Biological Stochastic Dynamics Group Activities

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Activity Subgroups

- Molecular Motors
- Stochastic Single Neuron Models
- Microswimming
- Modeling Biological Swarms Using Nonlinear Diffusions
- Reaction Networks

Molecular Motors

Mesoscale stochastic model for multiple motors interacting with cargo

- Scott McKinley, Avanti Athreya, John Fricks, Peter Kramer
- at least one paper in preparation
- two NSF group grant proposals submitted (with Will Hancock, bioengineer)

Stochastic Single Neuron Models

Most activities joint with Qualitative Stochastic Dynamics working group.
"How sample paths of Leaky Integrate and Fire models are influenced by the presence of a firing threshold"

- Cindy Greenwood, Laura Sacerdote, Maria Teresa Giraudo
- submitted to *Neural Computation*

Stochastic Morris-Lecar models

- Avanti Athreya, Badal Joshi, Xueying Wang
- Coherence and self-induced stochastic resonance in Morris-Lecar neurons
- Effects of synaptic noise in two or three coupled neurons
- Characterizing correlations between observed spike trains in two neurons

Escape from stable equilibrium in Morris-Lecar neurons

- Avanti Athreya, Scott McKinley, Ravi Srinivasan

Microswimming

Activity stimulated by talks in SAMSI workshop "Self-Organization and Multi-Scale Mathematical Modeling of Active Biological Systems" (Fall 2009)

- Concerted effort to stochastically model anomalous self-similarity reported in Dynamics of Enhanced Tracer Diffusion in Suspensions of Swimming Eukaryotic Microorganisms by Leptos, Guasto, Gollub, et al.
  - abandoned when confounding issues of experimental measurement were unable to be satisfactorily addressed
- Idea emerging from Michael Shelley's talk on kinetic theories for suspensions of microswimmers and Peter Mucha's question on the importance of modeling diffusion stochastically in suspensions is being pursued by Peter Kramer, his graduate student, and colleague Patrick Underhill

Modeling Biological Swarms using Nonlinear Diffusions

Activity stimulated by talks in SAMSI workshop "Self-Organization and Multi-Scale Mathematical Modeling of Active Biological Systems" (Fall 2009), particularly that of Andrea Bertozzi Amarjit Budhiraja, Oliver Diaz, and Xin Liu are exploring using techniques from theory of nonlinear diffusions

- attempt to capture key aspects of phenomological continuum theories from more fundamental stochastic particle systems with mean field interactions
- added insight and more tractable simulations
- long term goal: rigorous hydrodynamic limit and fluctuation theorems

Reaction Networks

Stochastic model for genetic regulatory network in suprachiasmatic nucleus (circadian rhythms)

- John Fricks, Badal Joshi, John McSweeney, Richard Yamada
- stochastic simulations exhibit oscillations in concentrations not seen in deterministic mass-action model
- goal: explain oscillations through coarse-graining of stochastic model via, e.g., van Kampen expansion