

William R. Holmes

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Employment History

- Vanderbilt University,
 - Assistant Professor - Department of Physics and Astronomy (2015 - Present)
 - Associate Director - Quantitative Systems Biology Center (2017 - Present)
 - Assistant Professor (Courtesy) - Department of Mathematics (2017 - Present)
- University of Melbourne, Continuing Lecturer (TT Asst. Prof. equivalent), Department of Mathematics and Statistics, November 2014 - August 2015
- University of California Irvine, Assistant Researcher, Department of Mathematics and the Centre for Complex Biological Systems, 2012 - 2015
- University of British Columbia (UBC), Postdoctoral Fellow in Mathematics, 2010-2012
- Rolls Royce Aerospace, Experimental Test Engineer , 2002- 2003

Education

- Ph.D. Mathematics, Indiana University Bloomington, 2010.
 - Thesis: A 3-D Non-Local Model of the Mammalian Cochlea with Numerical Simulation (with Jacob Rubinstein and Michael Jolly)
- M.A. Mathematics, Indiana University Bloomington (IUB), 2007.
- B.S. Engineering Physics, University of Tennessee (UTK), 2005.

Grants

- 2016-2020 - NSF #DMS1562078 (PI) - Early Mammalian Embryo Development: Stochastic Modeling and Experiments
- 2015-2019 (no-cost-extension) - NSF #SES1556325 (co-PI) - The Impact of Dynamically Changing Information on Decision Processes
 - 2015-2018 - Supplement: Research Experience for Undergraduates.
 - 2016-2018 - Supplement: Research Experience for Undergraduates.
- 2018 - American Society of Clinical Pathology (N/A) - This is not a direct grant. Rather the society (in agreement with their CEO) will provide space and financial support to facilitate data collection at their annual conference. Linked to publication [27](#).
- 2017-2018 - Internal VUMC Department of Pathology grant (co-PI) - Investigation of Cognitive Factors involved in Diagnostic Decision-Making in Pathology.
- 2016-2017 - Vanderbilt International Research Grant (PI) - Computational Modeling of Cell-Environment Interactions.
- 2016-2017 - Vanderbilt International Research Grant (co-PI) - Computational Models of Dynamic Decision-making.

- 2014-2018 - NIH #R01GM107264 (Senior Personnel, PI's are Qing Nie and Tom Schilling) - Stochastic Dynamics and Noise Control in Patterning Systems (2014-2018) (Devised and co-wrote aspects of the proposal as Senior Personnel. Relinquished when I relocated to University of Melbourne).
- 2009 - NSF #0913159 (PI) - The effect of spatial heterogeneity on the secretion properties of parotid acinar cells (Graduate student research grant with attached funds from NZ Ministry of Science.)

Publications

* Indicates equal contributing or co-corresponding authors.

35. W. R. Holmes, (2018) "Sub-diffusive dynamics lead to depleted particle densities near cellular borders", Submitted
34. W. R. Holmes, J.S. Trueblood, N.J. Evans, A. Heathcote, (2018) "The adaptable interplay between integration and urgency in rapid choice.", Submitted
33. N.J. Evans, J.S. Trueblood, W.R. Holmes, (2018) "A parameter recovery assessment of time-variant models of decision-making.", Submitted
32. N. J. Evans, W. R. Holmes*, J. S. Trueblood*, (2018) "Comparing models of context effects in multi-attribute choice", Revision Submitted
31. Y. Lin, A. Heathcote, W. R. Holmes (2018) "Parallel Probability Density Approximation", Accepted in Behavioral Research Methods
30. W.R. Holmes*, L. Edelstein-Keshet*, (2018), "Editorial Overview: Mathematical Modeling Issue", Current Opinion in Systems Biology, Accepted
29. Vijay Rajagopal*, W. R. Holmes*, Peter Vee Sin Lee, (2018) "Computational Modelling of Single Cell and Cytoskeletal Mechanobiology", WIREs Systems Biology and Medicine 10(2), e1407
28. J. S. Trueblood*, W. R. Holmes*, 8 others (including one VU Undergraduate), (2018). "The impact of speed and bias on the cognitive processes of experts and novices in medical image decision-making". Cognitive Research: Principles and Implications, 3(1), p.28.
27. W. R. Holmes, Jennifer S. Trueblood, (2018) "Bayesian analysis of the piecewise diffusion decision model", Behavioral Research Methods 50(2), pp. 730-743
26. Anna A.W.M. Sanders, Kevin Chang, Xiaodong Zhu, Roslin J. Thoppil, W. R. Holmes*, Irina Kaverina* (2017) "Non-random γ -TuNA-dependent spatial pattern of microtubule nucleation at the Golgi", Molecular Biology of the Cell 28(23), 3181-3192
25. W. R. Holmes 1 of 27 co-authors, (2018) "The Quality of Response Time Data Inference: A Blinded, Collaborative Approach to the Validity of Cognitive Models", Psychological Bulletin and Review, pp. 1-19
24. W. R. Holmes, JinSeok Park, Andre Levchenko, Leah Edelstein-Keshet, (2017) "A mathematical model coupling polarity signaling to cell adhesion explains diverse cell migration patterns", PLoS Computational Biology 13 (5), e1005524
23. JinSeok Park, W. R. Holmes, Sung-Hoon Lee, Hong-Nam Kim, Deok-Ho Kim, Moon Kyu Kwak, Chiao Chun Joanne Wang, Kahp-Yang Suh, Leah Edelstein-Keshet, Andre Levchenko, (2017) "A mechano-chemical feedback underlies co-existence of qualitatively distinct cell polarity patterns within diverse cell populations", PNAS, 201700054
22. W. R. Holmes*, Nabora Soledad Reyes de Mochel*, Qixuan Wang, Huijing Du, Michael Chiang, Olivier Cinquin, Ken W.Y. Cho, Qing Nie, (2017) "Gene Expression Noise Enhances Robust Organization of the Early Mammalian Blastocyst." , PLoS Computational Biology 13 (1), e1005320
21. Qixuan Wang*, W. R. Holmes*, Julian Sosnik, Thomas Shilling, Qing Nie, (2017) "Cell sorting and noise induced cell plasticity coordinate to sharpen boundaries between gene expression domains", PLoS Computational Biology 13 (1), e1005307

20. W. R. Holmes, Leah Edelstein-Keshet, (2016) "Analysis of a minimal Rho-GTPase circuit regulating cell shape", *Physical Biology* (13), 046001
19. W. R. Holmes*, Jennifer Trueblood*, Andrew Heathcote, (2016) "A new framework for modeling decisions about changing information: The Piecewise Linear Ballistic Accumulator model", *Cognitive Psychology* (85), 1-29
18. W. R. Holmes, Adriana E. Golding, William M. Bement, Leah Edelstein-Keshet, (2016) "A mathematical model of GTPase pattern formation during single-cell wound repair", *Journal of the Royal Society Interface Focus* 6(5), 20160032
17. Darragh Walsh, Philipp Roth. W. R. Holmes, Kerry Landman, Tobias Merson, Barry Hughes, (2016) "Is cell migration or proliferation dominant in the formation of linear arrays of oligodendrocytes?", *Journal of Theoretical Biology* (406), 17-30
16. W. R. Holmes, (2015) "A practical guide to the Probability Density Approximation (PDA) with improved implementation and error characterization" *Journal of Mathematical Psychology*, 68, 13-24
15. W. R. Holmes*, Laura Liao*, William Bement, Leah Edelstein-Keshet, (2015) "Modeling the roles of protein kinase C beta and eta in single cell wound repair". *Molecular Biology of the Cell*, 26(22): 4100-4108
14. Huijing Du, Qing Nie, W. R. Holmes, (2015) "The interplay between Wnt mediated expansion and negative regulation of growth promote robust intestinal crypt structure and homeostasis.", *PLoS Computational Biology*, 11(8): e1004285
13. W. R. Holmes, May Anne Mata, Leah Edelstein-Keshet, (2015) "Local Perturbation Analysis: A computational tool for biophysical reaction-diffusion models." *Biophysical journal* 108.2, 230-236
 - This was the first article published under BJ's software article class.
12. Alexander Gord*, W. R. Holmes*, Xing Dai, Qing Nie, (2014) "Computational modeling of epidermal stratification highlights the importance of asymmetric cell division for predictable and robust layer formation". *Journal of the Royal Society Interface*, 11(99), pp. 20140613
11. W. R. Holmes, Qing Nie, (2014) "Interactions and tradeoffs between cell recruitment, proliferation, and differentiation affect CNS regeneration", *Biophysical Journal*, 106(7), pp. 1528-1536
10. W. R. Holmes, (2014) "An excitable compass guides chemotaxis?", *Biophysical Journal*, 106(5), pp. 989
9. W. R. Holmes, (2014) "An efficient, non-linear stability analysis for detecting pattern formation in reaction diffusion systems", *Bulletin of Mathematical Biology*, 76(1), pp. 157-283
8. L. Edelstein-Keshet, W. R. Holmes, Mark Zajac, Meghan Dutot, (2013) "From simple to detailed models for cell polarization", *Philosophical Transactions of the Royal Society B*, 338, pp. 20130003
7. M. Meta, M. Dudot, L. Edelstein-Keshet, W. R. Holmes, (2013) "A model for intracellular actin waves explored by nonlinear local perturbation analysis", *Journal of Theoretical Biology*, 334, pp. 149-161
6. B. Lin, W. R. Holmes, J. Wang, T. Ueno, A. Harwell, L. Edelstein-Keshet, T. Inoue, and A. Levchenko, (2012) "Synthetic graded Rac activation drives cell polarity and locomotion", *PNAS*, 109(52), E3668-E3677
5. W. R. Holmes, L. Edelstein-Keshet, (2012) "A Comparison of Computational Models for Eukaryotic Cell Shape and Motility", *PLoS Computational Biology*, 8(12), e1002793
4. W. R. Holmes, A. Carlsson, and L. Edelstein-Keshet, (2012) "Regimes of Wave Type Patterning driven by Refractory Actin Feedback: Transition from Static Polarization to Dynamic Wave Behaviour", *Physical Biology*, 9(4), 046005
3. W. R. Holmes, B. Lin, A. Levchenko, and L. Edelstein-Keshet, (2012) "Modelling cell polarization driven by synthetic spatially graded Rac activation", *PLoS Computational Biology*, 8(6), e1002366

2. W. R. Holmes, M.S. Jolly, and J. Rubinstein, (2011) "Hydro-elastic waves in a cochlear model: Numerical simulations and an analytically reduced model", *Confluentes Mathematici*, Vol. 3, No. 3 pp. 523-541
1. T.A. Perkins*, W. R. Holmes*, J. F. Weltzin, (2007) "Multi-species interactions in competitive hierarchies: new methods and empirical test". *Journal of Vegetation Science*: Vol. 18, No. 5 pp. 685-692

Publications in Preparation

1. C. Zmurchok, W. R. Holmes, (2018, In Preparation) "Rho GTPase signaling dynamics promote shape diversity in cellular populations."
2. W. R. Holmes, I. Kaverina, (2018, In Preparation) "Microtubules Regulate the Localization and Availability of Insulin in Beta Cells"
3. P. O'Daniels, J. Trueblood, W. R. Holmes, (2018, In Preparation) "A joint neural network / diffusion approach to modeling image based medical decisions"
4. Z. Kilpatrick, W. R. Holmes, K. Josic, (2018, In Preparation) "Optimal decision making in dynamic environments"
 - Invited review to *Current Opinion in Neurobiology*

Invited Seminars

1. Internal Seminars - Physics Colloquium, Quantitative Systems Biology Center seminar (2x), Center for Quantitative Systems seminar, Mathematics department seminar
2. Job Talks (2015) University of Michigan (Biophysics), Vanderbilt University (Physics and Astronomy), University of Pittsburg (Biomedical Engineering), Carnegie Mellon (Computer Science), UC Santa Cruz (Applied Mathematics), UC Irvine (Physics), University of Minnesota (Cell and Developmental Biology)
3. University of Houston (Networks Seminar, 2018) - Modeling spatially organizing networks regulating cellular polarity and organization
4. MTSU (2017) - Modeling cell motility regulation
5. Queensland University of Technology (Applied Math seminar), (2015) Local Perturbation Analysis: A tool for analysing complex, pattern forming regulatory systems with applications to chemotactic polarization
6. Swinburne University (Applied Math seminar), (2015) Local Perturbation Analysis: A tool for analysing complex, pattern forming regulatory systems with applications to chemotactic polarization
7. University of Utah (Mathematical Biology Seminar), (2014) A unifying mechanism for spontaneous, stimulus induced, and dynamic cell polarity
8. North Carolina State (Applied Math Seminar), (2014) From cell polarity to embryogenesis
9. University of Kentucky (Colloquium), (2013) Topics in Mathematical Cell Biology: Cell polarity, embryogenesis, and central nervous system regeneration
10. Ohio State (Applied Mathematics Seminar), (2013) Asymptotic analysis of models of spontaneous, induced, and dynamic polarity establishment
11. University of California at Irvine (Applied Mathematics Seminar), (2012) Response thresholds and noise sensitivity in polarizing cells
12. University of Victoria (Mathematical Biology Seminar), (2012) Regulatory control of response thresholds during chemotactic polarization

13. University of Tennessee Knoxville and the National Institute for Mathematical and Biological Synthesis (NIMBioS) (NIMBioS short term visitor and Departmental Colloquium), (2011) A local analysis of symmetry breaking with applications to HeLa cell polarization: theory and experiment
14. John Innes Centre, Norwich UK, (2011) New methods for detecting symmetry breaking in cell polarization
15. University of British Columbia (PIMS Seminar), (2009) The role of the cochlear aspect ratio in hearing: simulation, asymptotics, and experiment
16. University of Auckland (Applied Mathematics Seminar), (2009) Modelling the hydro-elastic properties of the cochlea

Other Oral Presentations

1. BIRS Conference on Mathematical of the Cell, (2018) Modeling cytoskeletal regulation of insulin availability in Beta cells
2. AIMS Dynamical Systems, (2018) Crosstalk between Rac and Rho GTPases promote morphological heterogeneity among motile cells
3. SIAM Life Sciences, (2018) Mathematical modeling of rapid decisions involving changes of information
4. Gordon Conference on Motile and Contractile Systems, (2017) Feedbacks between ECM signaling, GTPase signaling, and cytoskeletal remodeling promote morphological heterogeneity among motile cells
5. Society for Mathematical Psychology Annual Meeting, (2017) Evidence accumulation versus urgency gating: what's the distinction?
6. Japan-UCI 3D Morphogenesis Meeting, (2017) Stochastic dynamics and organization in early mammalian blastocyst
7. Gordon Conference on Cell Migration, (2017) Crosstalk between Rac, Rho and ECM signaling promotes heterogeneity among motile cells
8. SIAM Life Sciences Conference, (2016) A minimal GTPase circuit regulating cell shape and motility phenotype
9. QBio Conference, (2016) Stochasticity improves robustness of early embryonic development
10. Annual Summer Interdisciplinary Conference (ASIC), (2016) A new framework for modeling decisions about changing information
11. Aspen Center for Physics, (2016) Stochasticity dynamics and organization in the developing mammalian blastocyst
12. Society for Mathematical Biology conference, (2015) The genesis of actin waves and dynamic transitions in motile cells
13. Australia New Zealand Industrial and Applied Mathematics meeting, (2015) Asymmetries in the distribution of gene expression noise direct spatial organization in the developing mammalian embryo
14. Australasian Mathematical Psychology Society Meeting, (2015) Dynamic decision making: integration and adapting to new informational
15. Australian Mathematical Society Annual Meeting, (2014) Static to dynamic wave transitions in cells
16. Mathematics of the Cell: Integrating Genes, Biochemistry and Mechanics, (Banff - BIRS, 2014) Regulation of Dynamic Motility: Waves, Polarity, and Links to Cell Invasiveness

17. SIAM Conference on Nonlinear waves and coherent structures, (Cambridge, 2014) Actin Nucleation Waves in Motile Cells
18. SIAM Life Sciences, (Charlotte, 2014) Regulation of the First Embryonic Developmental Decision
19. Society for Mathematical Society Annual Meeting, (Quebec City, 2014) Accumulator models of decision-making under changing information
20. Mathematics at the Frontier of Developmental Biology, (PIMS Workshop, Vancouver 2014) Spatio-temporal Regulation of Early Blastocyst Development
21. University of California Irvine, Biomedical Engineering Seminar (2014) Design principles and control in biological systems
22. Biophysical Society Annual Meeting, (San Francisco, 2014) Dynamics of central nervous system regeneration
23. Q-Bio Conference, (Santa Fe, 2013) Heterogeneity of spatial regulation mitigates tradeoffs between short and long time repair responses in the adult central nervous system
24. AMS Western Sectional Meeting, (University of Colorado Boulder, 2013) Spatio-temporal regulation of developmental processes
25. Center for Complex Biological Systems Retreat, (Los Angeles, 2013) Population and distribution of cell states defined by a gene regulatory network
26. SIAM Life Sciences Meeting, (2012) A multi-scale approach to spatially distributed regulatory networks
27. Society of Mathematical Biology Annual Meeting, (2012) Mechanisms for biochemical sensitivity control in spatially distributed cellular systems
28. University of Tennessee Knoxville (Undergraduate Colloquium), (2011) Foundations of spatio-temporal pattern formation with applications to cell biology and ecology
29. International Congress on Industrial and Applied Mathematics, (2011) A mathematical basis for cell polarization
30. SIAM Great Lakes Conference: Modelling and Numerical PDEs in Mathematical Biology, (2010) Cochlear dynamics: dispersion and the uncertainty principle
31. SIAM Meeting on Dynamical Systems, (2009) Mixed method computations in cochlear dynamics
32. University of British Columbia (PIMS Seminar), (2008) Cochlear dynamics
33. Coalition for National Science Funding Annual Meeting at the request of the Math Association of America (MAA), (Washington, 2005), Competition and invasion, a multispecies view
34. APS Annual Meeting, (2004) Monte Carlo vs molecular dynamics in 2D crystalline defect diffusion

Poster Presentations

1. Stochastic Physics in Biology (Gordon Conference), (2015) Stochastic regulation of early blastocyst development
2. National Centers for Systems Biology Meeting, (NIH - Bethesda, 2013) Spatio-temporal control of early blastocyst development
3. Systems Biology of Stem Cells conference (UC Irvine, 2013) Roles of chemotaxis, differentiation and quiescence of progenitor cells in adult CNS repair
4. Center for Complex Biological Systems Retreat, (2013) Tradeoff arise between conflicting goals of directed motility and differentiation in lineage restricted progenitor populations

5. American Society for Cell Biology (ASCB) Annual Meeting, (2012) Interactions between actin and its effectors yields both polarized and dynamic phenotypes
6. Biophysical Society Annual Meeting, (2012) Cytoskeletal waves driven by the interaction of a conservative wave generator with refractory actin feedback
7. Ohio State (Mathematical Biology Institute): Young Researchers Conference, (2011) Autonomous symmetry breaking in cell polarization: combined theory and experiment
8. Mathematical Biology of the Cell: Cytoskeleton and Motility conference (Banff International Research Station, 2011) A model for HeLa cell polarization with matching experiments
9. European Conference on Mathematical and Theoretical Biology, (2011) A local analysis of symmetry breaking with applications to cell motility
10. Biophysical Society Annual Meeting, (2011) Autonomous symmetry breaking in cell polarization: combined theory and experiment
11. Joint Math Meetings, (2005) Lotka Volterra parameter estimation applied to a micro-organism community

Research Supervision

- Vanderbilt University
 - Postdoc
 - * Cole Zmurchok (Aug 2018 - Present) - NSERC Fellow
 - * Nathan Evans (2017 - 2018)
 - Student Supervision
 - * John Vastola (2017 - Present) - Physics PhD
 - * Tyler Taplin (2017 - 2018) - Physics PhD
 - Rotation Student Supervision
 - * Geena Ildefonso (2016) - QCB Rotation Student
 - * Ian Setliff (2016) - QCB Rotation Student
 - Undergraduate Student Supervision
 - * Linghui Feng (2018-Present, Mathematics, Economics, Computer Science)
 - * Payton O'Daniels (2018-Present, Computer Science) - NSF REU student
 - * Sophia Druffner (2016-2017, Applied Mathematics) - SYBURE student.
 - * Jared Ohlund (2016, Computer Science) - NSF REU student
 - * Megan Woodruff (2016-Present, Computer Engineering), NSF REU student
 - * Aneesha Dasari (2016 - Present, Undecided major)
 - Committee member
 - * Sylvia Morrow (2017 - Present) - Physics PhD student
 - * Matthew Feldman (2017 - Present) - Physics PhD student
 - * Aaron Stephens (2017 - Present) - Physics PhD student
 - * Corey Hayford (2016 - 2017) - External reviewer of PhD proposal materials (CPB program).
 - * Oscar Ortega (2016 - Present) - CPB PhD student
 - * Erin Shockley (2016 - Present) - CPB PhD student
 - * Weizhuang Peng (2016 - Present) - Physics PhD student
 - * Mario Avaldi (2016) - Physics Honors student
- University of Melbourne
 - Phillip Brown (2015-2016) - Masters student. Since moved into PhD.

Teaching Experience

- 2017-2018: Physics of Living Systems (Phys 3122/8122, Vanderbilt, Spring 2017, 2018, 6, 8 students respectively)
- 2015-2018: Introductory Physics for Life Sciences (Phys 1501, Vanderbilt, Fall 2015-2017, 70-80 Students / course)
- 2015: Advanced Mathematical Modeling: Case Studies (MAST 90080, Winter 2015 in Australia, 20 Students)
- 2015: Calculus 2 (MAST 10006, University of Melbourne, 2015, 300 students)
- 2012: Infinite Series and Basic Linear Algebra (Math 2J, UC Irvine, Fall 2012, 100 Students)
- 2012: PIMS Mathematical Cell Biology Graduate Summer Course, Invited lecturer (University of British Columbia (UBC), 2012, 5 lectures - 2 hours each)
- 2010-2011: Integral Calculus with Applications to Life Sciences (UBC, Math 103, 110 students, 2010 and 2011)
- 2008: Mathematics Subject Graduate Record Examination (GRE) Prep Course (Indiana University (IUB), 10 students)
- 2008: Advanced calculus refresher for incoming graduate students (IUB, 20 students, summer short course)
- 2006: Introduction to Algebra (Jo10, IUB, 30 students, Groups Program Course for first generation college students from underprivileged backgrounds)
- 2005-2006: Algebra / Pre-Calculus (Mo25, IUB, 30 students, twice)

Service

- Departmental Service
 - Member of the Colloquium Committee (2018-Present)
 - Member of the Physics and Astronomy graduate program committee (2015-2018).
 - Member of the Physics and Astronomy long range planning committee (2016-2018)
- University Service
 - Member of the Graduate Faculty Delegate Assembly (2015 - Present).
 - Member of the Quantitative and Chemical Biology / Interdisciplinary Graduate Program steering committee (2016-present).
 - Panel member for: “Academic Job Search: Advice From Junior Faculty” (2016)
- Service to the community.
 - Co-editor of “Mathematical Modelling” special issue at Current Opinion in Systems Biology (to be published 2018)
 - NSF panel member (2016, twice)
 - Ad hoc grant reviewer for the Netherlands Organization for Scientific Research (NWO) (2016)
 - Lecturer, Systems Biology Short Course (at UC Irvine, 2014)
 - Co-supervised summer research experience for a local high school student (2013)
 - Volunteer, MathCounts mathematics program for middle school students (2013)
 - Volunteer, Euclid high school mathematics competition (Canada, 2012)

- Co-organizer Frontiers in Biophysics (2011) conference at UBC (participation throughout the pacific northwest). Funding secured through the Pacific Institute for the Mathematical Sciences (PIMS) and Mathematics of Information Technology and Complex Systems (MITACS).
- Reviewed for - Royal Society Interface, Wires Systems Biology and Medicine, BMC Systems Biology, Applied Mathematical Modelling, Biophysical Journal, Journal of Computational Physics, Discrete and Continuous Dynamical Systems B, PLoS Computational Biology, Molecular Biology of the Cell (MBoC), PLoS One, New Journal of Physics, Journal of Mathematical Biology, Nonlinearity, Journal of Theoretical Biology, Biomechanics and Modeling in Mechanobiology, SIAM Journal of Applied Mathematics, Behavioral Research Methods, Trends in Cognitive Sciences, PNAS

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