, 2018.
- 12) D.J.W. Simpson. Grazing-Sliding Bifurcations Creating Infinitely Many Attractors. *Int. J. Bifurcation Chaos*, 27(12):1730042, 2017.
- 13) D.J.W. Simpson and C.P. Tuffley. Subsumed Homoclinic Connections and Infinitely Many Coexisting Attractors in Piecewise-Linear Maps. *Int. J. Bifurcation Chaos*, 27(2):1730010, 2017.
- 14) D.J.W. Simpson. The Structure of Mode-Locking Regions of Piecewise-Linear Continuous Maps: I. Nearby Mode-Locking Regions and Shrinking Points. *Nonlinearity*, 30(1):382–444, 2017.
- 15) D.J.W. Simpson. The Instantaneous Local Transition of a Stable Equilibrium to a Chaotic Attractor in Piecewise-Smooth Systems of Differential Equations. *Phys. Lett. A*, 380(38):3067–3072, 2016.
- 16) D.J.W. Simpson. Unfolding Homoclinic Connections formed by Corner Intersections in Piecewise-Smooth Maps. *Chaos*, 26:073105, 2016.
- 17) D.J.W. Simpson. Border-Collision Bifurcations in \mathbb{R}^N . *SIAM Rev.*, 58(2):177–226, 2016.
- 18) D.J.W. Simpson and M.R. Jeffrey. Fast Phase Randomisation via Two-Folds. *Proc. R. Soc. A*, 472(2186):20150782, 2016.
- 19) D.J.W. Simpson and R. Kuske. Stochastic Perturbations of Periodic Orbits with Sliding. *J. Nonlin. Sci.*, 25(4):967–1014, 2015.
- 20) D.J.W. Simpson and R. Kuske. The Positive Occupation Time of Brownian Motion with Two-Valued Drift and Asymptotic Dynamics of Sliding Motion with Noise. *Stoch. Dyn.*, 14(4):1450010, 2014.
- 21) D.J.W. Simpson and R. Kuske. Stochastically Perturbed Sliding Motion in Piecewise-Smooth Systems. *Discrete Contin. Dyn. Syst. Ser. B*, 19(9):2889–2913, 2014.
- 22) D.J.W. Simpson. On the Relative Coexistence of Fixed Points and Period-Two Solutions near Border-Collision Bifurcations. *Appl. Math. Lett.*, 38:162–167, 2014.

- 23) D.J.W. Simpson. Scaling Laws for Large Numbers of Coexisting Attracting Periodic Solutions in the Border-Collision Normal Form. *Int. J. Bifurcation Chaos*, 24(9):1450118, 2014.
- 24) D.J.W. Simpson. Sequences of Periodic Solutions and Infinitely Many Coexisting Attractors in the Border-Collision Normal Form. *Int. J. Bifurcation Chaos*, 24(6):1430018, 2014.
- 25) M.R. Jeffrey and D.J.W. Simpson. Non-Filippov Dynamics Arising from the Smoothing of Nonsmooth Systems, and its Robustness to Noise. *Nonlinear Dyn.*, 76(2):1395–1410, 2014.
- 26) D.J.W. Simpson. On Resolving Singularities of Piecewise-Smooth Discontinuous Vector Fields via Small Perturbations. *Discrete Contin. Dyn. Syst.*, 34(9):3803–3830, 2014.
- 27) D.J.W. Simpson, J. Hogan and R. Kuske. Stochastic Regular Grazing Bifurcations. *SIAM J. Appl. Dyn. Sys.*, 12(2):533–559, 2013.
- 28) D.J.W. Simpson and J.D. Meiss. Aspects of Bifurcation Theory for Piecewise-Smooth, Continuous Systems. *Phys. D*, 241(22):1861–1868, 2012.
- 29) D.J.W. Simpson, R. Kuske and Y.-X. Li. Dynamics of Simple Balancing Models with State Dependent Switching Control. *J. Nonlin. Sci.*, 22(2):135–167, 2012.
- 30) D.J.W. Simpson and R. Kuske. Mixed-Mode Oscillations in a Stochastic Piecewise-Linear System. *Phys. D*, 240:1189–1198, 2011.
- 31) D.J.W. Simpson and J.D. Meiss. Resonance near Border-Collision Bifurcations in Piecewise-Smooth, Continuous Maps. *Nonlinearity*, 23(12):3091–3118, 2010.
- 32) D.J.W. Simpson and J.D. Meiss. Simultaneous Border-Collision and Period-Doubling Bifurcations. *Chaos*, 19(3):033146, 2009.
- 33) D.J.W. Simpson and J.D. Meiss. Shrinking Point Bifurcations of Resonance Tongues for Piecewise-Smooth, Continuous Maps. *Nonlinearity*, 22(5):1123–1144, 2009.
- 34) D.J.W. Simpson, D.S. Kompala and J.D. Meiss. Discontinuity Induced Bifurcations in a Model of *Saccharomyces cerevisiae*. *Math. Biosci.*, 218(1):40–49, 2009.
- 35) D.J.W. Simpson and J.D. Meiss. Unfolding a Codimension-Two Discontinuous Andronov-Hopf Bifurcation. *Chaos*, 18(3):033125, 2008.
- 36) D.J.W. Simpson and J.D. Meiss. Neimark-Sacker Bifurcations in Planar, Piecewise-Smooth, Continuous Maps. *SIAM J. Appl. Dyn. Sys.*, 7(3):795–824, 2008.
- 37) B. Marts, D.J.W. Simpson, A. Hagberg and A.L. Lin. Period Doubling in a Periodically Forced Belousov-Zhabotinsky Reaction. *Phys. Rev. E*, 76(2):026213, 2007.
- 38) D.J.W. Simpson and J.D. Meiss. Andronov-Hopf Bifurcations in Planar, Piecewise-Smooth, Continuous Flows. *Phys. Lett. A*, 371(3):213–220, 2007.
- 39) D.J.W. Simpson, V. Kirk and J. Sneyd. Complex Oscillations and Waves of Calcium in Pancreatic Acinar Cells. *Phys. D*, 200:303–324, 2005.

 OTHER PUBLICATIONS

- 1) M.E. Roberts, C. Kueh, E. Greenbank, D. Clarke, S. van Hove, D.J.W. Simpson, A. Williams and J. Williams. Modelling the Mechanical Action of a Front Loading Washing Machine. *ANZIAM J.*, 59: M30–M62, 2019.
- 2) D.J.W. Simpson. Open Problems on Border-Collision Bifurcations. In: Colombo A., Jeffrey M., Lázaro J., Olm J. (eds). *Extended Abstracts Spring 2016*. 8:163–166, 2017.
- 3) D.J.W. Simpson. Piecewise-Linear Maps: Intricate Dynamics with Explicit Solvability. *NZMS Newsletter*, 125:8–10, 2015.
- 4) D.J.W. Simpson. DSWeb Media Gallery. 2014.
<http://www.dynamicalsystems.org/pi/fr/detail?item=140>
- 5) D.J.W. Simpson and D.S. Kompala. *Mathematica Demonstrations*. 2008-2009.
<http://demonstrations.wolfram.com/author.html?author=David+J.+W.+Simpson>
- 6) D.J.W. Simpson. *Bifurcations in Piecewise-Smooth, Continuous Systems*. PhD thesis, University of Colorado. 2008.

- 7) D.J.W. Simpson. A Bifurcation Analysis of a Mathematical Model of Intracellular Calcium Waves. Master's thesis, University of Auckland. 2004.

SUPERVISORY EXPERIENCE

- Co-supervised PhD students
 - Sishu Muni, November 2018 – present
 - Hammed Fatoyinbo, January 2017 – present
 - Christian Offen, November 2016 – July 2020
 - Howida al Fran, May 2013 – 2017
- Supervised summer students on projects involving original research on dynamical systems
 - Edward Chen, November 2017 – February 2018
 - Liam Bignell, November 2016 – February 2017
 - Sam Irvine, November 2015 – February 2016
 - Harjinder Pal, December 2014 – February 2015
- Supervised graduate students for honours-level projects
 - Edward Chen, February 2018 – June 2018
 - Alex Gibbs, July 2017 – October 2017
 - Sangeetha Basnayake, March 2013 – November 2013

TEACHING EXPERIENCE

- **Instructor**
 - Linear Mathematics, 160.102*, Massey University Semester 1, 2016–2019
 - Methods of Mathematics, 160.103*, Massey University Semester 1, 2013–2015
 - Differential Equations II, 160.318*, Massey University Semester 1, 2013–2019
 - Studies in Applied Differential Equations, 160.734*, Massey University Semester 1 or 2, 2013–2019
 - Linear Algebra, 160.211*, Massey University Semester 2, 2013–2019
 - Classical Fields, 124.332*, Massey University Semester 2, 2013–2019
 - Methods of Mathematical Physics, 160.317*, Massey University Semester 2, 2012, 2013
 - Linear Differential Equations*, University of British Columbia Fall 2011
 - Partial Differential Equations*, University of British Columbia Fall 2009, 2010
 - Complex Variables and Applications*, University of Colorado at Boulder Spring 2009
 - Differential Equations and Linear Algebra*, University of Colorado at Boulder Summer 2008
- Responsible for class instruction, lecture planning, course structure, writing and grading exams, writing homework assignments, maintaining a course webpage, holding office hours, coordinating with other instructors and supervising teaching assistants.

SELECTED PRESENTATIONS

- **NZMS Colloquium** (Plenary speaker) Dec. 5, 2019
Massey University, Palmerston North, NZ
Border-Collision Bifurcations of Switched Dynamical Systems: From Fixed Points to Robust Chaos
- **SIAM Conference on Applications of Dynamical Systems** May 22, 2019
Snowbird, UT, USA
Towards a General Bifurcation Theory for Equilibria of Piecewise-Smooth ODEs
- **Mathematics Department Seminar** May 13, 2019
University of Manchester, UK
New Developments in the Dynamics of Multi-Dimensional Piecewise-Linear Maps
- **ANZIAM** Feb. 4, 2019
Nelson, NZ
Stability in Piecewise-Smooth Maps: Fixed Points, Fractals, and Friction

- **Workshop on Complex Networks** June 26, 2018
 ICTS, Bangalore, India
Fractal Structures in Multi-Dimensional Piecewise-Linear Maps
- **ANZIAM** Feb. 8, 2018
 Hobart, Australia
The Sausage-String Structure of Mode-Locking Regions of Piecewise-Linear Maps
- **Dynamics Days** Jan. 6, 2018
 Denver, CO, USA
The Sausage-String Structure of Mode-Locking Regions of Piecewise-Linear Maps
- **SIAM Conference on Applications of Dynamical Systems** May 22, 2017
 Snowbird, UT, USA
Desynchronising Collections of Oscillators by using Two-Fold Singularities
- **School/Workshop on Applicable Theory of Switched Systems** June 10, 2016
 The University of Texas at Dallas, TX, USA
Using Two-Fold Singularities to Desynchronise Collections of Oscillators
- **CRM Research Program on Advances in Nonsmooth Dynamics** Feb. 11, 2016
 Autonomous University of Barcelona, Spain
Noisy Sliding Motion and a Probabilistic Notion of Forward Evolution through a Two-Fold
- **Conference on Open Problems in Nonsmooth Dynamics** Feb. 1, 2016
 Autonomous University of Barcelona, Spain
Border-Collision Bifurcations: Myths, Facts and Open Problems
- **Applied Mathematics Department Seminar** May 28, 2015
 University of Colorado at Boulder, CO, USA
Noisy Sliding Motion
- **SIAM Conference on Applications of Dynamical Systems** May 20, 2015
 Snowbird, UT, USA
Infinitely Many Coexisting Attractors in the Border-Collision Normal Form
- **ANZIAM** Feb. 5, 2014
 Rotorua, NZ
Effects of Noise on Nonsmooth Dynamical Systems
- **NZMS Colloquium** Dec. 5, 2013
 Tauranga, NZ
Probabilistic Forward Evolution through Singularities of Discontinuous Vector Fields
- **Engineering Mathematics Department Colloquium** July 5, 2013
 University of Bristol, Bristol, England
Stochastic Perturbations of Sliding Motion and Periodic Orbits with Sliding Segments
- **SIAM Conference on Applications of Dynamical Systems** May 19, 2013
 Snowbird, UT, USA
Stochastic Grazing Bifurcations
- **The 9th AIMS Conference on Dynamical Systems, Differential Equations and Applications** July 1, 2012
 Orlando, FL, USA
The Effects of Noise on Sliding Motion
- **Engineering Mathematics Department Colloquium** Jan. 27, 2012
 University of Bristol, Bristol, England
Resonance in Piecewise-Smooth Continuous Maps
- **Maps, Gaps and Noise Workshop** (Keynote speaker) Jan. 17 & 18, 2012
 University of Bath, Bath, England
Noisy Sliding Motion

- **7th European Nonlinear Dynamics Conference**
 Sapienza - Università di Roma, Rome, Italy
Dynamics of a Prototypical Balancing Model with Switching Control

July 26, 2011
- **International Council for Industrial and Applied Mathematics**
 Vancouver, Canada
Noise-Induced Mixed-Mode Oscillations via Canards in a PWL FitzHugh-Nagumo Model

July 21, 2011
- **International Workshop on Resonance, Oscillations and Stability of Nonsmooth Systems**
 London Imperial College, London, England
Shrinking Point Bifurcations of Resonance Tongues for PWS, Continuous Maps

June 19, 2009

ACADEMIC SERVICE

- Associate Editor for the Book Review section of *SIAM Review* since January 2018
- Webmaster for the NZMS since December 2018
- Minisymposium organiser for the SIAM Conferences on Applications of Dynamical Systems, Snowbird, Utah, USA, May 2013, 2015, 2017, and 2019
- Co-organiser of the 17th Manawatu-Wellington Applied Maths Conference (MWAM-15) held at Massey University, Palmerston North, July 9, 2015
- Member of NZMS, ANZIAM & SIAM
- Refereed research articles for 23 different journals since January 2016
 - “Outstanding Reviewer” for *Nonlinearity*, 2017
- Composed questions for the Massey University Mathematics and Statistics Quiz (M3S) for Year 12 students, 2014–2019

COMPUTER LANGUAGE CAPABILITIES

- AUTO, Excel, HTML, Java, L^AT_EX, Maple, Mathematica, Matlab, Python