Talk Abstracts

Thursday, Jan. 3

Ant Dynamics: Digging, Falling, and Jamming in Subterranean Tunnels

Daniel I. Goldman, *Georgia Institute of Technology*
Jan. 3, 8:45 AM - 9:20 AM

Colony members of the ~ 1 mm fire ant (*Solenopsis invicta*) collectively construct complex nests in a variety of soils. Nests consist of networks of tunnels connecting subterranean chambers, and are constructed through repeated excavation and deposition of grains or soil pellets. To discover principles of environmental interaction which allow rapid nest construction, we perform laboratory experiments in quasi-two-dimensional arenas filled with small wetted glass particles. The apparatus allows visualization of both the ants and the excavated substrate. We observe that excavated area and topological nest features such as edge-vertex scaling and degree distribution of the tunnel network are independent of body size of worker groups. We thus hypothesize that rules for construction of certain morphological features of the nest are pre-programmed. Observation of movement of ants in these tunnels reveals that locomotion is rarely smooth, but repeated slips occur during ascending and descending climbs. However, ants rapidly arrest these slips using antennae, limbs and body parts to jam and stabilize falls. Monitoring jamming events during controlled perturbation experiments imply that the ants engineer their environments to simplify the task of moving within.

Nonequilibrium Fluctuations and Climate Variability

Jeffrey Weiss, *University of Colorado at Boulder*
Jan. 3, 9:20 AM - 9:40 AM

Nonequilibrium steady-states are characterized by entropy producing fluctuations. These fluctuations take the form of finite-time events with preferred lifecycles. Nonequilibrium fluctuations are typically studied in nano-scale systems, where individual fluctuations can be resolved. We show that despite the large physical scale of the climate system, aspects of natural climate fluctuations can be considered thermodynamically small due to having a small number of dynamically important degrees of freedom. The vast majority of the climate systems' energy is stored as thermal energy in the ocean. The thermal energy of the ocean is roughly in a nonequilibrium steady-state, driven by solar heating and damped by heat transfer to the atmosphere and radiation to space. We investigate the natural variability of ocean heat content, the role of fluctuations about the nonequilibrium steady-state, and the connection to phenomena such as El Niño.

Percolation, Cascades, and Optimal Interdependence of Networks

Raissa D'Souza, *University of California Davis*

Jan. 3, 9:40 AM - 10:15 AM

Collections of networks are at the core of modern society, spanning technological, biological and social systems. Understanding the network structure of individual systems has lead to tremendous advances in the past decade. Yet, in reality, none of these individual networks lives in isolation and the consequences of interdependence can be surprising. Here we present results from random graph models of interacting networks. First, from a structural perspective, we show that interactions between different types of networks can enhance or delay the onset of large scale connectivity. Second, we consider a dynamical process on coupled networks. We use the classic Bak-Tang-Wiesenfeld sandpile model as an abstraction for cascades of load shedding and show that there can exist optimal levels of interconnectivity between networks that provide stabilizing effects with respect to cascades.

Hierarchical Paths to Synchronization in Networks with Community Structure

Per Sebastian Skardal, *University of Colorado at Boulder*

Jan. 3, 10:55 AM - 11:15 AM

The study of emergent collective behavior in large networks of interacting dynamical systems represents a large area of complexity theory. In the research of these systems, a main question lies in understanding how different network topologies affect the dynamics of interacting agents and give rise to macroscopic phenomena. Here we address this question by studying synchronization of Kuramoto oscillators in networks with modular, or community, structure. In particular, we study the hierarchical path of synchronization in such networks, which often first occurs locally within each community, then globally as communities synchronize with one another. We first consider a community-wise mean-field network structure where we can obtain analytical results that completely describe hierarchical synchronization by applying the dimensionality reduction technique of Ott and Antonsen first on a local scale within each community, and then on a global scale where communities synchronize with each other. Next, we use these analytical results to predict both local and global synchrony in modular networks where the detailed topology is preserved and find excellent agreement. These results help shed light on the hierarchical paths of dynamical processes in modular networks.

Uncovering Oceanic Transport Barriers

Thomas Peacock, *Massachusetts Institute of Technology*

Jan. 3, 11:15 AM - 11:50 AM

Recent years have seen several major environmental disasters throughout the Earths oceans, such as the Montara oil spill, the Deepwater Horizon oil spill and the Tohoku Tsunami that caused the release of substantial amounts of debris and radioactive contamination. In each of these disasters, material was released from what was essentially a point source into the environment, and predicting where this material would be transported by the surrounding ocean flow was (and in the case of the Tsunami debris, still is) of paramount importance. In order to predict the outcome of pollution events, the standard approach is to run numerical simulations of the ocean and use the resulting velocity field data sets to generate predicted trajectories of the pollutant. Whilst certainly a powerful predictive tool, the resulting trajectories can often be convoluted, resulting in 'spaghetti plots' that are difficult to interpret because of their inherent complexity. More significantly, perhaps, the trajectory analysis approach provides little explanation for 'why' things behave the way they do. To improve understanding and forecasting, therefore, there is a pressing need to develop new concepts and methods that provide deeper insight into what guides the transport of material in environmental flows. The field of Lagrangian Coherent Structures (LCSs) has been a vibrant research field over the past few years, providing a new framework for understanding how material transport is organized in spatially and temporally complex time-dependent fluid flows. The LCS approach provides a means to uncover the key transport barriers that are the underlying skeleton of Lagrangian transport in a fluid flow, facilitating a deeper understanding of advective transport. Here, we review the state-of-the-art in LCS methodology, and demonstrate the power of the approach through applications to several high-profile examples, including the Deepwater Horizon oil spill and the debris field from the Tohoku Tsunami.

Chaos Induced Energy Hopping in Periodically Kicked Rydberg Atoms

Korana Burke, *University of California Davis*

Jan. 3, 11:50 AM - 12:10 AM

A highly excited quasi one-dimensional Rydberg atom exposed to periodic alternating external electric field pulses exhibits chaotic behavior. Time evolution of this system is governed by a geometric structure of phase space called a homoclinic tangle and its turnstile. We use the knowledge about the geometric structure of phase space to design short pulse sequences that quickly and efficiently transfer electronic ensemble from a starting energy state ($n \sim 306$) to a desired final energy state. The final state can have either much lower ($n < 230$) or much higher energy ($n > 500$) depending on the relative position of the starting ensemble with respect to the turnstile. We also present how the phase space geometry influences the efficiency of the transport between the energy states.

Experiments on the Growth and Form of Icicles

Antony Szu-Han Chen, *University of Toronto*

Jan. 3, 2:00 PM - 2:20 PM

Icicles are a ubiquitous feature of cold winter weather. The origin of their interesting and diverse morphologies has only begun to be systematically explored. Icicle growth is controlled by the removal of latent heat, which is transferred into the surrounding air via a thin film of water flowing over the ice surface. Predicting the evolving morphology of an icicle is a complex free-boundary growth problem. Theory suggests that overall, icicles have self-similar shapes related to those of stalactites. The ice-water interface can also become unstable to form ripple patterns on the surface of icicles. We conducted controlled experiments using a table-top icicle-growing apparatus, and we analyzed the evolution of the icicle form as functions of the ambient temperature, feed water supply rate, air motion, and water purity. We find self-similar profiles under certain conditions. In some cases, the icicle stops growing abruptly or splits at the tip. The rippling instability is tied to the purity of the water. Adding surfactants to pure feed water does not produce ripples. Ripples appear when small concentrations of salt are added to the feed water. The ripple amplitude grows with salt concentration.

Jamming and Dynamics of Granular Materials

Bob Behringer, *Duke University*

Jan. 3, 2:20 PM - 3:10 PM

This talk will consider the near-jamming behavior of granular systems consisting of frictional particles. We have recently shown that there exists a range of packing fractions for which it is possible to start from zero (tensoral) stress states, and by applying shear strain, traverse a regime of fragile states, ultimately arriving at a jammed state. These results have been obtained by using photoelastic particles, which allow detailed force and contact information, and from several different kinds of experiments. The largest density, ϕ_J, for which this behavior applies is comparable to the jamming density of frictionless disks, and the lowest density for which this occurs, ϕ_S, may be tied to the random loose packing density. Shear-jammed states are characterized by anisotropy in various quantities such as the stress, the fabric, and in general, the force networks. Shear jamming is of particular interest for dynamics, since many granular shear flows occur near this regime. For example, Couette flow, flows in shear bands, and flows in hoppers may all be influenced by shear jamming. As time permits, I will show how dynamic force structures regulate the stopping of a high speed object impacting a granular material.

Linear Response Closure Approximation for Multiscale Systems

Marc Kjerland, *University of Illinois at Chicago*
Jan. 3, 3:10 PM - 3:30 PM

Many applications of contemporary science involve multiscale dynamics, typically characterized by time and space scale separation of patterns of motion, with a large set of rapidly evolving variables and a smaller set of slowly evolving variables. This causes direct numerical simulation to be computationally expensive, due to the large number of variables and to the small timestep discretization needed for the fast-scale dynamics. We present a method to obtain a closed system for the evolution of the slow variables, requiring only a simple computation of statistics of the fast variables and use of the fluctuation-dissipation theorem, a tool from statistical dynamics, to get a correction term for the averaged fast dynamics. We apply this method to a two-scale model with linear coupling and accurately capture the statistics of the full system and response to forcing perturbations.

Exotic Dynamical Behaviour in Coupled Dynamical Systems

Peter Ashwin, *University of Exeter*
Jan. 3, 4:10 PM - 4:45 PM

I will give some examples of the types of detailed emergent dynamics that can appear in coupled dynamical systems. For globally coupled phase oscillators, the functional form of the coupling function in the absence of heterogeneities in the system is critical for the types of dynamics that can appear. In addition to fairly simple periodic behaviour there can be a wide range of aperiodic behaviours including robust heteroclinic networks in small numbers of oscillators. These can be understood via a mixture of studies in moderately low dimensions and methods from symmetric dynamics. I will also briefly discuss some recent work with C Postlethwaite (Auckland) on how one can also design networks of simple nonlinear systems that will realise heteroclinic networks with a given arbitrary structure, suggesting novel ways to design nonlinear systems that can realise nontrivial computational tasks.

Establishing the Turing Mechanism Using Synthetic Cells

Nathan Tompkins, *Brandeis University*

Jan. 3, 4:45 PM - 5:05 PM

In 1952 Alan Turing published his seminal paper The Chemical Basis of Morphogenesis in which he described a basis for physical morphogenesis due solely to a reaction-diffusion system. His mechanism has been tested extensively but remains controversial and not fully demonstrated for cellular systems. Now 60 years after its debut, we describe an experimental system that demonstrates all six of his phenomenological predictions with additional support that these observations are due specifically to the Turing mechanism itself. Further we demonstrate a nonlinear phenomena in the same system that was not predicted by Turing and which is not explained by a linear solution analysis of the governing system equations. Finally we also demonstrate that this system undergoes chemical and physical morphogenesis as Turing suggested.

How Things Slide: Rapid Dynamics at the Onset of Friction

Jay Fineberg, *The Hebrew University of Jerusalem*

Jan. 3, 5:05 PM - 5:40 PM

The dynamics of how two rough frictional interfaces detach is a fundamental question in fields ranging from material science to geophysics. On the one hand, the onset of frictional motion is thought to be characterized by the static friction coefficient that couples two materials. For hundreds of years, this has been considered to be a material constant. On the other hand, the same processes that give rise to the onset of frictional motion also cause earthquakes, when tectonic plates locked together by friction start to slip. We describe new experiments that examine how rapid crack-like processes that fracture a frictional interface cause the onset of macroscopic motion that we know as frictional sliding. Results of this study are surprising. We both demonstrate that a number of different types of earthquakes exist and that the "static friction coefficient" is not a material constant at all, but is intimately related to the details of how forces are applied to a system.

Friday, Jan. 4

The Structural Determinants of Competitive Advantage in Team Competitions

Aaron Clauset, *University of Colorado at Boulder*
Jan. 4, 8:30 AM - 9:05 AM

In most professional sports, the structure of the competitive environment is intentionally neutral so that consistent scoring imbalances may be attributed to differences in team skill. As a result, it remains unknown what impact structural heterogeneities can have on the dynamics of competition and what role they play in producing sustained competitive advantages. Applying a novel generative model of scoring dynamics to roughly 10 million heterogeneously structured team competitions drawn from a popular online game, we quantify the relationship between a competition's structure and its scoring tempo, balance, and outcome predictability. Despite wide variations in environmental structure, competition rules, resource quality, and team skill, we find the same three-phase pattern in the tempo of events observed in many professional sports. Furthermore, competition tempo, scoring balance and outcome predictability are all highly predictable from the competition's structural features alone. Like competition between firms, teams exploit environmental and resource heterogeneities for sustained competitive advantage. However, the most balanced competitions arise from specific environmental heterogeneities, not from equally skilled teams competing in a homogeneous environment. These results shed new light on the principles of balanced competition, and illustrate the rich potential of online game data for investigating social dynamics and competition.

Localization Phenomena in Three-Dimensional Doubly Diffusive Convection

Cedric Beaume, *University of California Berkeley*
Jan. 4, 9:05 AM - 9:25 AM

Doubly diffusive convection is a classic example of a pattern-forming system. Among the variety of solutions exhibited by systems of this type are the interesting time-independent spatially localized states called convectons. Here, we focus on a three-dimensional binary fluid in a vertically extended cavity with no-slip boundary conditions whose motion is driven by temperature and concentration differences between a pair of opposite vertical walls. No-flux boundary conditions are imposed on the remaining walls. When the temperature and concentration contributions to buoyancy balance the system admits a conduction state whose instability leads to different types of spatial structures, including two types of three-dimensional convectons: quasi two-dimensional spatially localized rolls along a primary snaking branch and fully three-dimensional twisted convectons, consisting of twisted rolls, present on secondary snaking branches. The numerical continuation results are supplemented by direct numerical simulations.

Flight of the Fruit Fly

Itai Cohen, *Cornell University*

Jan. 4, 9:25 AM - 10:00 AM

There comes a time in each of our lives where we grab a thick section of the morning paper, roll it up and set off to do battle with one of natures most accomplished aviators - the fly. If however, instead of swatting we could magnify our view and experience the world in slow motion we would be privy to a world-class ballet full of graceful figure-eight wing strokes, effortless pirouettes, and astonishing acrobatics. After watching such a magnificent display, who among us could destroy this virtuoso? How do flies produce acrobatic maneuvers with such precision? What control mechanisms do they need to maneuver? More abstractly, what problem are they solving as they fly? Despite pioneering studies of flight control in tethered insects, robotic wing experiments, and fluid dynamics simulations that have revealed basic mechanisms for unsteady force generation during steady flight, the answers to these questions remain elusive. In this talk I will discuss our strategy for investigating these unanswered questions. I will begin by describing our automated apparatus for recording the free flight of fruit flies and our technique called Hull Reconstruction Motion Tracking (HRMT) for backing out the wing and body kinematics. I will then show that these techniques can be used to reveal the underlying mechanisms for flight maneuvers, wing actuation, and flight stability. Finally, I will comment on the implications of these discoveries for investigations aimed at elucidating the evolution of flight.

The Dynamical Underpinnings of Subcellular Calcium Alternans in Cardiac Myocytes

David Christini, *Weill Cornell Medical College*

Jan. 4, 10:40 AM - 11:15 AM

Cardiac alternans is a dangerous rhythm disturbance of the heart, in which rapid stimulation elicits a beat-to-beat alternation in the action potential duration and calcium transient amplitude of individual myocytes. Recently, "subcellular alternans," in which the calcium transients of adjacent regions within individual myocytes alternate out-of-phase, has been observed. Using experiments and computational modeling, we show that subcellular alternans is a striking example of a biological Turing instability.

Chimera States in Coupled Chemical Oscillators

Simbarashe Nkomo, *West Virginia University*

Jan. 4, 11:15 AM - 11:35 AM

We report experimental studies of the chimera state in populations of coupled chemical oscillators [1]. The counter-intuitive phenomenon involves the coexistence of subpopulations of oscillators, with same coupling structure, exhibiting synchronous and asynchronous oscillations [2]. The oscillators were divided into two groups based of the model proposed by Abrams and coworkers [3]. Every oscillator is globally coupled to its group members and to the members of the other group via an inter-group coupling. We used photosensitive Belousov-Zhabotinsky chemical oscillators [4] and the nondimensional ZBKE model [5] in the experiment and simulations, respectively. In-phase, out-of-phase, and phase-cluster synchronized states, as well as the chimera state, were found in both experiments and simulations. The probability of finding a chimera state decreases with increasing intra-group coupling strength. We found that the level of heterogeneity in the frequencies of the oscillators in our system decreased the lifetime of a chimera.

References

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Dynamic Origins of Solar Magnetism

Mark Miesch, *High Altitude Observatory, National Center for Atmospheric Research*

Jan. 4, 11:35 AM - 12:10 PM

Modern solar telescopes such as those on the Solar Dynamics Observatory (SDO) spacecraft reveal a stunning array of dynamical phenomena on the Sun, from the intricate structure of sunspots at the solar surface to arcing loops of plasma in the thin solar corona to dramatic eruptions of matter and energy in solar flares and coronal mass ejections. All of these phenomena are linked to magnetism and are regulated by the 22-year magnetic activity cycle. Understanding how such cyclic magnetic activity is produced is still one of the foremost challenges in solar physics. In this talk I will discuss what the latest solar observations and magnetohydrodynamic (MHD) simulations have to say about this timeless problem, covering both recent insights and outstanding challenges. Highlights include the origins of solar mean flows (differential rotation and meridional circulation), wreathes of magnetism produced by convective dynamo action and rotational shear, and the buoyant destabilization and emergence of magnetic flux from the deep solar interior.

Granular Dynamics during Impact

Kerstin Nordstrom, *University of Maryland*

Jan. 4, 2:00 PM - 2:20 PM

In this work, we study the impact of a projectile onto a bed of 3 mm grains immersed in an index-matched fluid. Using a laser sheet scanning technique, a high speed camera, and particle tracking, we can measure the trajectory of each grain throughout an impact event. We characterize the bulk and microscopic dynamics within the granular material as a function of initial sample preparation, specifically applying a uniaxial prestrain to the sample. We find that small changes in sample preparation lead to drastic departures from the universal depth scaling seen in previous studies of shallow granular impacts. By examining the nonaffine motion within the system, we propose the effect is due to different loading and buckling of force chains within the system.

Critical Dynamics and Integrative Networks of the Normal Brain

Dietmar Plenz, *National Institutes of Health*

Jan. 4, 2:20 PM - 3:10 PM

One of the major challenges in neuroscience is the identification of normal brain dynamics. Recent progress in my lab has identified two features that characterize resting state dynamics in the mammalian cortex: neuronal avalanches and an integrative weight organization. At criticality, the myriads of interactions between nerve cells are exquisitely balanced leading to a scale-invariant organization of neuronal avalanches that optimizes numerous aspects of information transfer. The organization of avalanches translates into weighted, directed small-world networks built on the principle of integrative neighborhoods. These functional networks share unique aspects with gene networks and human social and communication networks and can be built based on local learning rules and global error signals. Avalanches and integrative network organization are found in the ongoing activity of normal neocortex recorded in the dish as well as in awake monkeys suggesting they constitute a robust framework of mammalian brain function.

Dispersal-Induced Oscillatory Turing Instabilities in Ecological Networks

Shigefumi Hata, *Fritz-Haber Institute of the Max-Planck Society*

Jan. 4, 3:10 PM - 3:30 PM

Along with his work on cryptanalysis and mathematical algorithms, the discovery of diffusion-induced instabilities was one of the greatest contributions by Alan Turing [1]. Turing patterns, developing in chemical reactions and playing an important role in biological morphogenesis [2-5], provide a classical example of self-organization. It is known that their analogs are possible in networks of coupled reactors or biological cells [6,7] and statistical properties of stationary Turing patterns in large random networks have been investigated [8]. Here, our attention is focused on ecological systems representing metapopulations formed by habitats with dispersal connections [9,10]. Our analysis reveals that dispersal-induced instabilities should be typical for such ecosystems. However, starting from three trophic levels, they often correspond to a different bifurcation, also introduced by Turing [1] but remaining less known. Instead of static differentiation [6-8], oscillations are then spontaneously developing in a fraction of populations, depending on the network architecture and species mobility. Such behavior may be essential for understanding the stability and dynamics of metapopulations, contrasting the view that dispersal connections tend to enhance the overall stability of a system.

References

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Devil's Staircases, Crackling Noise and Phase Transitions in Percolation

Jan Nagler, *Max Planck Institute for Dynamics and Self-Organization*

Jan. 4, 4:10 PM - 4:30 PM

We identify and study certain phenomena in percolation that can subvert predictability and controllability in networked systems. We establish devil's staircase phase transitions, non-self-averaging, and power-law fluctuations in percolation. We provide exact conditions for percolation that exhibits multiple discontinuous jumps in the order parameter where the position and magnitude of the jumps are randomly distributed - characteristic of crackling noise. The framework can be linked to magnetic effects and fragmentation processes.

Packing of Wires in Cavities and Growing Surfaces

Hans Herrmann, *ETH Zürich*

Jan. 4, 4:30 PM - 5:05 PM

We investigate the morphologies and maximum packing density of thin wires packed into spherical cavities. Using simulations and experiments with nylon lines, we find that ordered as well as disordered structures emerge, depending on the amount of internal torsion. We find that the highest packing densities are achieved in a low torsion packing for large systems, but in a high torsion packing for small systems. An analysis of both situations is given in terms of energetics and comparison is made to analytical models of DNA packing in viral capsids. In two dimensions we also find that wires can crumple into different morphologies and present the associated morphological phase diagram. Our results are based on experiments with different metallic wires and confirmed by numerical simulations using a discrete element model. We show that during crumpling, the number of loops increases according to a power-law with different exponents in each morphology. Furthermore, we observe a power-law divergence of the structure's bulk stiffness similar to what is observed in forced crumpling of a membrane. We also investigate the morphology of thin discs and rings growing in circumferential direction. Recent analytical results suggest that this growth produces symmetric excess cones (e-cones). We study the stability of such solutions considering self-contact and bending stress. We show that, contrary to what was assumed in previous analytical solutions, beyond a critical growth factor, no symmetric e-cone solution is energetically minimal any more. Instead, we obtain skewed e-cone solutions having lower energy, characterized by a skewness angle and repetitive spiral winding with increasing growth. These results are generalized to discs with varying thickness and rings with holes of different radii. Simple experiments with cardboard confirm the simulations.

Saturday, Jan. 5

A Network Approach to the Orientation Problem in Genome Assembly

Michelle Girvan, *University of Maryland*

Jan. 5, 8:30 AM - 9:05 AM

In the past several years, the problem of genome assembly has received considerable attention from both biologists and computer scientists. One important issue in genome assembly is finding the correct orientation of sequenced DNA pieces. In order to sequence an entire genome, DNA is chopped up into many small segments which are then sequenced from either end. Because of the limitations on the number of nucleotides that can be read sequentially, these small segments are not sequenced in their entirety. The sequenced fragments read from the two ends of such a DNA segment are identified as connected, and for each connected pair, the relative orientations of the two fragments is then known. These fragments are then grouped into longer DNA sections called contigs, based on the overlap of sequences. However, because these processes can involve a significant amount of error, identifying the correct relative orientations of all the contigs from the data is a challenging optimization problem. Previous studies have shown the orientation optimization problem to be NP-hard. Our work applies a heuristic network approach to this problem in which the contigs are nodes connected by signed, weighted edges, depending on the number of fragment pairs that connect the contigs, and what each fragment pair suggests for the relative orientation of contig pair. We demonstrate how a hierarchical clustering algorithm applied to this network structure can find a better solution than currently employed approaches. To illustrate the effectiveness of our approach, we present results obtained from applying our algorithm to the turkey genome.

Forgetting and Remembering in Chaotic Dynamical Systems

Ryan James, *University of California Davis*

Jan. 5, 9:05 AM - 9:25 AM

Chaotic systems generate information. The amount is quantified by the Kolmogorov-Sinai entropy or the Lyapunov exponents. When positive, a system is unpredictable and appears random. But what is the quality of this information? We answer this by showing that it consists of two components: Randomness that a system forgets (ephemeral information) and randomness that a system remembers (bound information). We show how to calculate these informations in the logistic, tent, and Lozi maps, demonstrating that this new decomposition identifies hitherto unseen structural features in their dynamics.

Asymptotic approaches for rotationally constrained flows

Keith Julien, *University of Colorado at Boulder*

Jan. 5, 9:25 AM - 10:00 AM

Current models and simulations of fluid turbulence in the atmosphere and oceans, and planetary interiors are conducted at parameters that do not closely resemble observed realistic values. Thermal and rotational forces are sometimes orders of magnitude too small. Improvements in computing power through Moore's laws will produce minimal advances with present-day models (specifically, a doubling of resolution in each direction every six years for three-dimensional problems). It is therefore clear that advances must occur through new model development and associated simulations utilizing extreme parameter values in an asymptotic manner. This will require a body of knowledge gained from large-scale direct numerical simulations that explore the nature of extreme values in controlled settings.

One such area has been that of convection under the influence rotation. In general numerical simulations of rotationally constrained flows are unable to reach realistic parameter values (e.g., Reynolds Re and Richardson Ri numbers). In particular, low values of Rossby number Ro, defining the extent of rotational constraint, compound the already prohibitive temporal and spatial restrictions present for high-Re simulations by engendering high-frequency inertial waves and the development of thin (Ekman) boundary layers.

Recent work in the development of reduced partial differential equations (PDEs) that filter fast waves and relax the need to resolve boundary layers has been extended to construct a hierarchy of balanced equations that span the stably and unstably stratified limits. By varying the aspect ratio for spatial anisotropy characterizing horizontal and vertical scales, rapidly rotating convection and stably stratified quasi-geostrophic motions can be described within the same framework.

In this talk, the asymptotic PDEs relevant for rotating convection are explored. Direct numerical solutions that correctly capture the regular vortex columnar and irregular geostrophic turbulence regime of recent laboratory experiments are also presented and discussed.

Spatio-Temporal Evolution and Prediction of Electromechanical Alternans in Isolated Rabbit Hearts

Elena Tolkacheva, *University of Minnesota*

Jan. 5, 10:40 AM - 11:00 AM

Spatio-temporal evolution and prediction of electromechanical alternans in isolated rabbit hearts Abstract: Alternans, defined as a beat-to-beat alternation in the cardiac action potential duration (APD), has been considered to be a strong marker of electrical instability and a harbinger for ventricular fibrillation (VF), which is a major cause of sudden cardiac death. It is known that APD alternans can be accompanied by alternans in intracellular calcium transients ($[Ca^{2+}]_i$), leading to electromechanical alternans. Spatial evolution of $[Ca^{2+}]_i$ alternans in the whole heart has never been investigated, even though it has been suggested that $[Ca^{2+}]_i$ is the driving force of EM alternans. In addition, although some techniques have been developed to predict APD alternans, the onset of electromechanical alternans has never been predicted. In our recent study, we investigated spatio-temporal evolution of both $[Ca^{2+}]_i$ and APD alternans in the isolated rabbit heart using dual voltage-calcium optical mapping technique. We demonstrated that $[Ca^{2+}]_i$ alternans, similar to the APD alternans, has a local onset in the heart: it initially develops in a small area of the heart, and then evolves to occupy the entire heart. Our results indicated that the local onset of $[Ca^{2+}]_i$ amplitude alternans always preceded the local onset of APD alternans, while $[Ca^{2+}]_i$ duration alternans always followed APD alternans. We also demonstrated, for the first time, that $[Ca^{2+}]_i$ duration alternans can be predicted using the slopes measured in the restitution portrait the technique that was developed for the prediction of APD alternans. On the other hand, $[Ca^{2+}]_i$ amplitude alternans is seems to be correlated with the initial dispersion of $[Ca^{2+}]_i$ cycling.

Graph Spectra and Complex Networks

Mark Newman, *University of Michigan*

Jan. 5, 11:00 AM - 11:35 AM

Graphs and networks can be represented by any of several matrices, including the adjacency matrix and the graph Laplacian, and there are deep connections between the spectral properties of these matrices and both the structure and dynamics of the graphs they represent. In this talk I will report on a number of recent results combining spectral graph theory, random matrices, and free probability, to demonstrate first that graph spectra show clear signatures of certain types of structure in networks, such as hubs or community structure, and second that when that structure is weak, but not zero, those signatures can disappear. These results imply that there exist regimes in which a network can contain a particular type of structure but that structure will be indetectable by spectral methods, including popular and widely used methods such as spectral partitioning.

Quantum Fluid Flows: the Strange Things We See in Superfluid Helium

Daniel P. Lathrop, *University of Maryland*
Jan. 5, 11:35 AM - 12:10 PM

Long range quantum order underlies a number of related physical phenomena including superfluidity, superconductivity, the Higgs mechanism, Bose-Einstein condensates, and spin systems. While superfluidity in Helium-4 was one of the earliest discovered of these, it is not the best understood, owing to the strong interactions (making theoretical progress difficult) and the lack of local experimental probes. Approximately five years ago, our group discovered that micron-sized hydrogen particles may be used to label quantized vortices in flows of superfluid helium. Particles not on vortices trace the motion of the normal component of the superfluid. This ability has given a new perspective on an old subject. By directly observing and tracking these particles, we have directly confirmed the two-fluid model, observed vortex rings and reconnection, characterized thermal counterflows, and taken local observations of the very peculiar nature of quantum turbulence. One of many surprising observations is the existence of power law tails in the probability distribution of velocity for these flows. That was predicted by our group and verified as stemming from the reconnection on quantized vortices. Our summary conclusions are that quantum turbulence is dominated by reconnection and ring vortex collapse, making turbulence in a quantum liquid distinct from classical turbulence of a Newtonian fluid.

Predictability and Control of Extreme Events in Complex Systems

Daniel Gauthier, *Duke University*
Jan. 5, 2:00 PM - 2:20 PM

Common wisdom holds that extreme, catastrophic events in complex systems occur with scale-invariant probabilities, following power-law distributions, so that the largest events in the distribution tail are unpredictable and uncontrollable. Here, we study experimentally coupled chaotic oscillators that display extreme events. The mechanism responsible for the rare, largest events makes them distinct and their distribution deviates from a power-law. It is thus appropriate to call them "dragon-kings" to stress their specificity. Based on the identification of this mechanism, we show that it is possible to forecast in real time an impending dragon-king and that the dragon-kings can be suppressed by applying tiny perturbations to the system. The mechanism causing dragon-kings in our system is generic in extended coupled chaotic systems, suggesting that our results are relevant to a large class of complex systems appearing in areas as diverse as the physics of earthquakes, neuroscience, ecology, and even financial economics.

Observation and Theory of Modulational Instability and Nonlinear Mode Coupling in Saturn's Rings

Glen R. Stewart, *University of Colorado at Boulder*

Jan. 5, 2:20 PM - 3:10 PM

The Cassini spacecraft has been in orbit about the planet Saturn since 2004. During the past 8 years we have been able to observe the changing shape of the outer edge of Saturn's B ring, which exhibits multiple modes of oscillation in addition to the expected azimuthal wave number $m = 2$ signature associated with an orbital resonance with the satellite Mimas. In particular, the B ring edge has a slowly precessing $m = 1$ eccentric mode as well as rapidly rotating components with $m = 3, 4$ and 5. These additional modes are driven by nonlinear couplings with the resonantly forced mode via gravitational forces between ring particles. The process is analogous to modulation or side band instabilities that are well known in nonlinear optics. This nonlinear coupling exchanges energy between the different modes which may help explain why the amplitude and phase of the $m = 2$ mode has been observed to vary over time. Since the 4 year modulation period of the $m = 2$ mode is found to be sensitive to the surface density of the ring, we can effectively measure the mass of ring particles at this location.

Inhibition and Information Processing in the Cerebral Cortex

Woodrow Shew, *University of Arkansas*

Jan. 5, 3:10 PM - 3:30 PM

The cerebral cortex is a complex network comprised of two types of neurons: excitatory and inhibitory. The dynamics of this network are shaped by an ongoing competition between excitatory and inhibitory interactions. Recent experiments suggest that tuning inhibition from strong to weak can cause a phase transition. At the critical point of the phase transition, several aspects of information processing are predicted to be optimal. However these predictions stem from simplified models which did not explicitly include inhibitory neurons and from brain-in-a-dish experiments, which raises the question: Does real sensory information processing in intact cortex take advantage of the benefits of criticality? Here we present results from a more realistic model and preliminary experiments. Our findings suggest that real sensory cortex operates near criticality and by doing so optimizes information transfer from sensory organ to brain.

Bidirectional Sorting of Flocking Models in the Presence of Asymmetric Barriers

Cynthia Reichhardt, *Los Alamos National Laboratory*

Jan. 5, 4:10 PM - 4:30 PM

Recently it has been shown that noninteracting self-propelled agents such as E. coli bacteria can be rectified by asymmetric barriers, permitting the controlled accumulation of bacteria on one side of a separated container. Here we add particle-particle interactions in the form of flocking behavior using a modified Vicsek model and show that not only does the rectification persist, but rectification reversals can occur as a function of exclusion radii, interaction radii, and flocking noise. We demonstrate that it is possible to separate two different flocking species to opposite sides of a container using this mechanism. We also show that fluctuations induced by the self-driven particles can create attractive forces between plates immersed in a bacterial bath, similar to a classical Casimir effect.

Shock Solutions for High Concentration Particle-Laden Thin Films

Li Wang, *University of California, Los Angeles*

Jan. 5, 4:30 PM - 4:50 PM

We study the shock dynamics for a recently proposed model by Murisic et al. [J. Fluid. Mech., submitted] describing gravity-driven thin film flow of a suspension of negatively buoyant particles on an incline. The model is composed of an equilibrium ODE-based system for particle settling and a conservation law for transport of liquid and particles. When the particle concentration is above a critical value, we are in the ridged regime, where the particles travel at a faster speed than the liquid and form a particle-rich ridge in the wave-front. The Riemann problem in such a regime will lead to a double shock solution or a singular shock solution depending on thickness of the precursor. The nontrivial Hugoniot topology that causes the nonexistence of double shock solution when the precursor is thin, which is quite different from the well-known Keyfitz-Kranzer system, is carefully studied. Singular shock speed as well as the singular mass accumulation rate is obtained, based on the observation that the particles pile up with maximum packing fraction near the contact line. Numerical simulations are carried out to validate the theoretics.

Challenges for Computational Vision: From Random Dots to the Wagon Wheel Illusion

Leon Glass, *Department of Physiology, McGill University*

Jan. 5, 4:50 PM - 5:25 PM

Even understanding the way we perceive very simple images presents a major challenge for both neurophysiologists and computer scientists. In this talk I will discuss two visual effects. In one, random dots are superimposed on themselves following a linear transformation. In the second, a rotating disk with radial spokes is viewed under stroboscopic illumination, where the frequency and duration of the stroboscopic flash are varied. Though these phenomena are very different, in both correlation plays a major role in defining the structure of the image. In this talk, I will give demonstrations of these phenomena and discuss related experimental and theoretical work by ourselves and others. In particular, I focus on a theory that uses the theory of forced nonlinear oscillations to predict the percept of rotating disks during stroboscopic illumination over a wide range of disk rotation speeds and strobe frequencies. Finally, I suggest that the anatomical structure of the human visual system plays a major role in enabling the amazingly rapid and accurate computation of spatial and time dependent correlation functions carried out by the visual system.

Sunday, Jan. 6

Control of Synchronization Patterns in Neural-like Boolean Networks

David Rosin, *Duke University*

Jan. 6, 8:30 AM - 8:50 AM

Synchronization patterns have been observed in neurological time-delay networks of directed ring topologies. We study these networks experimentally using excitable nodes built with autonomous logic gates and heterogeneous link time delays. We observe a transition in the network synchronization dynamics for different refractory periods of the excitable nodes. When this quantity is comparable to the mean link time delays or the heterogeneity of the link time delays, cluster synchronization patterns are altered or suppressed, respectively. This mechanism can be used to control the network dynamics by adjusting the refractory period of only a small number of nodes with the largest in-degree. This result may have implications for synchronization phenomena in biological neural networks because the refractory period depends on hormone blood concentrations in the brain.

Deciphering the Topology of Planar Networks

Eleni Katifori, *Max Planck Institute for Dynamics and Self-Organization*

Jan. 6, 8:50 AM - 9:25 AM

Natural and man-made distribution networks frequently are planar, exhibit dense sets of closed loops, and are hierarchically organized. Ubiquitous examples include street networks, water distribution networks and the vasculature of dicotyledonous leaves. The methods that have been proposed to quantify these networks typically focus on local aspects of their structure. Instead, here we focus on the hierarchical organization of reticulate webs. We present an algorithmic framework that maps loopy networks to binary trees, preserving in the connectivity of the trees the architecture of the original graph. This algorithmic framework decouples the geometric information from the metric topology (connectivity and edge weight) and it ultimately allows us to perform a robust, sensitive, quantitative statistical comparison between predictions of theoretical models and naturally occurring loopy graphs.

Critical Slowing Down Provides Advance Warning of Population Collapse

Lei Dai, *Massachusetts Institute of Technology*

Jan. 6, 9:25 AM - 9:45 AM

Tipping points marking population collapse and other critical transitions in natural systems (e.g. ecosystems, the climate) can be described by a fold bifurcation in the dynamics of the system. Theory predicts that the approach of bifurcations will result in an increasingly slow recovery from small perturbations, a phenomenon called critical slowing down. Here we demonstrate the direct observation of critical slowing down before population collapse using replicate laboratory populations of the budding yeast Saccharomyces cerevisiae. We mapped the bifurcation diagram experimentally and found a significant increase in both the size and timescale of the fluctuations of population density near a fold bifurcation, in agreement with the theory. Furthermore, we connected yeast populations spatially to evaluate warning signals based on spatio-temporal fluctuations and to identify a novel warning indicator in space. We found that two leading indicators based on fluctuations increased before collapse of connected populations; however, the magnitude of increase was smaller than that observed in isolated populations, possibly because local variation is reduced by dispersal. We propose a generic indicator based on deterministic spatial patterns, "recovery length". As the spatial counterpart of recovery time, recovery length is defined as the distance for connected populations to recover from perturbations in space (e.g. a region of poor quality). In our experiments, recovery length increased substantially before population collapse, suggesting that the spatial scale of recovery can provide a superior warning signal before tipping points in spatially extended systems.

Pinning of Advection-Reaction-Diffusion fronts: the Role of Burning Invariant Manifolds

Kevin Mitchell, *University of California Merced*

Jan. 6, 9:45 AM - 10:05 AM

Recent experiments have demonstrated the pinning of reaction-diffusion fronts in magnetohydrodynamically-driven chemical flows [Solomon et al.]; a magnetic stage moving beneath the fluid layer "captures", and then drags, a reaction-diffusion pattern, which remains pinned to the frame of the stage. We explain the pinning phenomenon as a manifestation of "burning" invariant manifolds (BIMs). BIMs differ from invariant manifolds traditionally used to study passive advection; they are applicable instead to active fluids supporting front propagation. Using the BIM concept, we explain the sequence of bifurcations that leads from an unpinned to a pinned state, as well as bifurcations that change the topological structure of the pinning fronts. BIMs also reveal how different pinning behavior can coexist within the same fluid flow, and clarify the associated basins of attraction.

Supported by the US National Science Foundation under grants PHY-0748828 and CMMI-1201236.

Limited Imitation Social Contagion as a Model of Fashions

Kameron Harris, *University of Washington*

Jan. 6, 10:45 AM - 11:05 AM

We study binary state contagion dynamics on a social network where nodes act in response to the average state of their neighborhood. We model the competing tendencies of imitation and non-conformity by incorporating an off-threshold into standard threshold models of behavior. In this way, we attempt to capture important aspects of fashions and general societal trends. Allowing varying amounts of stochasticity in both the network and node responses, we find different outcomes in the random and deterministic versions of the model. In the limit of a large, dense network, however, these dynamics coincide. The dynamical behavior of the system ranges from steady state to chaotic depending on network connectivity and update synchronicity. We construct a mean field theory for general random networks. In the undirected case, the mean field theory predicts that the dynamics on the network are a smoothed version of the average node response dynamics. We compare our theory to extensive simulations on Poisson random graphs with node responses that average to the chaotic tent map.

Dynamic Icescapes

Wendy Wei Zhang, *The University of Chicago*

Jan. 5, 11:05 AM - 11:40 AM

In recent years, the ice coverage in both the Arctic and the Antarctic regions has changed rapidly and sometimes in an unusual ways. A dramatic example occurred in 2002: the Larson B ice shelf, a 50 km extent floating sheet of ice formed at the exit of several glaciers, disintegrated into fragments in a few days. Prior to this collapse, Larson B had existed for several thousand, if not ten thousand, years. This suggests that glaciological features can switch abruptly from a relatively slow mode of evolution to a more rapid, catastrophic one. We use field observations, idealized models and numerical simulations to assess the forces and mechanisms underlying these changes. Our work shows that, prior to collapse, the numerous crevasses marking the ice shelf can alter its elastic flexural response to ocean waves, thereby possibly switching the shelf response from localized to extended modes. After collapse, the iceberg-calving dynamics at the glacier exits can be influenced by the resistance exerted by the mélange of ice fragments created by the shelf disintegration.

Exact Coherent Structures in Turbulence

Michael Schatz, *Georgia Institute of Technology*

Jan. 6, 11:40 AM - 12:15 PM

Recent theoretical advances suggest ways to find unstable exact solutions to Navier-Stokes that capture many features of coherent structures, which have long been observed in turbulent flow. At present, experimental observations of these solutions, termed Exact Coherent Structures (ECS), are scarce. We will describe efforts to search for ECS in a thin fluid layer driven electromagnetically. Under suitable experimental geometries, the base flow approximates Kolmogorov flow (2D spatially-sinusoidal shear bands); with increasing current, the base flow undergoes a sequence of bifurcations leading to weak, quasi-2D turbulence. A 2D Navier-Stokes model has been constructed to match closely the conditions of the experiments; a number of ECS (equilibria and periodic orbits) have been identified in the model. We will discuss the current status of experimental searches for ECS that match those predicted by the model. In separate experiments, efforts are underway to search for 3D ECS in turbulent Taylor-Couette flow driven by rotation of the outer cylinder. We will describe preliminary results of attempts to measure ECS in Taylor-Couette by applying controlled disturbances and measuring velocity fields using time-resolved 3D tomographic PIV.

Poster Titles: Session A

Friday Jan. 4, 7:30pm-9:30pm

A1 - Existence and Stability of Left-Handedness: an Evolutionary Model
Daniel Abrams, Mark J. Panaggio, *Northwestern University*.

A2 - Criticality of Forcing Directions on the Clustering, Fragmentation and Resilience of Grid Networks
Cheryl Abundo, E.F. Legara, C. Monterola, *University of the Philippines Diliman, IHPC, Agency for Science, Technology and Research, Singapore*.

A3 - Population Scale Physiologic Measurement, Dynamics and Prediction
David Albers, George Hripcsak, *Department of Biomedical Informatics, Columbia University*.

A4 - Explosive Percolation in Directed Networks
Diego Alcala[1], Katherine Sytwu[2], Shane Squires[2], Thomas Antonsen[2], Michelle Girvan[2], Edward Ott[2], [1]*University of Northern Colorado,* [2]*University of Maryland*.

A5 - Complex Solitary Wave Dynamics in a Gain Loss Nonlinear Schrödinger Equation
Justin Q. Anderson, Rachel A. Ryan, Mingzhong Z. Wu, Lincoln D. Carr, *Colorado School Of Mines*.

A6 - Nonlinear Time-Reversal in a Wave Chaotic System,
Matthew Frazier, Biniyam Taddese, Edward Ott, Thomas Antonsen, Steven Anlage, *University of Maryland*.

A7 - Nonlinear Scale Interactions and Energy Pathways in the Ocean
Hussein Aluie, Matthew Hecht, Geoffrey Vallis, Kirk Bryan, Robert Ecke, Mathew Maltrud, and Beth Wingate, *Los Alamos National Laboratory*.

A8 - Furling Dynamics of a Small Wind Turbine
Douglas Armstead, Wesley LaQuaglia, *Westminster College*.

A9 - Parametric Instability in Waveguides with Axial Modulation of the Index of Refraction
Masoud Asadi-Zeydabadi, Randall Tagg, *University of Colorado Denver*.

A10 - The Complexity of Joint Processes and Channels
Nix Barnett, James P. Crutchfield, *University of California Davis*.

A11 - Analysis of Fluid Systems from the Optical Flow-Approximate Vector Fields
Ranil Basnayake, Erik Bollt, *Clarkson University*.

A12 - Periodicity, Chaos and Oscillations in Some Planar Monotone Discrete Dynamical Systems with Negative Feedback
Sukanya Basu, *Central Michigan University*.

A13 - Intervention-Based Stochastic Disease Eradication

Lora Billings[1], Luis Mier-y-Teran-Romero[2], Brandon Lindley[3], Ira Schwartz[3], [1]*Montclair State University,* [2]*Johns Hopkins Bloomberg School of Public Health,* [3]*US Naval Research Laboratory*.

A14 - How to Determine if the Cerebral Cortex Operates near Criticality

Doug Bohlman, Woodrow L. Shew, *University of Arkansas*.

A15 - Effects of Unresolved Turbulence on the Atmospheric Lagrangian Coherent Structures

Amir Ebrahim Bozorg Magham, Shane D. Ross, *Virginia Tech*.

A16 - Detecting the Position and Strength of Attenuating Elements in a Small Network

Kristine Callan, Damien Rontani and Daniel J. Gauthier, *Duke University*.

A17 - Synchronizing Frequency Selective Maps

Thomas Carroll, *US Naval Research Laboratory*.

A18 - On the Inverse Eigenvalue Problem by using the Kolmogorov-Sinai Entropy

Paul Cotae, *The University of the District of Columbia*.

A19 - On the Separation of Nearby Trajectories in Elliptical Stadia

Flavio M. de Aguiar, T. A. de P. Lima, *Universidade Federal de Pernambuco, Brasil*.

A20 - Classical and Quantum Properties of Irrational Triangular Billiards

Flavio M. de Aguiar, T. A. de P. Lima, S. Rodríguez-Pérez, *Universidade Federal de Pernambuco, Brasil*.

A21 - A New Method for Computing Lyapunov Exponents for the Chaotic Bouncing Ball

Joseph Dinius, Ricardo Sanfelice, Joceline Lega, *University of Arizona*.

A22 - Still Water: Dead Zones and Collimated Ejecta from the Impact of Granular Jets

Jake Ellowitz, Herve Turlier, Nicholas Guttenberg, Wendy W. Zhang, Sidney R. Nagel, *University of Chicago*.

A23 - Camassa-Holm Equations and Vortexons for Axisymmetric Pipe Flows

Francesco Fedele[1], Denys Dutykh[2], [1]*Georgia Institute of Technology,* [2]*University College Dublin & Universite de Savoie*.

A24 - The Cloud-Rain System as a Set of Coupled Oscillators

Graham Feingold, Ilan Koren, *NOAA Earth System Research Laboratory*.

A25 - Critical Asymmetric Tori in the Multiharmonic Standard Map

Adam Fox, James Meiss, *University of Colorado at Boulder*.

A26 - Blocking a Wave: Band Gap and Localization in the Vibrations of a Crevassed Ice Shelf

Julian Freed-Brown, Wendy Zhang[1], Arash Nowbahar[1], Jason Amundson[2] and Douglas MacAyeal[1], [1]*University of Chicago,* [2]*University of Alaska Southeast*.

A27 - Optimal Species Dispersal in the Presence of Ecological and Evolutionary Costs

Theodore Galanthay, Samuel M. Flaxman, *University of Colorado at Boulder*.

A28 - Patterns and Oscillations in Reaction-Diffusion Systems with Intrinsic Fluctuations
Michael Giver, Daniel Goldstein, Bulbul Chakraborty, *Brandeis University*.

A29 - Solitons in Armchair and Zigzag Geometries in the Nonlinear Dirac Equation
Laith Haddad[1], Lincoln D. Carr[1,2], [1]*Colorado School of Mines,* [2]*Universität Heidelberg*.

A30 - Three Dimensional Imaging of Slow Cyclic Shear-Driven Segregation
Matt Harrington[1], Joost Weijs[2], Wolfgang Losert[1], [1]*University of Maryland,* [2]*University of Twente*.

A31 - Engineered Gene Circuits: From Oscillators to Synchronized Clocks and Biopixels
Jeff Hasty, *University of California, San Diego*.

A32 - Dynamic Localization of an Interacting Wavepacket in an Anharmonic Potential
Mark Herrera[1], Thomas M. Antonsen[1], Edward Ott[1], Shmuel Fishman[2], [1]*University of Maryland,* [2]*Technion-Israel Institute of Technology*.

A33 - Nonlinear Mode Decomposition of Oscillatory Time-Varying Dynamics
Dmytro Iatsenko, Aneta Stefanovska and Peter V. E. McClintock, *Department of Physics, Lancaster University*.

A34 - Static Wealth Distribution on Complex Networks
Takashi Ichinomiya, *Graduate School of Medicine, Gifu University*.

A35 - Effects of Traumatic Brain Injury upon the Architecture and Nonlinear Dynamics of Cortical Networks
Andrei Irimia, S.Y. Matthew Goh, Micah C. Chambers, Paul M. Vespa, Jeffry R. Alger, David A. Hovda, Arthur W. Toga, Ron Kikinis, John D. Van Horn, *University of California, Los Angeles*.

A36 - Chaos in Astrophysics and Cosmology
Ed Iskander, *NMSU, Sandia National Lab, NASA-Ames*.

A37 - Growing Diverse Ensembles of Experts to Confront Non-Stationary Time Series
Abigail Jacobs[1], Cosma Shalizi[2], Kristina Klinkner[2], Aaron Clauset[1], [1]*University of Colorado at Boulder,* [2]*Carnegie Mellon University*.

A38 - Experimental Bifurcation Diagram of an External Cavity Semiconductor Laser: Dynamical Regimes
Byungchil Kim, Alexandre Locquet, David Citrin, *Georgia Institute of Technology-CNRS*.

A39 - Flocking in Turbulent-like Flow
Nidhi Khurana, Nicholas T. Ouellette, *Yale University*.

A40 - Spatially Dependent Parameter Estimation and Nonlinear Data Assimilation by Synchronization on a System of PDEs
Sean Kramer, Erik Bollt, *Clarkson University*.

A41 - Generating Real-Space Limit-Cycle Oscillation under Stationary DC Electronic Potential
Tomo Kurimura[1], Masahiro Takinoue[2], Masatoshi Ichikawa[1], and Kenichi Yoshikawa[1] [1]*Kyoto University,* [2]*Tokyo Institute of Technology*.

A42 - Statistical Properties of Avalanches in Networks
Daniel Larremore[1], Marshall Y. Carpenter, Edward Ott[2], Juan G. Restrepo[3], [1]*Harvard School of Public Health,* [2]*University of Maryland,* [3]*University of Colorado*.

A43 - Amplitude Control in Chaotic Systems
Chunbiao Li[1,2,3], J. C. Sprott[3], [1]*Southeast University, Nanjing, China,* [2]*University of Wisconsin,* [3]*Jiangsu Institute of Economics and Trade Technology, Nanjing, China.*.

A44 - Stochastic Competitive Population Dynamics: A Study on Evolutionarily Stable Dispersal Rate in Heterogeneous Spaces
Yen Ting Lin, Hyejin Kim, and Charles R. Doering, *Department of Physics, University of Michigan*.

A45 - Core Percolation on Complex Networks
Yang-Yu Liu, Endre Csóka, Haijun Zhou, and Márton Pósfai, *Northeastern University*.

A46 - Dynamic Jamming of the Granular Polymers
Lena Lopatina, Cynthia Olson Reichhardt, Charles Reichhardt, *Los Alamos National Laboratory*.

A47 - Symbolic Encoding in a Matched Filter Chaos-Based Communication
Alexandre Locquet[1], D.S. Citrin[1,2], M. Bennahmias[3], J. Laine[3], [1]*Georgia Tech-CNRS, Metz, France,* [2]*School of ECE, Georgia Institute of Technology,* [3]*Scieval LLC, Tarpon Springs, FL*.

A48 - Cutting and Shuffling: Mixing a Line Segment
Richard Lueptow[1], Marissa K. Krotter[1], Ivan C. Christov[2], and Julio Ottino[1], [1]*Northwestern University,* [2] *Princeton University*.

A49 - Relatively Coherent Sets as a Hierarchical Partition Method in time-dependent Chaotic Dynamical Systems
Tian Ma, Erik M. Bollt, *Clarkson University*.

A50 - An FTLE Analysis of Active Fluids
John Mahoney, Kevin Mitchell, *University of California, Merced*.

A51 - Set of Wires to Simulate Tokamaks with Poloidal Divertor, T. Kroetz[1]
Caroline G. L. Martins[2], M. Roberto[2], and I. L. Caldas[3], [1]*Universidade Tecnológica Federal do Paraná,* [2]*Instituto Tecnológico da Aeronáutica,* [3]*Universidade de São Paulo*.

A52 - Randomness of Perturbed Dice Throw Dynamics,
Nobuo Matsunaga, Yuzuru Sato, *RIES/Dept. of Mathematics, Hokkaido University*.

A53 - Spatial Periodic Forcing Can Displace Patterns It Is Intended to Control
Yair Mau, Aric Hagberg, and Ehud Meron, *Ben-Gurion University of the Negev, Israel*.

Poster Titles: Session B

Saturday Jan. 5, 7:30pm-9:30pm

B1 - Adaptive Stepping for Symplectic Integrators
C. Leland Ellison[1], A. S. Richardson[2], J. M. Finn[3], [1]*Princeton Plasma Physics Laboratory,* [2]*Naval Research Laboratory,* [3]*Los Alamos National Laboratory*.

B2 - Modeling Computer Dynamics: Can Noise Beat Determinism?
Joshua Garland, Liz Bradley, *University of Colorado at Boulder*.

B3 - Is Transient Growth a Common Feature of Nonlinear Systems?
Jonathan McCoy, Colby College.

B4 - Entanglement as a Classical, Nonlinear Phenomenon
Wm. C. McHarris, *Michigan State University*.

B5 - Anisotropic Transport beyond the Mass Tensor Approximation
Nicholas Mecholsky[1], Marco Fornari[2], Lorenzo Resca[1], Ian Pegg[1], [1]*The Catholic University of America/VSL,* [2]*Central Michigan University*.

B6 - Dynamical Properties of the Triangular Bouncer
Bruce Miller[1], Matthew Holtfrerich[2], [1]*Texas Christian University,* [2]*Northern Arizona University*.

B7 - Impact of Selection Strength on Evolution of Regulatory Networks
Garrett Mitchener, *College of Charleston*.

B8 - Detection of the Mediating Solution of Attractor Merging Crises
Tsuyoshi Mizuguchi, Makoto Yomosa, Naoya Fujiwara, Miki U. Kobayashi *Osaka Prefecture University*.

B9 - Continuum Simulations of Oscillated Granular Layers: Shocks and Patterns
Stefanie Moertl[1], Jonathan Bougie[1], Michael Hollowed[2], [1]*Loyola University Chicago,* [2]*University of Minnesota*.

B10 - Lattices of Entangled Cupolets
Matthew Morena, Kevin M. Short *University of New Hampshire*.

B11 - Quantifying Stretching and Rearrangement in Epithelial Sheet Migration
Rachel Lee, Kerstin Nordstrom, Douglas Kelley, Nicholas Ouellette, Wolfgang Losert, *University of Maryland*.

B12 - Unification of Ion Channel and Electrical Restitution-Based Viewpoints in the Study of Cardiac Action Potential Dynamics
Niels Otani, *Cornell University*.

B13 - Non-linear Dynamics of the Human Processual Phenotype
James Palmer, *Dept. Family Medicine, University of Colorado Denver School of Medicine*.

B14 - Chimera States on Periodic Spaces
Mark Panaggio, Daniel Abrams, *Northwestern University*.

B15 - Density Inversion in Oscillating Granular Layers
Joshua Panfil[1], Jon Bougie[1], Jennifer Kreft Pearce[2], Veronica Policht[3], [1]*Loyola University Chicago,* [2]*Roger Williams University,* [3]*University of Michigan-Ann Arbor*.

B16 - Mixing by Cutting & Shuffling in 3D Granular Flow: Exploring Relations to Piecewise Isometry
Paul P. Park, Paul B. Umbanhowar, Julio M. Ottino, Richard M. Lueptow, *Northwestern University*.

B17 - Automatic Sorting of Point Pattern Sets Using Minkowski Functionals
Joshua Parker, Eilon Sherman, Matthias van der Raa, Larry Samelson, Wolfgang Losert, *University of Maryland*.

B18 - Integrating Timescales of Ecological and Evolutionary Processes in an Intraguild Predation System
Swati Patel, Sebastian Schreiber, *University of California Davis*.

B19 - Tunneling and Electron Conductances in Chaotic and Regular Quantum Dot Systems
Louis Pecora[1], Ming-Jer Lee[2], Thomas Antonsen[2], Edward Ott[2], [1]*Naval Research Laboratory,* [2]*University of Maryland* .

B20 - Identifying and Quantifying Interactions in a Laboratory Swarm
James Puckett, Douglas H. Kelley, Nicholas T. Ouellette, *Yale University*.

B21 - Dynamics by the Dozen: Involving Many Levels of Students in Nonlinear Dynamics Research
Randall Tagg, Masoud Asadi-Zeydabadi, *University of Colorado Denver*.

B22 - Adaptive Pinning Synchronization Control Applied to a Network of Autonomous Vehicles
Luis Felipe R. Turci, Mateus M. R. Simões, *Federal University of Alfenas - UNIFAL-MG, Brazil*.

B23 - Desynchronization in Evolving Complex Networks
Luis Felipe R. Turci, *Federal University of Alfenas - UNIFAL-MG, Brazil*.

B24 - Neural Network Function – Density or Geometry?
Anca Radulescu, Sergio Verduzco, *University of Colorado at Boulder*.

B25 - Jamming to Clogging Transitions for Systems with Obstacle Arrays
Charles Reichhardt, Zohar Nussinov, Cynthia Reichhardt, *Los Alamos National Laboratory*.

B26 - Non-neutral Magnetic Vortex Dynamics
Steve Richardson, S. B. Swanekamp, *Naval Research Laboratory, Pulsed Power Physics Branch, Plasma Physics Division*.

B27 - Dynamical Instabilities in Coupled Huygens Pendulums
Jose R. Rios Leite[1], Josue S. da Fonseca[1,2], [1]*Universidade Federal de Pernambuco, Brasil,* [2]*Present address: Petrobras, Brazil*.

B28 - Nonlinear Amplification of RF Effects in Biological Magnetic Sensing
Gregory Robinson, *University of Colorado at Boulder*.

B29 - (Relativistic) Lattice Boltzmann Equation with Non-Ideal Equation of State
Paul Romatschke, *University of Colorado at Boulder*.

B30 - Experimental Boolean Kuramoto-like Oscillators: The Hunt for Chimera States Using Reconfigurable Chips
Damien Rontani, David P. Rosin, and Daniel J. Gauthier, *Duke University*.

B31 - Turbulence Particle Transport Driven by Plasma Drift Waves
Kauê Rosalem, M. Roberto, I.L. Caldas, *Instituto Tecnológico de Aeronáutica, Brazil*.

B32 - Hamiltonian Wave Dynamics on the Genesis of Eddies from Slow Waves in Rotating Flows
Amrik Sen, Keith Julien, Annick Pouquet, *University of Colorado at Boulder*.

B33 - Generalized Complex Ginzburg-Landau Equation: Local-to-Nonlocal-to-Global Coupling
Gautam Sethia[1], Abhijit Sen[1], George L. Johnston[2], [1]*Institute for Plasma Research, Bhat, India,* [2]*Edu Tron Corp., Winchester, MA, USA*.

B34 - Nonlinear Oscillations of Microdisk Resonators
Alexander Slawik, Daniel M. Abrams, *Northwestern University*.

B35 - Homeostasis and Genetic Robustness are Correlated in Responsive Biochemical Networks
Zeina Shreif, Vipul Periwal, *National Institutes of Health*.

B36 - Hierarchical Paths to Synchronization in Networks with Community Structure
Per Sebastian Skardal, Juan G. Restrepo, *University of Colorado at Boulder* .

B37 - Effects of Degree-Frequency Correlations on Network Synchronization
Per Sebastian Skardal[1], Jie Sun[2], Dane Taylor[1], and Juan G. Restrepo[1], [1]*University of Colorado at Boulder,* [2]*Clarkson University*.

B38 - Dynamics of Human Walking and Factorized Poincare maps
Manoj Srinivasan, Yang Wang, The Ohio State University.

B39 - Generalized Local Induction Equation, Elliptic Asymptotics, and Simulating Superfluid Turbulence
Scott Strong, Lincoln D. Carr, *Colorado School of Mines*.

B40 - Causality Inference beyond Granger Test and Transfer Entropy
Jie Sun, Erik M. Bollt, *Clarkson University*.

B41 - Large Systems of Interconnected Switches and Oscillators
Dane Taylor[1], Elana Fertig[2], Juan G. Restrepo[1], [1]*University of Colorado at Boulder,* [2] *Oncology Biostatistics, Johns Hopkins University*.

B42 - Spontaneous Mode-selection on a Self-running Droplet Driven by Interfacial Instability

Fumi Takabatake[1], Nobuyuki Magome[2], Masatoshi Ichikawa[1], Kenichi Yoshikawa[3], [1]*Kyoto University,* [2]*Dokkyo Medical University,* [3]*Doshisha University*.

B43 - Stability and Clustering of Self-similar Solutions of Aggregation Equations

Hui Sun, David Uminsky, Andrea Bertozzi, *University of California Los Angeles*.

B44 - Simulating Ginzburg Landau Dynamics with Efficient Spectral Galerkin Methods

Ty Thompson, *Colorado School of Mines*.

B45 - Experimental Chimeras: the Broken Symphony of Metronome Swing States

Shashi Thutupalli[1,3], Erik A. Martens [1,2], A. Fourriere[1], O. Hallatschek[1], [1]*Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany,* [2]*Technical University of Denmark,* [3]*Princeton University*.

B46 - Phase Transitions in the Quadratic Contact Process on Complex Networks

Chris Varghese, Rick Durrett, *Duke University*.

B47 - Noise-induced Oscillations in Network Motifs of Non-linear Oscillators with Delay

Andrea Vullings[1], Valentin Flunkert[2], Eckehard Schöll[1], [1]*Technische Universität Berlin,* [2]*Germany, IFISC, Palma de Mallorca, Spain*.

B48 - Dynamics of the Leaky Integrate-and-Fire Neuron with Inhibitory Feedback

Richard Watson, James Crutchfield, *University of California, Davis*.

B49 - Partial Control of Chaos and Continuity of Safe Sets

Genming Wang, Yuzuru Sato, *RIES/Dept. of Mathematics, Hokkaido University*.

B50 - Damped Oscillations in the Ratios of Stock Market Indices

Ming-Chya Wu, *Research Center for Adaptive Data Analysis, National Central University, Taiwan*.

B51 - Testing the Predictions of Random Matrix Theory in Low Loss Wave Chaotic Scattering Systems

Jen-Hao Yeh, Thomas M. Antonsen, Edward Ott, and Steven M. Anlage, *University of Maryland*.

B52 - Hydrodynamic Fluctuations and Shear Viscosity in the Unitary Fermi Gas

Ryan Young, Paul Romatschke, *University of Colorado at Boulder*.

B53 - Learning Cycles in Hopfield-type Networks with Delayed Coupling

Chuan Zhang, Gerhard Dangelmayr, Iuliana Oprea, *Colorado State University*.

B54 - Direct observation of Kelvin waves excited by quantized vortex reconnection

David Meichle, Daniel Lathrop, *University of Maryland*.