**Rachel Leander**

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Department of Mathematical Sciences

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**Research Interests**

Stochastic modeling of the cell cycle

Network control

Computational immunology and cell signaling

**Education**

2001-2005 The University of Tennessee, Knoxville, TN

B.S. in Mathematics

2005-2010 The University of Tennessee, Knoxville, TN

Ph.D. Mathematics

**Experience**

2010-2013 Postdoctoral Fellow, Mathematical Biosciences Institute

2009-2010 Graduate Research Associate, National Institute for Mathematical and Biological Synthesis

2005-2008 Graduate Teaching Assistant, University of Tennessee

**Publications**

* R. Leander, S. Lenhart, V. Protopopescu, Using optimal control theory to identify network structures that foster synchrony. Physica D. 241 (2011) 574-582.
* S. E. Riechert, R. Leander, and S. M. Lenhart, A role-playing exercise that demonstrates the process of evolution by natural selection: Caching squirrels in a world of pilferers, Am. Biol. Teach. 73 (2011) 208-216.
* R. Leander, S. P. Dai, L. Schlesinger, and A. Friedman, A Mathematical Model of CR3/TLR2 Crosstalk in the context of Francisella tularensis infection. PLoS Comput. Biol. 8 (2012) e1002757. doi: 10.1371/journal.pcbi.1002757.
* S. P. Dai, H.M. Curry, R. Leander and L. Schlesinger, Fine tuning inflammation at the front door: Macrophage Complement Receptor 3-mediates phagocytosis and immune suppression for Francisella tularensis. PLoS Pathog. 9 (2013) e1003114. doi: 10.1371/journal.ppat.1003114.
* R. Leander and A. Friedman. Modulation of the cAMP response by G alpha i and G beta gamma: a computational study of G protein signaling in immune cells. Bull Math Biol. 76 (2014) 1352-1375.
* R. Leander, E. J. Allen, S. P. Garbett, D. R. Tyson. Derivation And Experimental Comparison Of Cell-Division Probability Densities, J Theor Biol. 359 (2014) Pages 129-135.
* Friedman, C.Y. Kao, and R. Leander. On the dynamics of radially symmetric granulomas. Journal of Mathematical Analysis and Applications. 412 (2014) 776–791.
* R. Leander, S. Lenhart, V. Protopopescu, Optimal control of continuous systems with impulse controls. Optim Contr Appl Met. 36 (2015) 535-549.
* R. Leander, S. Lenhart, V. Protopopescu. Controlling Synchrony in a Network of Kuramoto Oscillators with Time-Varying Coupling. Physica D. 31-32 (2015) 36-74, doi: 10.1016/j.physd.2015.03.003.
* R. Leander, W. Goff, C. Murphy, S. Pulido. Modeling Ebola within a community. Epidemiol Infect. 144 (2016) 2329-2337, doi:10.1017/S0950268816000558.
* Hayes, Heusinkveld, Sircy, Ding, Leander, McClelland, and Nelson. Modulation of Macrophage Inflammatory signaling by intracellular Cryptococcus neoformans. J Biol Chem. 291 (2016) 15614-15627.

**Conference Talks**

* “Multipart Stochastic Models for the Analysis of Intermitotic time data.” American Institute of Mathematical Sciences Conference on Dynamical Systems, Differential Equations and Applications. Orlando, FL. July, 2016. (invited)
* “Using Optimal Control Theory to Identify Network Structures and Dynamics that Foster Synchrony.” MBI, Columbus OH. April, 2016. (invited)
* R. Leander, S. Lenhart, and V. Protopopescu . “Controlling synchonry in a network of Kuramoto oscillaotrs with time-varying coupling.” Southeastern Atlantic Regional Conference on Differential Equations, UNC Greensboro, October 2015.
* R. Leander, E. J. Allen, S. P. Garbett, D. R. Tyson. “Modeling intermitotic time distributions,”Mathematical Biosciences Institute Workshop: Targeting Cancer Cell Proliferation and Metabolism. March 23-27, 2015.
* R. Leander, E. J. Allen, S. P. Garbett, D. R. Tyson. “Modeling the dynamics of intermitotic time distributions,*”* Joint Mathematics Meeting in San Antonio.  Special Session: Applications of Dynamical Systems to Biological Models. January 10, 2015. (invited)
* R. Leander, S. Lenhart, and V. Protopopescu . “Optimal Control of Continuous Systems with Impulse Controls.” SIAM Conference on the Life Sciences, Charlotte, NC, 2014.
* R. Leander, S. Lenhart, and V. Protopopescu. “Optimal control of continuous systems with impulse controls,” Southeastern Sectional Meeting of the American Mathematical Society, Louisville, KY, October, 2013. (invited)
* R. Leander, E. Allen, D. Tyson, S. Garbett, and V. Quaranta. **“**Derivation and experimental comparison of cell-division probability densities,” Southeastern Atlantic Regional Conference on Differential Equations, Knoxville, TN, September, 2013.
* R. Leander, S. Lenhart, and V. Protopopescu . “Using Optimal Control Theory to Identify Topological Structures that Promote Synchrony.” Network Frontier Workshop, Northwestern University, 2011. (invited)
* R. Leander, S. Dai, L. S.Schlesinger, A. Friedman. “A Mathematical Model of CR3/TLR2 Crosstalk in the Context of Francisella tularensis Infection.” Center for Microbial Interface Biology, The Ohio State University, 2011. (invited)
* R. Leander, S. Dai, L. S.Schlesinger, A. Friedman. “A Mathematical Model of CR3/TLR2 Crosstalk in the Context of Francisella tularensis Infection.” The Mathematical Biosciences Institute, The Ohio State University, 2011. (invited)
* R. Leander, S. Dai, L. S.Schlesinger, A. Friedman. “A Mathematical Model of CR3/TLR2 Crosstalk in the Context of Francisella tularensis Infection.” Duke University, 2011. (invited)
* R. Leander, S. Lenhart, and V. Protopopescu . “Using Optimal Control Theory to Identify Topological Structures that Promote Synchrony.” Mathematical Biosciences Institute Seminar, The Ohio State University, 2011. (invited)
* R. Leander, S. Lenhart, and V. Protopopescu . “Impulse Control of Biological Systems.” SIAM Southeastern-Atlantic Section Conference, North Carolina State University, 2010.
* R. Leander, S. Lenhart, and V. Protopopescu. “Optimal Control of Kuramoto Oscillators.” AMS Sectional meeting, Huntsville, AL, October, 2008.

**Funding Experience**

* Co-PI, Faculty Research and Creative Activity, MTSU, “Statistical Methods for the Analysis of Individual-Cell Data on Death and Division.” Submitted Fall 2016, $13,000 (pending).
* Co-PI, NSF NRT Program 15-542, “*Real-World Partners for Academic Research in the Computational Sciences (RPAR)*.” 2015, $300,000 (not funded).
* Key personnel, NIH R-15, “*Modulation of Macrophage Inflammatory Signaling by Intracellular Cryptococcus neoformans*.” 2015, $300,000 (not funded).
* Co-PI, NSF Mathematical Biology: “*Investigating the sources and implications of stochasticity in cellular proliferation and death*.” 2015, $624,834 (not funded).
* PI, Faculty Research and Creative Activity, MTSU, “*Modeling the Evolution of Intermitotic Time Distributions for Cancer Cells.*” 2014, $6,084.35 (funded).
* Co-PI, Instructional Technologies Development Grant: “*Technological Resources to Support Undergraduate Research in Mathematical Biology.”* 2014, $5891.73 (awarded).
* Key Personnel, DTRA Basic Research for Combating Weapons of Mass Destruction Broad Agency Announcement (HDTRA1-11-16-BRCWMD-BAA), GRANT10909737 “*Genomics-Based Discovery Of Francisella And Burkholderia Interaction With Human Macrophages*.” Total Cost: $3,716,511 (not funded)

**Teaching:**

* **1810 Applied Calculus:** This course satisfies the General Education Mathematics requirement and meets specific requirements for programs as outlined in the MTSU Undergraduate Catalog. Topics include mathematical modeling applied to real-world problems, sets, functions, limits, continuity, single variable differentiation, implicit differentiation, exponential, and logarithmic models. (Fall 2015, Spring 2016)
* **1910 Calculus I.** An introduction to calculus with an emphasis on analysis of functions, multidisciplinary applications of calculus, and theoretical understanding of differentiation and integration. Topics include the definition of the derivative, differentiation techniques, and applications of the derivative. Calculus topics related to trigonometric, exponential, and logarithmic functions also included. Course concludes with the fundamental theorem of calculus; the definition of antidifferentiation and the definite integral; basic applications of integrations; and introductory techniques of integration. (Fall 2014, and Fall 2016)
* **Math 3120: Differential Equations.** Introduced students to the study of differential equations: classification of differential equations, initial value problems, existence and uniqueness of solutions, methods of solution (separation of variables, integrating factors, characteristic equations, undetermined coefficients, variation of parameters), modeling, qualitative analysis of systems of differential equations (critical points, the phase plane), differential operators, Laplace Transform method, and numerical methods. (Fall 2013, Spring 2014)
* **MATH 3460: Foundations of Higher Mathematics.** Lead students in the study of basic logic, propositional calculus, set theory, induction, functions, relations, number systems, and mathematical structures. (Fall 2013)
* **Math 4602: Introduction to Undergraduate Research in Mathematical Biology.** Students gain mathematical, computational, modeling, and research skills through formal instruction and active learning. Students construct, analyze, and simulate mathematical models of biological systems.Content: linearization and linear stability analysis, global stability and Lyapunov functions, periodic solutions, ecological, epidemiological and biochemical models, solving systems of ODEs in MATLAB, manuscript preparation and professional speaking. (Fall 2014, Spring 2016)
* **Math 6170: Sets and Logic.** Propositions, predicates, quantifiers, truth tables, tautologies, and methods of mathematical proof including mathematical induction. 2) Sets, relations, functions, graphs, cardinality, and the Axiom of Choice. 3) Applications of these foundations to selected results in algebra and analysis as time permits. (Spring 2014, Spring 2015, Fall 2015)
* **Math 6190: Analysis I.** Rigorous treatment of limits, continuity, differentiation, and integration in n-dimensional Euclidean space; infinite series; introduction to metric spaces.
* **Math 6260: Advanced Differential Equations.** Qualitative and quantitative analysis of systems of differential equations. Gradient systems, Sturm-Liouville problems. Elementary techniques for boundary value problems of partial differential equations.
* **6300 Optimization.** (Independent study) Constrained and unconstrained optimization problems. Methods include orthogonalization, conjugate gradient, and quasi-Newton algorithms. (Spring 2014)
* **Math 6310 Control Theory.** (Independent study). An introduction to control theory: discrete and continuous systems, time-invariant systems, linear systems, linearized systems, controllability, reachability. (Fall 2013)

**Outreach:**

* Club MARVEL. MTSU, November 2013 and 2014. I designed and lead local primary school students in an exploration of mathematical modeling.
* Summer Graduate Workshop on Stochastics Applied to Biological Systems, The Ohio State University, 2012. I assisted in the instruction of a two-day course on the use of stochastic differential equations in mathematical biology, and helped a group of graduate students construct a stochastic model of Salmonella fecal shedding patterns in pigs.
* Course Instructor, Kids U, Biology by Numbers! University of Tennessee, Summer 2009. I co-developed and taught a summer camp course for 4th-8th graders.
* Biology in a Box. I developed a series of interdisciplinary activities for children in grades K-12. These activities were incorporated into the Biology in a Box program, which services children throughout the state of Tennessee.

**Professional Activities**

* Co-organizer of the special session, “Modeling and control of epidemiological and ecological processes,” SIAM conference on the Life Sciences, August 2014.
* Organizer of the Workshop for Young Researchers in Mathematical Biology, The Mathematical Biology Institute, August 2012.
* Organizer of the professional development seminar for postdoctoral researchers, The Mathematical Biosciences Institute, 2011-2012.
* Reviewer. I referee articles for numerous journals including The Journal of Theoretical Biology, Nonlinearity, Journal on Discrete and Continuous Dynamical Systems, PRIMUS, Industrial and Engineering Chemistry Research, Optimal Control Applications and Methods, SIAM Journal of Applied Mathematics, International Journal of Mathematics and Mathematical Sciences, Chaos, and Mathematical Reviews/MathSciNet.

**Professional Development**

* Teaching Workshop: “Writing an Effective Teaching Philosophy.” MTSU, September 2016.
* Teaching Workshop. “Professional Learning Communities in Higher Education.” Presenter: Heather Dillard, Educational Leadership. MTSU, April 2015.
* Teaching Workshop. “Turning Learning on Its Head: The Transformational Potential of the Flipped Classroom.” MTSU, September 2014.
* Teaching workshop on clickers and peer instruction in STEM classrooms. MTSU, August 2014.

**Service**

* Faculty Senate (Fall 2016).
* Faculty Research and Creative Activity Committee (Fall 2015 and Spring 2016).
* Teaching Evaluation and Effectiveness Committee. (Fall 2014-Fall 2016)
* B. S. External Review Committee. (Fall 2016)
* Statistics Search Committee. (Fall 2015-Spring 2016).
* Strategic Planning Committee (2014-2015)
* Environmental Health and Safety Committee (2014-2015).
* NIST-SURF Selection Committee (2014).
* Research Committee. (2013-2014)