News & Events

Dynamical Systems & Nonlinear Science Seminar

Fridays 224 Fine Hall 1:30 pm
collapse all – expand all

2012 Collapse/Expand

Date: November 9
Speaker: Matthew Williams, PACM, Princeton University
Title: Neuro-mechanical control of forward, backward and sideward stepping
Abstract: Due to their prevalence in physical applications, the dynamics and behavior of nonlinear PDEs and large coupled systems of nonlinear ODEs are of interest to scientists and engineers; mathematically, we desire the solution branches and bifurcations of the underlying system. However, the computational cost associated with using standard methods for numerical continuation can often be prohibitive due to the large state space. In this talk, I will discuss the application of data driven methods such as the Proper Orthogonal Decomposition to the Waveguide Array Mode-Locking (WGAML) Model in nonlinear optics and Euler's equations for standing surface water waves in order to generate reduced order models (ROMs). Using the resulting ROMs, I then compute the solutions and bifurcations involved in the multi-pulsing transition of WGAML model and the solution branches of time-periodic standing surface waves. I will also discuss the generalization of these data-driven methods for other uses, such as in an adaptive ROM/PDE integrator.

Date: October 5
Speaker: Sylvia Daun-Gruhn, Computational Biology, Zoological Institute, University of Cologne
Title: Neuro-mechanical control of forward, backward and sideward stepping
Abstract: The coordination of the movement of single and multiple limbs is essential for the generation of locomotion. Movement around single joints and the resulting stepping patterns are usually generated by the activity of antagonistic muscle pairs. In the stick insect, the three major muscle pairs of a leg are the protractor-retractor, the levator-depressor and the flexor-extensor. The protractor-retractor moves the coxa and thereby the leg forward and backward, the levator-depressor moves the femur up and down and the flexor-extensor flexes or extends the tibia around the femur-tibia joint. The underlying neuronal mechanisms for a forward stepping middle leg have been intensively studied in experimental and theoretical studies. However, details about neuronal and mechanical mechanisms driving a single stepping leg in situations other than forward walking remain largely unknown. In my talk I'm going to present a neuro-mechanical model of the coupled three joint control system of the stick insects middle leg that is able to produce forwards, backwards or sidewards walking. Switching between these three different behaviors is achieved by minimal changes to the central control to the neuro-mechanical model. I will hypothesize a neuronal control mechanism that could underlie this behavior in the real animal.

Date: April 6
Speaker: Tian Shen, MAE Dept, Princeton University
Title: Modeling Human Collaborative Decision Making Dynamics
Abstract: In this talk I will present preliminary work towards understanding the dynamics of consensus decision making in the case of humans who must work together but may have different, and possibly conflicting, information about their task. The effort makes use of data from experiments in which pairs of human players jointly controlled a virtual object to follow as closely as possible a sequence of separately issued visual cues that require a series of binary decisions. We propose an ODE model to describe the continuous-time individual trajectories and the mutual interaction levels. We assume that a player's trajectory is influenced by the dynamic interplay between social interaction and external cues. Through fitting the model to data and interpreting parameter values, we hope to understand how human players interact with each other to make a quick joint decision, despite having indirect communication and conflicting visual cues. With the model as a prototype, we examine an augmented system with arbitrary number of agents, and investigate how individual parameters and team size

affect the group-level behavior.

Date: February 17
Speaker: Simon Cotter, University of Oxford
Title: Solution of the Effective Fokker-Planck Equation for High Dimensional Chemical Systems
Abstract: When modelling biochemical reactions within cells, it is vitally important to take into account the effect of intrinsic noise in the system, due to the small copy numbers of some of the chemical species. Deterministic systems can give vastly different types of behaviour for the same parameter sets of reaction rates as their stochastic analogues, giving us an incorrect view of the bifurcation behaviour. The stochastic description of this problem gives rise to a multi-dimensional Markov jump process, which can be approximated by a system of stochastic differential equations. Long-time behaviour of the process can be better understood by looking at the steady-state solution of the corresponding Fokker-Planck equation. In this talk we consider a new finite element method which uses simulated trajectories of the Markov-jump process to inform the choice of mesh in order to approximate this invariant distribution for systems of 3 chemical species. We will also briefly outline how this method can be used in conjunction with appropriate multiscale methods in order to approximate the invariant distribution of up to 3 slow species for much higher dimensional systems.

2011 Collapse/Expand

Date: February 18
Speaker: Farzan Nadim, Dept. of Mathematical Sciences, NJIT / Dept. of Biological Sciences, Rutgers University
Title: Preferred frequencies of synapses in a central pattern generating network
Abstract: click to view
Recent publications from our lab have shown that neurons in the crustacean pyloric central pattern generator exhibit membrane resonance and that the resonance frequency of the pyloric pacemaker neurons is correlated with the pyloric network frequency. I will show new data demonstrating the presence of preferred frequencies in pyloric synapses and use reduced models to explore the potential consequences of such short-term dynamics in oscillatory network.

Date: March 4
Speaker: Andy Stewart, Princeton University
Title: Humans in the Loop: Decision-Making Teams for Management of Automated Systems
Abstract: click to view
With an eye towards design of human-in-the-loop systems, we investigate human decision making in a social context for tasks that require repeated choices among finite alternatives. In applications that involve human supervisory control of automated platforms, humans are often faced with making repeated choices among finite alternatives in response to observations of the evolving system performance. In order to design humans into such systems, it is important to develop a systematic description of human decision making in this context. We consider a human decision maker receiving feedback on their own performance as well as on the choices of others performing the same task. In this talk I will present a predictive model for decision making in a two-alternative choice task that has been studied experimentally by psychologists and behavioral scientists. I will show conditions for this model to be a Markov process, and derive the steady-state probability distribution for choice sequences and individual performance as a function of the strength of the social feedback. It has recently been shown in behavioral experiments that human decision-making performance for a relatively easy task is decreased with this social feedback; we show that analytic predictions agree with this finding. Using the analytic expression for this distribution, we also prove suboptimal behavior for tasks that exhibit a matching point in reward and we compute the sensitivity of steady-state choices to a model parameter that measures the decision maker's "exploratory" tendency.

Date: April 1
Speaker: Darren Pais, Princeton University
Title: Limit Cycles in Replicator-Mutator Network Dynamics
Abstract: click to view
Replicator-mutator equations from evolutionary dynamics can serve as a model for the evolution of language, behavioral dynamics in social networks, and decision-making dynamics in networked multiagent systems. Analysis of the equilibrium points of these dynamics has been a focus in the literature, where symmetry in fitness functions is typically assumed. We

explore asymmetry in fitness and show that the replicator- mutator equations exhibit Hopf bifurcations and stable limit cycles. We prove conditions for the existence of stable limit cycles for the dynamics in the case of circulant fitness matrices, and illustrate their existence for noncirculant fitnesses. These limit cycles correspond to sustained oscillations of grammar selection in evolution of language, to oscillations of preferences in social networks, and to oscillations of decisions in a group between exploratory and exploitative behaviors.

Date: September 30
Speaker: Jean-Luc Thiffeault, University of Wisconsin - Madison
Title: Topological chaos and optimization
Abstract: click to view
Topological chaos is a type of chaotic behavior that is 'forced' by the motion of obstacles in some domain. I will review two topological approaches, with applications in particular to stirring and mixing in fluid dynamics. The first involves constructing systems such that the fluid motion is topologically complex, usually by imposing a specific motion of rods. I will then discuss optimization strategies that can be implemented. The second is diagnostic, where flow characteristics are deduced from observations of periodic or random orbits and their topological properties.

Date: October 7
Speaker: Andrea Nedic, Princeton - Electrical Engineering
Title: Models for individual decision-making with social feedback
Abstract: click to view
To investigate the influence of input from fellow group members in a constrained decision-making context, we develop 2-armed bandit tasks in which subjects freely select one of two options and are informed of the resulting reward following each choice. Each task is designed to probe a different type of behavior, and subjects work in groups of five with feedback of other group members' choices, of their rewards, of both, or with no knowledge of others' behavior. We employ a soft-max choice model that emerges from a drift-diffusion process, commonly used to model perceptual decision making with noisy stimuli. Our most complex model, involving both choice and reward feedback, contains only four parameters, but nonetheless reveals significant differences in individual strategies. Strikingly, we find that rewards feedback can be either detrimental or advantageous to performance, depending upon the task. We also investigate data from a two-dimensional spatial exploration task in which rewards received are determined by a spatially-dependent schedule whose mean varies along one dimension, with no change in rewards, on average, along the other direction. We examine how rewards may be inferred over the space being explored, and then consider how this reward-inference model may elucidate behavioral changes and different propensities for exploration or exploitation arising from various types of social feedback.

Date: October 28
Speaker: Eli Shlizerman, University of Washington, Seattle
Title: Activity Measure Evolution Equations: Dimension reduction for networks of neurons
Abstract: click to view
The collective behavior of a finite size neural population is often determined by the individual dynamics. The interactions within the population effectively modify the individual dynamics even in the presence of synchrony. In this talk I will present a framework called Activity Measure Evolution Equations (AMEE) that we have developed to take into account the individual dynamics and interactions between individuals. The resulting equations model the dynamics of a projection that expresses the functionality of a network. In the presence of an attractor, we show that the AMEE shadow the activity of the network, composed from neurons governed by continuous conductance based equations and general interactions. When the attractor is spatially-synchronous these equations serve as a dimension reduction for the complex network. Beyond synchrony, such an approach allows to construct low-dimensional models that retain the dynamics of coherent structures and identify responsible mechanisms for decoherence. Computational results comparing various networks dynamics with their corresponding AMEE models and an application of the theory to decision making in the olfactory system will be presented.

Date: December 9
Speaker: Carlo Laing, Massey University, NZ
Title: Chimera States in Heterogeneous Kuramoto Networks

Abstract: click to view
Chimera states occur when a network of identical oscillators splits into two groups, one consisting of synchronous oscillators, the other of partially-synchronous oscillators. We show how to analyze such states when the oscillators are not identical, using the recent ansatz of Ott and Antonsen to derive non-local differential equations governing the network dynamics in the continuum limit. The same techniques can be used to study transient fronts which connect regions of high synchrony with regions of asynchrony.

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Date: January 22
Speaker: Eli Shlizerman, University of Washington, Seattle
Title: From Order to Spatiotemporal Chaos in the Perturbed Nonlinear Schrodinger
Abstract: click to view
The one-dimensional nonlinear Schrodinger equation (1D NLS) emerges as a first order model in a variety of fields--from high intensity laser beam propagation to Bose-Einstein condensation to water waves theory. The 1D NLS is completely integrable, hence solvable, on the infinite line or with periodic boundary conditions. The realization that the integrable structure might not persist under small perturbations led to the study of the periodic 1D NLS perturbed by a slightly conservative periodic forcing. In this talk I will describe our studies in which we show co-existence of various types of perturbed solutions such as ordered, temporal chaotic and spatiotemporal chaotic solutions. The prediction of the initial profiles that evolve into the different types of perturbed solutions is performed by utilizing a novel geometrical phase space description of the integrable unperturbed equation. As a result, we identify three mechanisms of temporal chaos in the perturbed NLS: homoclinic chaos, hyperbolic resonance, and parabolic resonance. For the latter mechanism we show that it serves as a route from initial data near an unperturbed stable plane wave to a regime of spatiotemporal chaos. Statistical measures are employed to demonstrate that this spatiotemporal chaos is intermittent: there are windows in time for which the solution gains spatial coherence. This is a joint work with V. Rom-Kedar.

Date: February 12
Speaker: Gordon Berman, Physics Dept, Princeton
Title: Optimization, Control, and Flies
Abstract: click to view
Why do animals move in the way they do? This question, though broad, provides the undergirding for the types of problems in which I am interested. For instance, what role does energetics play in locomotion? Do animals perform tasks in a manner which can be viewed as "optimal" in some sense, or has evolution arrived at a solution which is more complicated? Also, how do animals make decisions about their locomotion in often noisy, challenging environments? How do they use the complicated, conflicting reports of sensory organs, prior experience, and inter-individual interactions to induce a desired body motion? In this talk, I will speak about the research my collaborators and I have done exploring these questions through the lens of flying insects. Through a combination of theoretical modeling, computational simulation, and high speed videography, we look at how these fascinating animals locomote and what this can say about larger questions in biomechanics, dynamics, and evolution.

Date: February 19
Speaker: Michael Schemmer, Applied Mathematics, University of California at Davis
Title: The Effects of Dendritic Properties on the Dynamics of Oscillatory Neurons
Abstract: click to view
Neurons can have extensive spatial geometries, but they are often modeled as single-compartment objects that ignore the spatial anatomy of the cell. This simplification is made for mathematical tractability and computational efficiency. However, many neurons are not electrotonically compact, and single-compartment models cannot be expected to fully capture their behavior. Dendritic properties can have substantial effects on the dynamics of single neurons, as well as the activity in neuronal networks. We study the influences of thin and general diameter passive dendrites on the dynamics of single neuronal oscillators. For sufficiently thin dendrites and general somatic dynamics, we elucidate the mechanisms by which

dendrites modulate the firing frequency of neurons. We find that the average value of the somatic oscillator's phase response curve indicates whether or not the dendrite will cause an increase or decrease in firing frequency. For general diameter dendrites and idealized somatic dynamics, we find that the neuron displays bistable behavior between periodic firing and quiescence. In this case, the dendritic properties cause the cell to behave like a neuronal switch. Furthermore, we identify the mechanism that causes this bistability to occur. This mechanism was previously only described in models that contain active dendritic conductances.

Date: February 26
Speaker: Josh Proctor, MAE, Princeton University
Title: Chasing the Cockroach: How reflexes enhance running
Abstract: click to view

Neuromuscular systems are stabilized and controlled by both feedforward and feedback signals. Feedforward pathways driven by central pattern generators (CPGs), in conjunction with mechanical reaction forces and nonlinear muscle properties, suffice to produce stable stereotypical gaits. (1) These preflexive mechanisms combine with neural reflexes originating in proprioceptive sensors to yield robust behavior in uncertain environments. Experiments, though, have shown that feedback is present and important for both slow and rapid running. (2,3) The focus of the current study is to understand how neural feedback, reflexes, can affect the motor program of the cockroach. We have developed a one dimensional neuromechanical model that represents a single actuated joint consisting of a neural system periodically activating agonist/antagonist muscles. We consider two types of feedback representative of sensory feedback in the cockroach: phasic or spike-timing, and tonic or firing rate. Phasic feedback encodes state information, such as position, in the timing of individual spikes. In contrast, firing rates can encode graded measures of force or other continuous variables. Using this single actuated joint model, we can investigate how the output of the neural system is changed by different sensory feedback. Results show that both phasic and tonic feedback can shift the relative phasings of the motoneurons thereby affecting the motion of the joint. These changes seen in the model can be qualitatively matched to experimental observations in the cockroach. These sensory systems have also been implemented in a complex hexapedal model and demonstrates that the system with feedback is more robust than the one without. In order to further analyze the hexapedal model, we employ phase reduction and averaging theory to replace 264 ordinary differential equations (ODEs) describing the neural system with 24 one-dimensional phase oscillators that describe motoneuronal activation of agonist-antagonist muscle pairs driving the jointed legs. We show that the reduced model captures the dynamics of unperturbed gaits and the effects of an impulsive perturbation as accurately as the original one. Moreover, the phase response and coupling functions provide an improved understanding of the effects of reflexive feedback.

References (1) P. Holmes, R.J. Full, D. Koditschek, and J. Guckenheimer. (2) S. Sponberg and R.J. Full. (3) S.N. Zill, A.L. Ridgel, R.A. DiCaprio, and S.F. Frazier

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Date: March 5
Speaker: Philip Eckhoff, Intellectual Ventures Lab, Bellevue, WA
Title: Modeling Mosquitoes for Malaria Eradication
Abstract: click to view
Malaria is responsible for over 500 million cases and 1 million deaths a year, but it has been targeted for global eradication. Malaria has a complicated life cycle, with several parasite stages in the human host and several stages in female Anopheles mosquitoes. A mosquito can be infected with the parasite by feeding on an infectious individual and can then transmit to a new individual on a later bite, after a latent interval. Since the mosquito is an essential link in the the transmission cycle, it is not surprising that mosquito control is a key component for fighting malaria. We present a model to estimate the effects of different forms of vector control on malaria transmission, focusing on mosquito population dynamics. Forms of vector control studied include treated bednets, indoor spraying, larvicides, and new technologies under development.

Date: March 12
Speaker: Ronit Fuchs, Weizmann Institute, Israel
Title: Kinematics and Geometrical Invariance

Abstract: click to view
Human movements show several prominent features, such as movement duration being nearly independent of movement size (the isochrony principle), the dependency of instantaneous speed on the movement's curvature (captured by the 2/3 power law, also known as constant equi-affine velocity) and that complex movements are composed of simpler elements (movement compositionality). No existing theory can successfully account for all of the above features. I will present a new theory of trajectory formation inspired by geometrical invariance. The theory proposes that movement duration and compositionality arise from combining Euclidian, equi-affine and full affine geometries. Further, the theory suggests that the choice of the specific combination of geometries can be explained by optimization principles. In our work we show that the actual movement duration reflects a particular tensorial mixture of these geometrical parameters. The theory succeeded in accounting for the kinematic and temporal features of recorded locomotion and drawing movements.

Date: April 9
Speaker: Greg Stephens, Physics Dept., Princeton University
Title: The emergence of stereotyped, long-time behaviors in c elegans
Abstract: click to view
Animal behaviors are often decomposable into discrete, stereotyped elements. In one view, such behaviors are triggered by specific commands; in the extreme case, the discreteness of behavior is traced to the discreteness of action potentials in the individual command neurons. Here, we use the crawling behavior of the nematode C. elegans to explore the opposite extreme, in which discreteness and stereotypy emerges from the dynamics of the entire behavior. A simple stochastic model for the worm's continuously changing body shape during crawling has attractors corresponding to forward and backward motion; noise-driven transitions between these attractors correspond to abrupt reversals. We show that, with no free parameters, this model generates reversals at a rate within error bars of that observed experimentally, and the relatively stereotyped trajectories in the neighborhood of the reversal also are predicted correctly.

Date: September 24
Speaker: Andrea Barreiro, University of Washington
Title: Modeling cooperative activity in neural systems
Abstract: click to view
Collective activity is widespread in the nervous system and has important implications for functionality. When can we represent such activity by lower dimensional models, and how does our ability to do so depend on basic circuit properties such as input statistics, internal dynamics and network connectivity? We take some first steps toward answering this question by studying the ability of maximum entropy models to characterize the spiking activity of networks modeled on retinal circuitry.

Date: October 1
Speaker: Hillel Raz, Cardiff University, UK
Title: Minimal Partitions of Quantum Graphs
Abstract: click to view
The eigenfunction of the nth eigenvalue of the Laplacian ($-d^2/dx^2$) on a bounded regular domain partitions that domain into k subdomains (known as nodal domains). Courant's nodal domain theorem states that $k\le n$. We study the relationship between the nth eigenfunction of the Laplacian on quantum graph (a graph where each edge has a positive length with specific boundary conditions at the vertices) and partitions of the graph into n parts. We describe a procedure of attaining eigenfunctions, and hence the spectrum, by investigating these partitions, in particular minimal ones. The minimal partitions are found by assigning a score to each partition which is the maximum of the first eigenvalue of the Laplacian over each part of the partition. No prior knowledge of quantum graphs is necessary. This is joint work with Ram Band, Gregory Berkolaiko and Uzy Smilanskybased and is based partially on results by Bernard Helffer, Thomas Hoffmann-Ostenhoff, Susanna Terracini et al.

Date: November 12
Speaker: Philippe Trinh, Princeton University
Title: Have you seen our water waves?

Abstract: click to view
When water flows past an obstruction such as a ship or a step in a channel, waves are often produced behind or ahead of the disturbance. Recently, techniques in exponential asymptotics have allowed us to predict the theoretical existence of new classes of gravity-capillary waves. These waves have never been seen before---in nature or in the digital world. Do they truly exist? Come and decide for yourselves!

Date: November 19
Speaker: Audrey Sederberg, Princeton University
Title: The emergence of motion-processing circuits in primary visual cortex
Abstract: click to view
Neurons in primary visual cortex acquire direction selectivity only after the animal is shown moving visual stimuli. This experimental observation inspires our study of the input-driven dynamics of the development of cortical circuits. I will discuss a simple theory based on Hebbian dynamics for the development of a motion-processing circuit. This work suggests a strong role for lateral inputs to the cell, leading to our effort to quantify the structure of cell-cell cross-correlations in layer 2/3 of developing ferret visual cortex based on the analysis of two-photon imaging data.

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2009 Collapse/Expand

Date: October 16
Speaker: Georgi Medvedev, Drexel University
Title: Synchronization and denoising in dynamical systems interacting via dissipative coupling
Abstract: click to view
Dynamics of systems with multiple stable or metastable states can be very sensitive to the size of random perturbation. We show that by combining local randomly perturbed dynamical systems in a coupled network, one can preserve the attractors of the underlying local deterministic systems, while drastically reducing the effects of noise on the local dynamics. Denoising can be used to make the dynamics of the local systems more reliable (i.e., better predictable) in the presence of noise. It can also be an important factor shaping the network dynamics. The mechanism of denoising is closely related to that of synchronization. We analyze both effects and discuss several applications to computational neuroscience.

Date: December 4
Speaker: Miranda Holmes-Cerfon, Courant Institute, NYU
Title: Particle dispersion and energy focusing by random waves in the ocean
Abstract: click to view
The ocean is filled with fast, small-scale motions called internal waves, which are too small to be resolved by numerical models, yet which are the most energetic motions in the ocean's interior. How do they affect the larger-scale circulation? We look at two possible mechanisms. The first is horizontal dispersion: even though a linear wave field is periodic, we show that a random wave field can disperse particles in a diffusive manner because of nonlinear corrections which are required to make the velocity field dynamically consistent. The second mechanism is dissipation: we consider how an internal wave is modified as it propagates over random topography. The solution for periodic topography is easy to derive and leads to energy focusing on a single characteristic trajectory; we show that in the random case the same focusing happens and is related to the properties of an underlying random attractor for the dynamical system describing the wave characteristics. We then derive scaling laws for energy dissipation, and show that there is a universal length scale controlling tidal energy dissipation in the ocean which is independent of the scale of the waves.

Date: December 11
Speaker: KongFatt Wong-Lin, Princeton University (PACM)
Title: Contributions of time-varying gain modulation in perceptual decision making
Abstract: click to view
Recent studies have shown that some form of urgency signals may play a role during the temporal integration of sensory evidence in perceptual decision-making in primates. Neuronal correlates of such temporal integration have been found in

several brain areas, such as the parietal cortex. Furthermore, it has been shown in many studies that parietal cortical neurons can exhibit multiplicative gain modulation properties. In this theoretical work, we connect this growing body of research areas by investigating how time-varying single-cell gain modulation can contribute to the decision network dynamics and performance in two-choice motion-discrimination tasks. We implement a biologically-based nonlinear network model for decision making and use dynamical systems analysis to study how the decision dynamics evolves over different time epochs of a simulated task trial. Results from our analyses and simulations show that increasing the gains of both excitatory and inhibitory neurons is necessary to capture the full characteristics of the observed neuronal dynamics and decision performance (accuracy and reaction times) in various motion-discrimination tasks. Through simulations, we also study how fast the recruitment of gain modulation is needed to attain maximum reward rate (total number of correct responses over total time taken). Our work provides an integrative and coherent understanding of the interplay among separate neuronal processes that enable flexible and optimal decision performance. This is joint work with Ritwik Niyogi.

Date: January 22
Title: From Order to Spatiotemporal Chaos in the Perturbed Nonlinear Schrodinger
Abstract: click to view
The one-dimensional nonlinear Schrodinger equation (1D NLS) emerges as a first order model in a variety of fields--from high intensity laser beam propagation to Bose-Einstein condensation to water waves theory. The 1D NLS is completely integrable, hence solvable, on the infinite line or with periodic boundary conditions. The realization that the integrable structure might not persist under small perturbations led to the study of the periodic 1D NLS perturbed by a slightly conservative periodic forcing. In this talk I will describe our studies in which we show co-existence of various types of perturbed solutions such as ordered, temporal chaotic and spatiotemporal chaotic solutions. The prediction of the initial profiles that evolve into the different types of perturbed solutions is performed by utilizing a novel geometrical phase space description of the integrable unperturbed equation. As a result, we identify three mechanisms of temporal chaos in the perturbed NLS: homoclinic chaos, hyperbolic resonance, and parabolic resonance. For the latter mechanism we show that it serves as a route from initial data near an unperturbed stable plane wave to a regime of spatiotemporal chaos. Statistical measures are employed to demonstrate that this spatiotemporal chaos is intermittent: there are windows in time for which the solution gains spatial coherence. This is a joint work with V. Rom-Kedar

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2008-2009 Collapse/Expand

Date: October 3
Speaker: Philip Eckhoff, PACM, Princeton University
Title: A new intrahost model of *P. falciparum* infections
Abstract: click to view
Malaria is one of the most important global health challenges, with almost 1 million dead a year, mostly children in Africa. Mathematical models can help determine the likely impact of interventions such as bed nets or drug distribution. The way a single infection is modeled can strongly influence the result, whether it is an exponential distribution for a duration of constant infectiousness, samples from empirical data, or a bottom-up mechanistic model. Within each of these categories, there are a variety of approaches with different levels of realism. We review other approaches and present a new mechanistic model, the results of which are compared to malariatherapy data.

Date: October 10
Speaker: Joshua Proctor, MAE, Princeton University
Title: The Role of Proprioceptive Feedback in Cockroach Locomotion
Abstract: click to view
The Cockroach is a quick and nimble runner, navigating a variety of environments with an adeptness that eludes any robot. These specific characteristics have inspired biologists, mathematicians, engineers, and roboticists to investigate rapidly running cockroaches. At these speeds, previous studies have shown that cockroach locomotion is driven by a feed-forward architecture in which a neuronal system rhythmically activates muscles and legs, ballistically driving the body over rough terrain. In contrast, slipping or mis-stepping at slow speeds may require reflexes, much the same as in the human body, that

help the insect recover from perturbations. The importance of reflexes, via proprioceptive sensors in the legs, and how they can modulate movement is the primary concern of this research. Integrating feedback in neuro-mechanical locomotion models, we can investigate the importance of different types of feedback (e.g. position of, velocity of, or load on a leg). Understanding how feedback is utilized in these systems will provide insight into the remarkable ability of insects and animals to adapt and modulate their running behavior to interact effectively with their environments.

Date: November 7
Speaker: Yi Sun, CIMS, New York University
Title: Network dynamics of Hodgkin-Huxley neurons
Abstract: click to view
The reliability and predictability of neuronal network dynamics is a central question in neuroscience. We present a numerical analysis of the dynamics of all-to-all pulsed-coupled Hodgkin-Huxley (HH) neuronal networks. Since this is a non-smooth dynamical system, we propose a pseudo-Lyapunov exponent (PLE) that captures the long-time predictability of HH neuronal networks. The PLE can capture very well the dynamical regimes of the network. Furthermore, we present an efficient library-based numerical method for simulating HH neuronal networks. Our pre-computed high resolution data library can allow us to avoid resolving the spikes in detail and to use large numerical time steps for evolving the HH neuron equations. By using the library-based method, we can evolve the HH networks using time steps one order of magnitude larger than the typical time steps used for resolving the trajectories without the library, while achieving comparable resolution in statistical quantifications of the network activity. Moreover, our large time steps using the library method can overcome the stability requirement of standard ODE methods for the original dynamics.

Date: November 21
Speaker: Raghu Kukillaya, MAE, Princeton University
Title: A model for insect locomotion in the horizontal plane: Feedforward activation of fast muscles, stability, and robustness.
Abstract: click to view
We develop a neuromechanical model for running insects that includes a simplified hexapedal leg geometry with agonist-antagonist muscle pairs actuating each leg joint. Restricting to dynamics in the horizontal plane and neglecting leg masses, we reduce the model to three degrees of freedom describing translational and yawing motions. The muscles are driven by stylized action potentials characteristic of fast motoneurons, and modeled using activation via calcium release and nonlinear length and shortening velocity dependence. Parameter values are based on measurements from depressor muscles and observations of kinematics and dynamics of the cockroach *Blaberus discoidalis*; in particular, motoneuronal inputs are chosen to approximately achieve joint torques that are consistent with measured ground reaction forces. We show that the model has stable double-tripod gaits over the animal's speed range, that its dynamics at preferred speeds matches those observed, and that it maintains stable gaits, with low frequency yaw deviations, when subject to random perturbations in foot touchdown timing and action potential input timing. We explain this in terms of the low-dimensional dynamics.

Date: December 12
Speaker: Victor Yakhot, Mechanical Engineering, Boston University
Title: Stokes' Second Flow Problem in a High Frequency Limit: Application to Nanomechanical Resonators
Abstract: click to view
Solving the Boltzmann - BGK equation, we investigate a flow generated by an infinite plate oscillating with frequency ω. Geometrical simplicity of the problem allows a solution in the entire range of dimensionless frequency variation $0 \leq \omega\tau \leq \infty$, where τ is a properly defined relaxation time. A transition from viscoelastic behavior of Newtonian fluid ($\omega\tau \to 0$) to purely elastic dynamics in the limit $\omega\tau \to \infty$ is discovered. The relation of the derived solutions to nanofluidics is demonstrated on a solvable example of a "plane oscillator." The results from the derived formulae are favorably compared with experimental data on various nanoresonators operating in a wide range of both frequency and pressure variation. The universal relation for the dissipation rate in oscillating flows valid in both Newtonian and Non-Newtonian regimes is derived and compared with experimental data covering huge ranges of frequency ($10^3 \leq \omega \leq 10^9$ *Hz*) and linear dimension ($10^{-2} \leq L \leq 10^{-6}$ m) variation.

Date: January 16
Speaker: Luca Scardovi , MAE, Princeton University

Title: Synchronization and aggregation in natural and engineered networked systems
Abstract: click to view
Synchronization is the science of order in time and studies the ways rhythms become spontaneously organized. It is ubiquitous in nature and in engineering applications: groups of fireflies, neurons or pacemaker cells synchronize spontaneously; fish move in formations to escape predators and improve foraging; robots can coordinate to accomplish tasks more efficiently.

In this talk I will present a mathematical formalism, based on input/output operators and graph theory, to study the emergent behavior of networks of interconnected systems. Following a system theory approach, in the first step, the system is decomposed into smaller isolated subsystems by ignoring interconnections. In the second step, the information from the isolated systems is combined with the information about the interconnections to draw conclusions on the behavior of the overall system.

First I will employ the proposed methodology to relate, for a class of networked systems, the cohesiveness of the network to the connectivity of the underlying communication graph. Cohesiveness is characterized by providing a finite L2 gain condition (depending on the graph connectivity) for the interconnected system. Applications range from coordination problems, where there are conflicting objectives, to the study of aggregation phenomena, where perturbations of the nominal systems must be taken into account. Both scenarios arise in networks of biological and engineered coordinating systems. Then I will characterize synchronization for a class of nonlinear coupled systems where each system is described by input-output interconnections of heterogeneous subsystems. These interconnection structures are common in the modeling of biochemical networks. Specific examples include synchronization of genetic oscillators (regulating the circadian clocks of living organisms) like the Goodwin oscillator and the repressilator.

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2007-2008 Collapse/Expand

Date: October 5
Speaker: Mir Abbas Jalali, IAS
Title: Perturbative Solutions of the Collisionless Boltzmann Equation for a Galactic Disk

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Date: October 12
Speaker: Samuel Walcott, Molecular Physiology and Biophysics, University of Vermont
Title: Motor protein kinetics: How rate constants depend on load

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Date: October 19
Speaker: Kong-Fatt Wong, PACM, Princeton University
Title: Time-varying perturbations during perceptual decision-making

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Date: October 26
Speaker: Mathieu Coppey, Chemical Engineering and Lewis-Sigler Institute, Princeton University
Title: Dynamics of maternal gradients in the Drosophila embryo

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Date: November 9
Speaker: Sidhartha Goyal, Physics, Princeton University
Title: Growth-Induced Instability in Metabolic Networks

Date: November 16
Speaker: Katherine Bold, PACM, Princeton University
Title: Using "Equation-free" techniques to analyze network evolution and the collective motion of coupled oscillators

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Date: November 30

Speaker: David Hu, Courant Institute, New York University
Title: Snakes on a plane

Date: December 7
Speaker: William Ryu, Lewis-Sigler Institute of Integrative Genomics, Princeton University
Title: Thermosensation and motor response of E. coli and C. elegans

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Date: December 14
Speaker: Philip Eckhoff, PACM, Princeton University
Title: A Century of Malaria Modeling

Date: February 8
Speaker: Manoj Srinivasan, Mechanical and Aerospace Engineering, Princeton University
Title: Mechanics of muscle contraction

Date: February 15
Speaker: Haldun Komsuoglu, Electrical and Systems Engineering, University of Pennsylvania
Title: Sprawled Posture in a Hexapod Robot, the LLS Model and "Preflex" Stability in Level Ground Running

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Date: February 29
Speaker: Jayant Kulkarni, Center for Theoretical Neuroscience, Columbia University
Title: Common-input models for multineural spike-train data

Date: March 7
Speaker: Shugo Yasuda, Mechanical Engineering and Science, Kyoto University
Title: A Model for Hybrid Simulations of Molecular Dynamics and CFD

Date: March 14
Speaker: Shai Revzen, Integrative Biology, University of California, Berkeley
Title: "Phaser" -- Towards a general purpose algorithm of estimating phase from multidimensional experimental data

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Date: April 11
Speaker: Hyun Jae Pi, Physics, Brandeis University
Title: Synapse as a multistable system

Date: April 18
Speaker: Gabor Domokos, Budapest University of Technology and Economics
Title: Geometry of turtles and pebbles, or, some mechanical aspects of shapes.

Date: April 25
Speaker: Michael Raghib Moreno, Ecology and Evolutionary Biology, Princeton University
Title: Collective decision making: Lessons from Swarms

Date: May 2
Speaker: Milos Ilak, MAE, Princeton University
Title: Model Reduction of Fluids Using Balanced Truncation

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2006-2007 Collapse/Expand

Date: September 15

Speaker: Robert Clewley, Department of Mathematics, Cornell University
Title: Modelling neuromuscular control of finger motion

Date: September 29
Speaker: Derek Paley, MAE, Princeton University
Title: Cooperative Control of Collective Motion with Limited Communication

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Date: October 6
Speaker: Gregory Stephens, CSBMB, Princeton University
Title: Learning the language of movement: Dimensionality and dynamics in the motor behavior of C. elegans

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Date: October 20
Speaker: Manoj Srinivasan, MAE, Princeton University
Title: Rocking soda-cans and infinite velocities

Date: November 10
Speaker: Mark Hoefer, Department of Applied Mathematics, University of Colorado at Boulder
Title: Dispersive Shock Waves and Their Interactions

Date: December 1
Speaker: Steve Brunton, MAE, Princeton University
Title: Invariant Manifold Transport Tubes in Space Mission Design &Chemical Reaction Dynamics

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Date: December 8
Speaker: Madhusudhan Venkadesan, Cornell University
Title: Dexterous manipulation in humans: characterizing a noisy dynamical system

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Date: February 9
Speaker: Roy Goodman, New Jersey Institute of Technology
Title: The chaotic scattering in wave interactions: From PDE's to ODE's to iterated maps

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Date: March 2
Speaker: Georgi Medvedev, Drexel University
Title: Discrete models of bursting

Date: March 9
Speaker: Gabor Domokos, Budapest Univ. of Technology & Economics
Title: Discrete state models in chaotic population dynamics

Date: March 16
Speaker: Steven Schiff, Pennsylvania State University
Title: Dynamics and Control of Pattern Formation in the Brain

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Date: March 30
Speaker: Juan Gao, MAE, Princeton University
Title: Oscillatory circuits underlying the retinal detection of temporal periodic pattern

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Date: April 13
Speaker: Sophie Yuan Liu, MAE, Princeton University
Title: Decision Making: from Bayesian Updating to Drift Diffusion Process

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Date: April 27
Speaker: Patrick Simen, PACM, Princeton University
Title: Controlling decision making

Date: May 4
Speaker: Peter Varkonyi, PACM, Princeton University
Title: Arrays of relaxation oscillators and the lamprey CPG

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2005-2006 Collapse/Expand

Date: September 23
Speaker: Derek Paley, Mechanical & Aerospace Engineering, Princeton University
Title: Oscillator Models and Collective Motion: Stabilization of Symmetric Patterns of Self-Propelled Particles

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Date: September 30
Speaker: Tyler McMillen and Phil Holmes PACM and Mechanical & Aerospace Engineering, Princeton University
Title: An elastic rod model for angulliform swimming, or a rod with a mind of its own

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Date: October 7
Speaker: Gábor Domokos, Budapest University of Technology and Economics
Title: Bifurcations of optima in structural design

Date: October 21
Speaker: Fumin Zhang, Mechanical & Aerospace Engineering, Princeton University
Title: Curve tracking for legged and wheeled robots

Date: November 11
Speaker: Michael Raghib, PACM and Ecology & Evolutionary Biology
Title: Point processes, entropy and moment closure in spatial ecology

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Date: December 2
Speaker: Juan Gao, Mechanical & Aerospace Engineering, Princeton University
Title: Dynamics of Neuronal Synchronization

Date: February 17
Speaker: Peter Varkonyi, Budapest University of Technology and Economics, Hungary
Title: On the number of equilibria of convex, homogenous bodies

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Date: February 24
Speaker: Alistair Boettiger, Physics, Princeton University
Title: A Dynamical Model of Epithelial Sheet Migration

Date: March 3
Speaker: Manoj Srinivasan, MAE, Princeton University
Title: Energetics of legged locomotion: Why humans walk and run, and how to build efficient robots

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Date: April 7
Speaker: Hartmut Geyer, Massachusetts Institute of Technology
Title: Gaining insights into legged locomotion by hierarchically exploiting compliant leg behavior

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Date: April 14
Speaker: Peter Eckhoff, PACM, Princeton University
Title: Variable Drift Rate Models for Decision Making in Monkeys

Date: April 21
Speaker: Raghavendra Kukillaya, MAE, Princeton University
Title: Towards a hexapedal locomotion model with realistic legs

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Date: April 28
Speaker: Timothy Chung, Mechanical Engineering, California Institute of Technology
Title: Distributed Sensing and Decision-making for Intelligent Robotic Systems

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Date: May 5
Speaker: Vered Rom-Kedar, Weizmann Institute
Title: From forced NLS to surface waves - towards classifying the structure of chaotic solutions

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Date: June 2
Speaker: Sanjay Lall, Stanford University
Title: Error Bounds for Control and Model Reduction of Stochastic Systems

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2004-2005 Collapse/Expand

Date: September 24
Speaker: Katy Bold, PACM, Princeton University
Title: Differential Equations on a Network: from Dynamics to Structure

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Date: October 1
Speaker: Justin Seipel, Mechanical and Aerospace Engineering, Princeton University
Title: Models of Legged Locomotion

Date: October 8
Speaker: Greg Reeves, Chemical Engineering, Princeton University
Title: Patterning in Drosophila embryo: a model on a onedimensional cell lattice

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Date: October 15
Speaker: Tyler McMillen, Applied Mathematics, Princeton University
Title: The Dynamics of Choice

Date: February 11
Speaker: Fumin Zhang, Mechanical & Aerospace Engineering, Princeton University
Title: Cooperative Control of Periodic Motion: Satellite Formations

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Date: February 25
Speaker: Greg Stephens, Physics, Princeton University
Title: A Selection of Problems in Computational Neuroscience

Date: March 4
Speaker: Edgar Choueiri, Mechanical & Aerospace Engineering, Princeton University
Title: Ion Acceleration by Beating Electrostatic Waves: Theory, Experiments and Relevance to Spacecraft Propulsion

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Date: March 25
Speaker: Mikko Haataja, Mechanical & Aerospace Engineering, Princeton University
Title: Pattern formation in materials science: Continuum models for microstructure evolution in crystalline materials

Date: April 1
Speaker: Manoj Srinivasan, Cornell University
Title: Why do humans walk and run?

Date: April 7
Speaker: Irene Moroz, University of Oxford
Title: The Extended Malkus-Robbins dynamo as a perturbed Lorenz system

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Date: April 8
Speaker: Jan Skotheim, Harvard University
Title: How a Venus flytrap snaps: a design principle for hydraulically activated movement

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Date: April 22
Speaker: Robert Szalai, Massachusetts Institute of Technology
Title: Bifurcations and chaos in high-speed milling

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2003-2004 Collapse/Expand

Date: September 19
Speaker: Tyler McMillen, PACM, Princeton University
Title: Perversions and Whips

Date: September 26
Speaker: Phil Holmes, MAE & PACM, Princeton University
Title: Piecewise-holonomic mechanics, hybrid dynamical systems, and escaping cockroaches

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Date: October 3
Speaker: Sung Joon Moon, Chemical Engineering, Princeton University
Title: Pattern formation, instabilities, and kink-induced segregation in oscillated granular layers

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Date: October 17
Speaker: Yannis Kevrekidis, Chemical Engineering, Princeton University
Title: Equation-Free Complex Systems Modeling: or how to make fine things coarse

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Date: November 14
Speaker: Jaime Cisternas, Chemical Engineering, Princeton University
Title: Modeling of Influenza A Evolution: Coarse-grained computations with individual-based models

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Date: November 21
Speaker: Jeff Moehlis, University of California, Santa Barbara
Title: A low-dimensional model for shear flows

Date: December 5
Speaker: Stan Shvartsman, Chemical Engineering & Genomics Institute, Princeton University
Title: Modeling and manipulating EGFR-mediated cell communication in development

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Date: February 6
Speaker: Sergey Kryazhimskiy, PACM, Princeton University
Title: Global Domain of Attraction of a Step-Like Contrast Structure

Date: February 13
Speaker: Raffaele M. Ghigliazza, Mechanical and Aerospace Engineering, Princeton University
Title: Bursting neurons: revised Hodgkin-Huxley formalism and an application to hexapedal locomotion

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Date: February 27
Speaker: Roy Goodman, New Jersey Institute of Technology
Title: Interaction of Sine-Gordon solitons with Defects

Date: April 2
Speaker: Patrick Leenheer, Rutgers University
Title: Growth on 2 nutrients in the chemostat: an application of monotone systems theory

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Date: April 9
Speaker: Marius Usher, Birkbeck, University of London
Title: Neural dynamics of choice, active-maintenance and selection

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Date: April 23
Speaker: Patrick Simen, PACM and Psychology, Princeton University
Title: Neural mechanisms for control in complex cognition

Date: April 30
Speaker: Eva Kanso, California Institute of Technology
Title: Swimming in an Ideal Fluid

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2002-2003 Collapse/Expand

Date: September 13
Speaker: Bruno Eckhardt, Marburg University
Title: Lagrangian chaos in oscillatory flows

Date: September 20
Speaker: Jeff Moehlis, PACM, Princeton University
Title: Response of Neurons in the Brain Region Locus Coeruleus to Stimuli

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Date: October 4
Speaker: Joshua Plotkin, PACM, Princeton University
Title: Some deterministic and stochastic models of Influenza

Date: October 18
Speaker: Steve Shkoller, University of California, Davis
Title: The anisotropic Lagrangian averaged Navier-Stokes equations

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Date: October 25
Speaker: Rodolphe Sepulchre, Univ of Liege (Belgium) and Princeton University
Title: Iterative computational algorithms viewed as dynamical systems: three examples

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Date: November 8
Speaker: Claudia Wulff, University of Surrey
Title: Stability of Hamiltonian relative equilibria and applications to underwater vehicles

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Date: December 6
Speaker: Kevin Mitchell, College of William and Mary
Title: Fractal Escape Times and the Chaotic Ionization of Hydrogen in Parallel Fields

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Date: December 13
Speaker: Igor Mezic, University of California, Santa Barbara
Title: Model validation and reduction using spectral properties of Koopman operator

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Date: February 7
Speaker: Edgar Knobloch, University of California, Berkeley and University of Leeds
Title: Nearly Inviscid Faraday Waves

Date: March 28
Speaker: Kevin Lynch, Northwestern University
Title: Motion Planning for Underactuated Mechanical Systems

Date: April 4
Speaker: Michael Leyton, Rutgers University
Title: A Generative Theory of Shape

Date: April 11
Speaker: Len Pismen, Technion (Israel)
Title: Pattern formation, reconstruction, and roughening on a catalytic surface

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Date: April 25
Speaker: Jonathan Mattingly, Institute for Advanced Study
Title: Long time computer simulations of stochastic differential equations

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Date: May 16
Speaker: Mathias Jungen, PACM, Princeton University
Title: On the modelling of cooling lava by nonlinear elasticity

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Date: May 23
Speaker: Geertje Hek, University of Amsterdam
Title: Stabilisation by slow diffusion in a real Ginzburg-Landau eqaution

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2001-2002 Collapse/Expand

Date: September 24
Speaker: Fei-Ran Tian, Ohio State University
Title: Lax-Levermore-Venakides Minimization Problem

Date: October 12
Speaker: Petter Ogren, Royal Institute of Technology, Sweden and Princeton University
Title: A Control Lyapunov Function Approach to Multi-Agent Coordination

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Date: October 19
Speaker: MAE Research Day - NO SEMINAR
Title:

Date: October 26
Speaker: Jeff Moehlis, PACM, Princeton University
Title: Canards (French Ducks): Examples from Chemistry and Biology

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Date: November 9
Speaker: Troy Smith, MAE, Princeton University
Title: Low Dimensional Models for Turbulent Plane Couette Flow Using the Proper Orthogonal Decomposition

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Date: November 16
Speaker: Jaime Cisternas, PACM, Princeton University
Title: Buckling of thin plates produced by exothermical oxidation

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Date: February 8
Speaker: Blaise Aguera y Arcas, Princeton University
Title: What does a single neuron compute?

Date: February 15
Speaker: Luc Moreau, MAE, Princeton University
Title: A note on the geometry of nonlinear inductor capacitor circuits

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Date: February 22
Speaker: Eduardo Sontag, Rutgers University & Princeton University
Title: Some theoretical questions in control and dynamics motivated by molecular biology

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Date: March 15
Speaker: Qiang Du, Penn State University
Title: Quantized vortices: from Ginzburg-Landau to Gross-Pitaevskii

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Date: April 12
Speaker: Robert M. Miura, New Jersey Institute of Technology
Title: Analysis of Bursting Electrical Activity in Pancreatic Beta-Cells

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Date: April 19
Speaker: Eduardo Sontag, Rutgers University & Princeton University
Title: The ISS philosophy as a unifying framework for stability-like behavior -- see below for location change

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Date: April 26
Speaker: Pini Gurfel, MAE, Princeton University
Title: Dynamics near a Unit Circle in the Two- and Three-Body Problems: From Horseshoe Orbits to Formation Flying

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Date: May 3
Speaker: Assyr Abdulle, PACM, Princeton University
Title: Large stiff systems and parabolic PDEs solved by ROCK methods

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Date: May 10
Speaker: Peter Mucha, Georgia Tech
Title: A unifying theory for velocity fluctuations in sedimentation

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2000-2001 Collapse/Expand

Date: September 25
Speaker: Heinz Hanßmann, Aachen and PACM, Princeton University
Title: On Perturbed Oscillators In 1-1-1 Resonance: The Case of Axially Symmetric Cubic Potentials

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Date: October 2
Speaker: Harm Hinrich Rotermund, Fritz-Haber-Institut der Max-Planck-Gesellschaft
Title: Shedding Light on Surface Reactions: Imaging Pattern Formation from Ultra-High Vacuum up to High Pressures

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Date: October 16
Speaker: Jeff Moehlis, PACM, Princeton University
Title: Bursts: Excursions To (And Back From) Infinity

Date: October 23
Speaker: Hsueh-Chia Chang, University of Notre Dame
Title: Fast-Igniting Catalytic Converters

Date: October 30
Speaker: Janpeter Wolff, Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin
Title: CO Oxidation On Pt Under The Influence Of Local Heating

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Date: November 20
Speaker: Heinz Hanßmann, Aachen and PACM, Princeton University
Title: On the bifurcations in the $3D$ H\'enon--Heiles family

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Date: November 27
Speaker: Craig Woolsey, MAE, Princeton University
Title: Stabilizing Underwater Vehicles Using Internal Rotors

Date: December 4
Speaker: Yannis Drossinos, European Commission Joint Research Centre
Title: Complex Dynamics of a Creep-Slip Model of Earthquake Faults

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Date: December 11
Speaker: Sima Setayeshgar, PACM, Princeton University
Title: Electrical Wave Propagation in the Heart: Dynamics of Scroll Waves in Anisotropic Excitable Media

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Date: December 18
Speaker: Thanasis Papathanasiou, Fritz-Haber Institut der MPG, Berlin
Title: Mechanisms of Magneto-Hydrostatic Instabilities: Experiments and Computational Analysis

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Date: February 12
Speaker: Chris Jones, Brown University
Title: Creating Stability from Instability

Date: February 19
Speaker: Michael D. Graham, University of Wisconsin-Madison
Title: Nonlinear coherent structures in viscoelastic shear flows

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Date: February 26
Speaker: Heinz Hanssmann, PACM, Princeton University
Title: On the global dynamics of Kirchhoff's equations : Rigid body models for underwater vehicles

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Date: March 5
Speaker: Jeff Moehlis, PACM, Princeton University

Title: Bifurcations With Symmetry: An Overview

Date: March 12
Speaker: Eric Brown, PACM, Princeton University
Title: Stability, synchrony, and symmetry in coupled rotator oscillators

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Date: March 19
Speaker: Gabor Domokos, Budapest University of Technology and Economics
Title: Ghost solutions in BVPs

Date: March 26
Speaker: Eddie Fiorelli, MAE, Princeton University
Title: Virtual Leaders, Artificial Potentials and Coordinated Control of Gruops

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Date: April 2
Speaker: Edriss Titi, University of California, Irvine
Title: On the Connection Between the Viscous Camassa-Holm Equations (Navier-Stokes-alpha model) and Turbulence Theory

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Date: April 9
Speaker: Edriss Titi, University of California, Irvine
Title: Postprocessing Galerkin Methods

Date: April 16
Speaker: H. Scott Dumas, University of Cincinnati
Title: Dynamical Theories of Particle Channeling in Crystals

Date: April 23
Speaker: Henry Mwambi, PEI, Princeton University
Title: Ticks and tick-borne diseases in Africa: a vector host interaction model of a three host tick

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Date: April 30
Speaker: Cyrill Muratov, New Jersey Institute of Technology
Title: Testing a Hypothesis in Developmental Biology: Modeling and Computational Analysis of Autocrine Loops in Drosophila Oogenesis

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1999-2000 Collapse/Expand

Date: September 24
Speaker: Phil Holmes, MAE/PACM
Title: Introductory lecture about the Hodgkin-Huxley model of a neuron (the giant axon of Loligo - a squid)

Date: October 1
Speaker: John Schmitt, MAE
Title: Mechanical Models for Insect Locomotion

Date: October 8
Speaker: Phil Holmes, MAE/PACM and Georgiy Medvedev, PACM/IAS
Title: Hodgkin-Huxley Eqns #2

Date: October 15
Speaker: Ed Belbruno, IOD
Title: Orbit design for cheap spaceflight

Date: October 22
Speaker: Georgiy Medvedev, PACM/IAS
Title: Hodgkin-Huxley Eqns #3

Date: October 29
Speaker: Leonid Kontorovich, Math
Title: Problems in Semitic NLP: Hebrew Vocalization Using Hidden Markov Models.

Date: November 12
Speaker: J.B. Pomet, INRIA
Title: Topological Equivalence and Qualitative Behaviour of Control Systems

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Date: November 19
Speaker: Georgiy Medvedev, PACM/IAS and Eric Brown, PACM
Title: Hodgkin-Huxley Eqns #4

Date: December 3
Speaker: Phil Holmes, MAE/PACM
Title: Reduced oscillator models of exctable and bursting neurons

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Date: December 17
Speaker: Oliver Downs, PACM and Gayle Wittenberg, Hopfield Lab
Title: Neural Networks

Date: February 11
Speaker: Dima Rinberg, NEC Research Institute, Inc.
Title: The Cockroach Escape Reflex and Fluid Dynamics

Date: February 18
Speaker: Oliver Downs, PACM
Title: Learning Models For Continuous Nonnegative Data

Date: February 25
Speaker: Natalia Komarova, Institute for Advanced Study
Title: Patterns Under Water

Date: March 3
Speaker: Clancy Rowley, CDS CalTech and MAE
Title: The Karhunen-Loeve Expansion for Systems with Symmetry and Low-Order Models of an Oscillating Cavity Flow

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Date: March 31
Speaker: Michael Shefter, Courant Institute of Mathematical Sciences, NYU
Title: Nonlinear Instability of Elementary Stratified Flows at Large Richardson Number

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Date: April 7
Speaker: David Pinto, Boston and Brown Universities
Title: The Fine Structure of Propagating Activity in Neocortex: Analysis and Biology

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Date: April 14
Speaker: John Rinzel, Center for Neural Science and Courant Institute of Mathematical Sciences, NYU

Title: Rhythms and Waves in a "Sleeping" Thalamic Slice Model

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Date: April 17
Speaker: Bard Ermentrout, University of Pittsburgh
Title: Global Spatial Patterning Through Distance and Delay

Date: April 18
Speaker: Jeff Moehlis, University of California, Berkeley
Title: Wrinkled Tori and Bursts due to Resonant Temporal Forcing

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Date: April 21
Speaker: Joshua Plotkin, PACM
Title: Spatial Patterns of Diversity in Tropical Forests

Date: April 28
Speaker: Roy Goodman, PACM
Title: Coupled Mode Equations for Nonlinear Fiber Optics

Date: May 5
Speaker: Yannis Kevrekidis, PACM & Chemical Engineering
Title: Coarse Bifurcation Analysis

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