UNIVERSITY OF MICHIGAN
Department of Mathematics

Seminar & Events Bulletin: Mathematical Biology

01-01-2013 to 06-30-2013

Monday, January 14, 2013	
12:00pm-1:00pm	**Mathematical Biology** -- Silas Alben (University of Michigan) *Mechanical models of fish and krill swimming* -- 335 West Hall

Friday, January 18, 2013	
3:00pm-4:00pm	**Mathematical Biology** -- Jean M.-S. Lubuma (Dept. of Mathematics and Applied Mathematics, University of Pretoria, South Africa) *On nonstandard finite-difference schemes in biosciences* -- 1084 East Hall

Monday, January 28, 2013	
12:00pm-1:00pm	**Mathematical Biology** -- Adam Stinchcombe (Courant Institute of Mathematical Sciences, New York University) *General gene-state switching models for stochastic gene expression* -- 335 West Hall

Monday, February 11, 2013	
12:00pm-1:00pm	**Mathematical Biology** -- Allen Liu (Dept of Mechanical Engineering, University of Michigan) *Systems analysis of clathrin-coated pit dynamics* -- 335 West Hall

Monday, March 18, 2013	
12:00pm-1:00pm	**Mathematical Biology** -- Gennady Cymbalyuk (Neuroscience Institutue, Georgia State University) *Cellular mechanisms controlling temporal characteristics of neuronal activity* -- 335 West Hall

Monday, April 22, 2013	
12:00pm-1:00pm	**Mathematical Biology** -- Joern Davidsen (Complexity Science Group, University of Calgary) *Inferring Causal Connections and Functional Networks* -- 335 West Hall

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Abstracts

Mathematical Biology
Monday, January 14, 2013, 12:00pm-1:00pm
335 West Hall
Silas Alben (University of Michigan)
Mechanical models of fish and krill swimming

We will give an overview of a few swimming problems with biological applications. First, we present a model of fish fin mechanics and solve a simple optimization problem for fish fins: what distributions of elastic components maximize the stiffness of the fin? We then discuss the resonant properties of flexible beams in fluid flows, as models for fish fins and bodies during swimming. Finally, we will discuss a simple model of krill swimming which asks: how should the krill coordinate the motions of its appendages for fast and efficient swimming?

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Mathematical Biology
Monday, March 18, 2013, 12:00pm-1:00pm
335 West Hall
Gennady Cymbalyuk (Neuroscience Institutue, Georgia State University)
Cellular mechanisms controlling temporal characteristics of neuronal activity

Central pattern generating neuronal networks control and coordinate rhythmic movements. In many such networks, the phase relations of activities of neurons are conserved over a range of values of cycle period. How temporal characteristics are maintained in oscillatory networks is an open question. We model cell intrinsic mechanisms that control temporal characteristics and produce phase maintenance in neuronal networks. We focus on the coregulation of a potassium current (IK) and a hyperpolarization-activated current (Ih). The dynamics of this model are governed by a codimension-2 bifurcation: the cornerstone bifurcation. The bifurcation satisfies conditions for the saddle-node bifurcation on invariant circle (SNIC) and the blue sky catastrophe. For parameter values close to the bifurcation, we achieved control over the burst duration and interburst interval by varying the voltages of half activation of IK and Ih. Similarly we were able to control the latency to spiking after inhibition in a spiking neuron and the duration of single evoked bursts in a silent neuron. We constructed a series of network motifs for central pattern generators typical for motor control and demonstrated how control of bursting activity on the level of individual cells controls phase constancy.

Mathematical Biology
Monday, April 22, 2013, 12:00pm-1:00pm
335 West Hall
Joern Davidsen (Complexity Science Group, University of Calgary)
Inferring Causal Connections and Functional Networks

Inferring cause-effect relationships from observations is one of the fundamental challenges in natural sciences and beyond. Due to the technological advances over the last decade, the amount of observations and data available to characterize complex systems and their dynamics has increased substantially, making scientists face this challenge in many different areas. Specific examples of general importance include seismicity as well as nerve cell cultures and even the brain. In this talk, I will discuss new methods from nonlinear sciences and complex network theory to infer causal interactions and characterize spatio-temporal clustering of point processes with a particular focus on the aforementioned applications. In particular, I will present a method that identifies triggering relationships between earthquakes such that seismicity can be described by triggering cascades and mapped to a complex network. This novel approach allows one to tackle many open questions related to earthquakes and seismicity.