

PER SEBASTIAN SKARDAL

CONTACT INFORMATION

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RESEARCH INTERESTS

My main research interests are in nonlinear dynamics and complex systems. My research predominantly focuses on two distinct areas, synchronization on networks and cardiac dynamics. Additional interests and work include bifurcation theory, chaos theory, complexity, and pattern formation.

Synchronization

Networks of coupled oscillators occur in many examples throughout science and nature and serve as a great model for emergence of collective behavior. I am interested in phenomena that occur as a result of effects such as network structure, adaptation, and various coupling mechanisms. Resulting phenomena include intermittent synchrony, coexistence of synchronized and unsynchronized states (a.k.a. "chimera" states), hierarchical synchrony, cluster synchrony, and macroscopic chaos. I am also interested in reducing the complexity of the study of such systems via dimensionality reductions.

Cardiac Dynamics

The heart is a complex dynamical system that exhibits nonlinear phenomena in many different ways. My interest in cardiac dynamics spans several different levels, from the spatiotemporal dynamics of both calcium- and voltage-driven alternans in patches of tissue to cellular regulation of ion channels yielding healthy cardiac behavior. Mathematical tools can provide insight into how the heart works and how to prevent certain kinds of cardiac arrhythmia.

EDUCATION

University of Colorado at Boulder, Boulder, Colorado USA

- Ph.D. Candidate, Applied Mathematics (expected graduation date: May 2013)
 - Advisor: Professor Juan G. Restrepo
- M.S., Applied Mathematics, May 2010

Boston College, Chestnut Hill, Massachusetts USA

- B.A., Mathematics (Minor: Computer Science), May, 2008

ACADEMIC EXPERIENCE

University of Colorado at Boulder, Boulder, Colorado USA

PhD Candidate

August, 2008 - present

Includes current Ph.D. research, Ph.D. and Masters level coursework

Research Assistant

September, 2011 - present

Conducted research of dynamics on complex systems, including synchronization on networks and cardiac dynamics, published several papers, and presented work at several conferences

- Advisor: Professor Juan G. Restrepo

Instructor of Record

June, 2010 - present

Duties included writing/giving lectures, writing exams, grading, and office hours

- APPM 2360 Differential Equations and Linear Algebra: Summer 2010, Summer 2011

Teaching Assistant

August, 2008 - present

Duties included leading recitations, leading exam reviews, teaching lab classes, writing lab projects, grading, and holding office hours

- APPM 1360 Calculus II: Spring 2009, Fall 2010
- APPM 2350 Calculus III: Fall 2009

- APPM 2360 Differential Equations and Linear Algebra: Fall 2008, Spring 2010, Spring 2011

Boston College, Chestnut Hill, Massachusetts USA

Research Assistant

May, 2006 - August 2007

Conducted research of computer vision, vision science, signal processing, and neuroscience

- Advisor: Professor David Martin (Summer 2007)
- Advisor: Professor Stella X. Yu (Summer 2006)

PUBLICATIONS

Per Sebastian Skardal, Alain Karma, and Juan G. Restrepo. **Unidirectional Pinning and Hysteresis of Spatially Discordant Alternans in Cardiac Tissue**. *Physical Review Letters* **108**, 108103 (2012).

Per Sebastian Skardal and Juan G. Restrepo. **Hierarchical Synchrony of Phase Oscillators in Modular Networks**. *Physical Review E* **85**, 016208 (2012).

Per Sebastian Skardal, Edward Ott, and Juan G. Restrepo. **Cluster Synchrony in Systems of Coupled Phase Oscillators with Higher-Order Coupling**. *Physical Review E* **84**, 036208 (2011).

Per Sebastian Skardal. **Spatiotemporal Chaos: Effect of Spatial Smoothing on Bifurcations in a Discrete-Time Chaotic Map**. University of Colorado, Department of Computer Science, Boulder, CO 80309-0430; Elizabeth Bradley; July 2010. Technical Report CU-CS 1066-10. p. 123.

CONFERENCE AND SEMINAR PRESENTATIONS

Invited and Contributed Talks

- Synchrony in Heterogeneous Networks: Effect of Community Structure, *Department of Applied Mathematics Dynamics Seminar*, March 21, 2012
- Hierarchical Synchrony in Networks with Community Structure, *SIAM FRAMSC*, March 2012
- Hierarchical Synchrony of Phase Oscillators in Modular Networks, *Network Frontiers Workshop*, December, 2011
- Cluster Synchrony in Systems of Coupled Oscillators, *Department of Applied Mathematics Dynamics Seminar*, September, 2011
- Spatiotemporal Dynamics of Calcium-Driven Alternans: novel behavior, *SIAM DS*, May, 2011
- Spatiotemporal Dynamics of Calcium-Driven Alternans, *Department of Applied Mathematics Dynamics Seminar*, September, 2010
- Spatiotemporal Dynamics of Calcium-Driven Alternans, *SIAM FRAMSC*, March, 2010

Poster Presentations

- Cluster Synchrony in Systems of Coupled Phase Oscillators, *Dynamics Days*, January, 2012
- Spatiotemporal Dynamics of Calcium-Driven Alternans, *Dynamics Days*, January, 2011
- An Adaptive Model for the Dynamical Regulation of Conductances in Cardiac Myocytes, *Dynamics Days*, January, 2010

HONORS AND AWARDS

- Recipient of the University of Colorado Graduate School Travel Grant for Spring 2012
- Boston College: graduated with Honors in Mathematics, 2008
- Inducted into Pi Mu Epsilon, National Mathematics Honor Society, 2007

PROFESSIONAL AFFILIATIONS

Member of SIAM: Society for Industrial and Applied Mathematics, 2008-present

COMPUTER SKILLS

- Copyrighted Software: *Synched* for Mac OS. *Synched* is a tools created for visualizing synchronizing phenomena of large complex systems in real-time. *Synched* includes many built-in models and is free to be downloaded and used for non-commercial purposes. Download available at: <http://amath.colorado.edu/student/skardal/Synched.html>

- Languages: C, C++, MATLAB, Java, FORTRAN, L^AT_EX, HTML, and some use of Unix shell scripts