Math Seminars

A Biphasic Isothermal miRNA Detector
Danielle Ciesielski
When: Thursday, April 19, 2018 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: MicroRNAs are small, non-coding RNAs involved in regulating developmental and physiological processes whose dysregulation has been associated with the development of certain diseases. Researchers trying to use miRNA in blood as biomarkers for in-the-field disease diagnosis are running into specificity and sensitivity issues along with the difficulties due to low concentrations of the target miRNA. A novel DNA amplification template designed to address these issues produces results that challenge previous understanding of the DNA amplification process and show the potential for an endogenous switch that could be tuned to increase detector sensitivity. In this talk, I will walk through the construction of a mathematical model designed to explain the peculiar results of this reaction and how we intend to exploit the novel template characteristics to increase the robustness of the biomarker detector.

Math Seminars

Invasion Fronts in Spatially Extended Systems
Matthew Holzer, Department of Mathematical Sciences, George Mason University
When: Thursday, April 12, 2018 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Invasion fronts refer to fronts propagating into unstable states. An important characteristic of such fronts is the speed at which they propagate. In this talk, I will review wave speed selection principles and discuss two recent research projects related to wave speed selection. In the first, we study the emergence of locked fronts in a class of two component reaction diffusion equations. In the second, a model of global epidemics is considered and predictions for arrival times are obtained based upon the linearization about the unstable steady state.

Math Seminars

An Open Computational Platform for Low-Latency Real-Time Audio Signal Processing Using Field Programmable Gate Arrays
Ross Snider – Electrical and Computer Engineering, MSU
When: Thursday, April 5, 2018 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Field Programmable Gate Arrays (FPGAs) provide flexible computational architectures that are ideal for digital signal processing (DSP). With support of an NIH/NIDCD SBIR grant*, we are developing an open FPGA platform for the speech, hearing, and acoustics research communities. The advantage of using FPGAs in a computational platform over conventional CPU approaches is the ability to implement low-latency high-performance signal processing with deterministic latencies.
The hardware portion of the platform includes an audio codec and an Intel System-on-Chip (SoC) FPGA that contains ARM CPUs alongside the computational fabric that allows custom data plane designs. Development uses Mathwork's Simulink that allows exploration and simulation of signal processing algorithms. Once a Simulink model has been developed to implement audio processing in either the time domain or frequency domain, VHDL code can be generated that implements the desired signal processing. The VHDL code is then implemented in the FPGA computational fabric where the FPGA functions as a real-time signal processor.

We are currently soliciting ideas/feedback from the speech, hearing, and acoustic communities as to what features they would like to see in the next iteration of the open FPGA-based computational platform.

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**Math Seminars**

**Emergence of Cooperative Behavior in Microbial Consortia**  
Diana Schepens – Mathematical Sciences, MSU  
*When:* Thursday, March 29, 2018 03:10PM to 04:00PM  
*Where:* Wilson Hall 1-144  
*Details:* Cooperative microbial communities and their impact are ubiquitous in nature. The complexities of the cross-feeding interactions within such communities invite the application of mathematical models as a tool which can be used to investigate key influences in the emergence of cooperative behavior and increased productivity of the community. In this work, we develop and investigate a differential equation model of competition within a chemostat between four microbial strains utilizing a substrate to produce two necessary metabolites. The population of our chemostat includes a wild type strain that generalizes in producing both metabolites, two cross-feeding cooperator strains that each specialize in producing one of the two metabolites, and a cheater strain that produces neither metabolite.

Using numerical methods we consider three key characteristics of the microorganisms and investigate the impact on the emergence of mutual cross-feeding in the community. First, we investigate the impact that substrate input concentration and the rate and type (active vs. passive) of metabolite transport between cells has on the emergence of cooperation and multi-stabilities resulting from the competition. Second, we investigate the role that resource allocation within metabolic pathways plays in the results of the competition between cells with different metabolite production strategies. Introducing metabolite production cost into the model leads to new outcomes of the competition, including stable coexistence between different strains. Lastly, we examine the effect that an initial population of a non-cooperative cheater strain has on the outcome of competition. Our results show that the emergence of a cross-feeding consortia relies on the availability and efficient use of resources, ease of transport of metabolites between cells, and limited existence of cheaters.

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**Math Seminars**

**Quad Meshing, Cross Fields, and the Ginzburg-Landau Theory**
Math Seminars
Exploring the Unexplored Erosion Distance and Analyzing Music Using TDA
Robin Belton - Department of Mathematical Sciences, MSU
When: Thursday, March 8, 2018 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details:
Abstract: In this talk, I will give a brief overview on two projects I am working on.

Exploring the Unexplored Erosion Distance:

Being able to compare Persistence Diagrams is crucial when using TDA. In this project, we study a relatively unexplored distance metric on Persistence Diagrams, the Erosion Distance, which is predicted to be more computationally efficient than other common distance metrics. We aim to understand the topological properties of the space of Persistence Diagrams endowed with the Erosion Distance as well as construct an algorithm to compute the Erosion Distance with $O(n \log n)$ complexity.

Using Persistent Homology to Analyze the Complexity of Music:
This project provides a procedure to convert a musical score to a data set that can then be analyzed using Topological Data Analysis (TDA) techniques. Once these techniques are applied, we can analyze the complexity" of that musical piece.

Math Seminars
Curvature Estimates of Point Clouds as a Tool in Quantitative Prostate Cancer Classification
Anna Schenfisch - Department of Mathematical Sciences, MSU
When: Thursday, March 8, 2018 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: According to the American Cancer Society, 1 in 9 men are diagnosed with prostate cancer during their life. The choice of treatment is often based on how severe the cancer is thought to be, which is determined by a qualitative assessment of tissue biopsies. However, this purely qualitative assessment has been shown to lead to inconsistencies. In response to this problem, we first develop a way to estimate the curvature of a point cloud. Using this method, we then propose a quantitative method of classifying the severity of prostate cancer based on curvature estimates of rings of nuclei appearing in the biopsy.

Stat Seminars
Communicate Your Work
Erin Strickland - Writing Center, MSU
When: Tuesday, March 6, 2018 03:10PM to 04:00PM
Where: Wilson Hall 1-134
Details: This goes beyond writing. How do you connect with clients, set expectations, manage communication in person and present your project in a way that the client can understand and value? This topic aligns so well with what I know from being a teacher for eight years and what I do every day when I work with students during Writing Center appointments. Let's talk about setting up the conditions necessary for good communication to happen.

Math Seminars
Nonlocal Interfacial Dynamics in Biological Systems
Scott McCalla - Department of Mathematical Sciences, MSU
When: Thursday, February 22, 2018 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Biological pattern formation has been extensively studied using reaction-diffusion models. These models are inherently local, however many biological systems are known to exhibit nonlocality. In this talk we will discuss nonlocal pattern forming mechanisms in the context of bacterial colony formation and surface striping on animals with an emphasis on arrested fronts. This will lead to a novel nonlocal framework to understand the interfacial motion in biological systems.
We will then use this approach to model an interesting bacterial phenomenon, and to understand simple microscopic requirements for at stripe solutions to persist in nature.

**Stat Seminars**
**Let Your Data Speak**
Erin Strickland - Writing Center, MSU
When: **Tuesday, February 20, 2018 03:10PM to 04:00PM**
Where: Wilson Hall 1-134
Details: Joshua Schimel claims in his book *Writing Science* that any good scientific paper is, at its core, a story. He claims that a scientist should let the data speak the same way a fiction writer lets her characters speak. Give me 50 minutes to convince you that this is not nonsense.

**Math Seminars**
**Sampling Conditions for Conforming Voronoi Meshing by the Borocrust Algorithm**
Ahmed Abdelkader – Computer Science, University of Maryland at College Park
When: **Thursday, February 15, 2018 03:10PM to 04:00PM**
Where: Wilson Hall 1-144
Details: We study the problem of decomposing a volume with a smooth boundary into a collection of Voronoi cells. Unlike the dual problem of conforming Delaunay meshing, a principled solution to this problem for generic smooth surfaces remained elusive. VoroCrust leverages ideas from weighted $\infty$-shapes and the power crust algorithm to produce unweighted Voronoi cells conforming to the surface, yielding the first provably-correct algorithm for this problem. Given a $\delta$-sparse $\varepsilon$-sample, we work with the balls of radius $\delta$-times the local feature size centered at each sample. The corners of the union of these balls on both sides of the surface are the Voronoi sites and the interface of their cells is the medial axis of the union of balls yielding a watertight surface reconstruction. With the surface protected, the enclosed volume can be further decomposed by generating more sites inside it. Compared to clipping-based algorithms, VoroCrust cells are full Voronoi cells, with convexity and fatness guarantees. Compared to the power crust algorithm, VoroCrust cells are not filtered, are unweighted, and offer greater flexibility in meshing the enclosed volume by either structured or randomly generated samples.

Joint work with Chandraljit L. Bajaj, Mohamed S. Ebeida, Ahmed H. Mahmoud, Scott A. Mitchell, John D. Owens, Ahmad A. Rushdi

**Math Seminars**
**Cooperative Activation of DNA-Based Biosensors**
Stephanie McCalla – Chemical & Biological Engineering, MSU
When: **Thursday, February 8, 2018 03:10PM to 04:00PM**
Where: Wilson Hall 1-144
Details: Switch-like responses to input stimuli are ubiquitous in nature. This switching behavior is common in cell signaling, transcription, and genetic regulatory networks; it is commonly accepted
that these switches react decisively to a true signal while filtering out noise. When properly designed, synthetic biosensors can also create a switch-like output: biosensors with two cooperative bindingsites produce an ultrasensitive response if the affinity of the target for the second site is altered by target association to the first site. This technique can create a rapid nucleic acid amplification method with an endogenous switching mechanism. I will discuss tuning these switch-like reactions, and their applications to disciplines such as DNA computing and clinical diagnostics.

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**Stat Seminars**
**Don't Forget the Figures**
Erin Strickland - Writing Center, MSU
*When: Tuesday, February 6, 2018 03:10PM to 04:00PM*
*Where: Wilson Hall 1-134*

**Details:** Figures can add much in the way of readability and ease of grasping information quickly. Or they can be a distracting, frustrating and confusing sidebar to your paragraphs. How can we make figures work for you, not against you?

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**Math Seminars**
**Spherical Assemblage and Pattern Formation in Anisotropic Particle Interactions**
Anthony Gaussoin - Department of Mathematical Sciences, MSU
*When: Thursday, January 25 03:10PM to 04:00PM*
*Where: Wilson Hall 1-144*

**Details:** Interacting particle systems appear in a wide range of applications. Examples include the Thomson problem, flocks and swarms, bacterial colonies, micelles, self-organization of soft matter, and viral capsids. For particles that self-assemble near the surface of a sphere, the stationary states range from platonic solids for small numbers of particles to complex patterns for large particle systems. Previous work (von Brecht et al., Nonlinearity, 30, 2016) uses a linear stability analysis for pairwise interacting anisotropic particles to predict what conditions on the interaction kernel allow for a uniform density sphere to occur. We adopt this framework to try and answer the inverse problem: can we design an anisotropic interaction potential that will destabilize a small number of desired modes to produce interesting patterns.

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**Stat Seminars**
**Recognize Good Writing**
Erin Strickland - Writing Center, MSU
*When: Tuesday, January 23, 2018 03:10PM to 04:00PM*
*Where: Wilson Hall 1-134*
Details: What makes writing in statistics good? When something is easy to read it means that it has been hard to write. We will take some time to look at ways that good writers make our job as a reader easier and ask ourselves what we can do with our own writing to give it that all important, often elusive, readability.

Stat Seminars
Monothetic Cluster Analysis with Extensions and Applications
Tan Tran, PhD Proposal Defense - Department of Mathematical Sciences, MSU
When: Thursday, December 14, 2017 01:30PM to 02:30PM
Where: Wilson Hall 1-144
Details: Monothetic clustering is a divisive clustering method based on recursive bipartitions of a data set choosing candidate splitting rules from each of the response variables, one at a time. This clustering technique is very helpful for applications where the source of groupings of observations as well as predicting new subjects into clusters are both important, as in generating disease profiles in medical applications. Based on the ideas of classification and regression trees, the standard monothetic clustering algorithm was implemented in R to allow further explorations and modifications. One of the common problems in building a binary tree is deciding when to stop splitting - deciding how many clusters are “enough”. Some well-established techniques are reviewed as well as proposed cross validation and permutation tests that can help researchers answer this question objectively. Monothetic clustering is of interest to be applied in a variety of situations. This can include data sets with circular variables, where the variables’ natures are not linear. The development of a method for monothetic clustering with circular variables is discussed that also could be used in other classification and regression tree situations. Clustering is also interesting for data sets where the responses can be transformed into functional data, which has unique properties that need exploring. Partitioning Using Local Subregions (PULS), a clustering technique inspired by monothetic clustering to overcome some of its disadvantages in clustering functional data, is discussed. In this algorithm clusters are formed based on aggregating the information from several variables or time intervals. In both monothetic clustering and PULS it is possible to limit the set of candidate splitting variables to be able to create clusters for new observations without observing all variables or times to assign new observations to the clusters. R packages for these methods have been developed for others to use and test and support the proposed research.

Math Seminars
Renewable Fuels, Chemicals, and Materials from Plant Biomass - Predicting Processing Outcomes from Plant Cell Wall Properties
David Hodge - Department of Chemical & Biological Engineering, MSU
When: Thursday, November 30, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: As the global demand for energy grows, the need for sustainable sources of energy and carbon as a supplement or replacement for fossil fuels is becoming
imperative. Among possible technology options, the chemical, catalytic, or biochemical conversion of the structural polymers contained within plant cell walls (i.e. lignocellulosic biomass) to biofuels, biochemicals, and biomaterials has the potential to displace current processes utilizing fossil resources. Plant cell walls exhibit substantial heterogeneity arising from differences in biopolymer composition, organization, and higher order structure. This heterogeneity is exhibited across length scales spanning several orders of magnitude, and is a complex function of plant genotype, maturity, tissue type, and the plant’s response to its environment. One theme underlying research in my laboratory is how improved characterization of the chemical, structural, and physical changes to the plant cell wall and the spectrum of compounds solubilized from the cell wall can better inform technologies for plant cell wall conversion to renewable fuels and chemicals. In this presentation, illustrative examples of work utilizing characterization data in empirical and mechanistic models to predict plant cell wall responses to a conversion process will be highlighted.

Stat Seminars
Statistics Writing Project and Writing Center Presentations
Kara Johnson, Michelle Miley and Erin Strickland - Department of Mathematical Sciences and Writing Center, MSU
When: Tuesday, November 28, 2017 03:10PM to 04:00PM
Where: Roberts Hall 208
Details: In the first half of this seminar, Kara Johnson will present her Statistics Masters writing project, "(Why) Were the Polls Wrong?" While some 2016 presidential election polls were accurate, others missed badly. This talk will look at which polls missed and why, covering sampling, analysis, and reporting. Topics discussed include perceptions of polls, social desirability bias, differential nonresponse bias, correlation between states, undecided and 3rd party voters, weighting, distributional assumptions, herding, understanding of probability and uncertainty, and the effect of media and political experts. In the second half, Michelle Miley and Erin Strickland from the MSU Writing Center will give a brief presentation of the services they provide. Services most pertinent to graduate students will be highlighted.

Math Seminars
Some Geometric Optimization Problems on Complex Projective Spaces, Part 2
Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Monday, November 27, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Motivated by problems in fiber optics and quantum measurement, I will introduce complex projective spaces and discuss some theoretical questions and computational challenges about their metric properties. The talk will be mostly elementary and accessible to students familiar with matrix theory and multivariable
Math Seminars

Some Geometric Optimization Problems on Complex Projective Spaces
Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: **Monday, November 20, 2017 04:10PM to 05:00PM**
Where: Wilson Hall 1-144
Details: Motivated by problems in fiber optics and quantum measurement, I will introduce complex projective spaces and discuss some theoretical questions and computational challenges about their metric properties. The talk will be mostly elementary and accessible to students familiar with matrix theory and multivariable calculus.

Math Seminars

Phylogenetic factorization: using the evolutionary tree to define a graph partitioning algorithm and matrix-factorization for biological big-data
Alex Washburne - Department of Microbiology & Immunology, MSU
When: **Thursday, November 16, 2017 03:10PM to 04:00PM**
Where: Wilson Hall 1-144
Details: Evolution happened. The evolutionary histories of a set of species can be estimated and represented through a tree, called the "phylogeny", which defines the hierarchy of clades and lineages connecting a set of species to their most recent common ancestor. Phylogenies are connected graphs with no cycles and may or may not have a root. Edges in the phylogeny represent continuous, historical lineages and nodes represent speciation events. Edges are sites in the phylogeny along which traits - such as lungs and limbs - arose, and an over-arching goal in ecology is to identify the sets of edges which define the set of traits underlying an ecological pattern ranging from land/sea associations in vertebrates to carbon sequestration in global forests or disease states in microbial communities. In this talk, I will discuss a graph partitioning algorithm, called "phylofactorization", developed to partition the phylogeny into sub-trees which capture blocks of variation in biological big-data. The algorithm can be defined using abstract "aggregation" and "contrast" operations and maximization of an objective function. A specific example involves the use of standardized differences (contrasts) of means (aggregates) in regression (objective functions include statistics from regression). Phylofactorization allows one to construct an orthonormal basis corresponding to edges along which hypothesized traits arose and can be used for diagnosing Crohn's disease and understanding global patterns of emergent infectious diseases. Unresolved math problems relating to phylofactorization are presented, including graph-topological challenges for cross-validation, incorporating the phylogenetic basis into generalized linear modelling, and calculating the relative size of Voronoi cells of a set of k>n vectors in a unit, n-dimensional hypersphere.
Enhancing STEM Education: An Overview of my Research Program
Jennifer L. Green - Department of Mathematical Sciences, MSU
When: Tuesday, November 14, 2017 03:10PM to 04:00PM
Where: Roberts Hall 208
Details: Statistics education research is at the interface between statistics and education, providing rich opportunities to explore interestingly complex questions about teaching and learning. As a statistics education researcher, my research program focuses the development of statistical methods and strategies to enhance and assess educational programs in Science, Technology, Engineering and Mathematics (STEM) related disciplines. This research focus manifests in two interrelated ways: 1) the development of statistical methodology to characterize the impact of professional development and educational programs on teacher effectiveness and student learning, and 2) the development of teachers of statistics in grades K-16. In this presentation, I will discuss each of these areas, highlighting a variety of the research projects I have participated or am currently participating in and the contributions each makes to the advancement of STEM education. Throughout the talk, I will showcase the interdisciplinary, collaborative nature of my work. Developing strong partnerships with colleagues within the department, across the campus, at other institutions, and in local schools is an instrumental part of my research program, strengthening the quality of the research and broadening its scope. By the end of the talk, everyone should have a sense of what I do and recognize potential opportunities for future research in statistics education.

From Knots to Number Fields, Part 2
Charlie Katerba - Department of Mathematical Sciences, MSU
When: Monday, November 13, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: This sequence of two talks will serve as an introduction to the arithmetic of hyperbolic three manifolds, an area of math that uses number theory to study geometry and vice versa. We will discuss a long standing open question in number theory and describe a way that knot theory may be used to resolve the conjecture.

Covariance-based tests of symmetric competition in stochastic communities and portfolios
Alex Washburne - Department of Microbiology & Immunology, MSU
When: Thursday, November 09, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Communities in ecology are often characterized by competition among species - for canopy space, prey, or other resources. Similarly, markets in economies are
characterized by competition among companies - for consumers, capital, or other resources. What do we expect to characterize the competition between species or between companies as evolution and innovation play out? One hypothesis is called "Neutral Theory" (Hubbell 2000) - that any competitive asymmetries lead to the extinction of less-competitive species, and the resultant asymptotic system is a symmetric one in which all species are competitively equivalent or "neutral". Tests of neutrality have often connected stationary distributions of neutral competition with rank abundance distributions observed in nature. However, infinitely many stochastic processes can yield the same stationary distribution - time-series tests are more powerful and informative. In this talk, I will discuss Neutral Theory - an urn process which converges to a symmetric system of stochastic differential equations in the limit of infinitely large urn size. Then, I will discuss recent findings for how one can exploit the symmetry of the quadratic covariation - in particular the invariance to grouping of species - to test time-series of ecological and economic data.

**Math Seminars**

**From Knots to Number Fields, Part 1**  
**Charlie Katerba - Department of Mathematical Sciences, MSU**  
**When:** Monday, November 06, 2017 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-144  
**Details:** This sequence of two talks will serve as an introduction to the arithmetic of hyperbolic three manifolds, an area of math that uses number theory to study geometry and vice versa. We will discuss a long standing open question in number theory and describe a way that knot theory may be used to resolve the conjecture.

**Math Seminars**

**NMR Measurements of Transport Phenomena**  
**Sarah L. Codd - Department of Mechanical Engineering, MSU**  
**When:** Thursday, November 02, 2017 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** Magnetic resonance (MR) techniques allow characterization of porous materials on the ~10 mm imaging scale. However, more importantly, within this spatial resolution molecular level properties such as nuclear magnetic relaxation and translational molecular diffusion can provide nanometer scale molecular dynamic information. This allows measurements in materials over a hierarchy of length and times scales from the pore to the system scales. Much of the work at MSU in the COE MR lab focusses on transport measurements either with or without spatial resolution. The use of spin echoes to determine diffusive molecular motion was first demonstrated in 1950 by Erwin Hahn. In 1965, Stejskal and Tanner added pulsed gradients (PGSE) and highlighted a direct relationship between the echo amplitude and the self-diffusion coefficient of the spins. This was the start of an exciting exploration into what information could be accessed by non-invasively measuring and comparing the average motion of fluids over various time windows. PGSE sequences have been developed to
explore progressively shorter times and smaller distances, and to separate coherent and stochastic motion over a spectrum of times. In particular, unique information has been yielded in turbulent flows, rheology of complex fluids such as polymers, emulsions and colloids, liquid flow in porous materials, and gas transport in porous media. The mathematical formulism of these MR techniques will be discussed and examples of results from a range of systems with environmental, geophysical and industrial relevance will be presented.

Stat Seminars
How an Idea Becomes a Peer-Reviewed Journal Article
The Statistics Faculty - Department of Mathematical Sciences, MSU
When: Tuesday, October 31, 2017 03:10PM to 04:00PM
Where: Roberts 208
Details: A panel discussion of the publication process from a group of statistics faculty members, drawing on combined decades of experience developing, writing, submitting, getting papers rejected, and then, eventually (usually), accepted. We will discuss publishing papers focused on statistical methodology, statistical applications, and statistics education. Some case studies from the peer-review process both from submitted and reviewer experiences will be provided. This talk is focused on trying to explain how an idea becomes a published paper for students unfamiliar with the process. We will also highlight some of the roles that statisticians play in different types of papers.

Math Seminars
Tying Exit-path Infinity-categories to Knots
Anna Cepek - Department of Mathematical Sciences, MSU
When: Monday, October 30, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The aim of this talk is to illustrate a connection between exit-path infinity categories of Ran spaces and knots. After introducing preliminary definitions, an exposition of the equivalence between the exit-path infinity-category of the Ran space of the circle and the opposite of the pericyclic category restricted to surjective morphisms will be given. Then the relationship between the implications of this equivalence and knots will be examined.

Math Seminars
Exploring Frequented Regions in Pan-Genomic Graphs
Brendan Mumey - Department of Computer Science, MSU
When: Thursday, October 26, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We consider the problem of identifying regions within a pan-genome de Bruijn graph that are traversed by many sequence paths. We define such regions and the sub
paths that traverse them as frequented regions (FRs). In this work, we formalize the FR problem and describe an efficient algorithm for finding FRs (the graphs in question may have millions of vertices and edges). Subsequently, we propose some applications of FRs based on machine-learning and pan-genome graph simplification. We demonstrate the effectiveness of these applications using data sets for the organisms Staphylococcus aureus (bacteria) and Saccharomyces cerevisiae (yeast). We corroborate the biological relevance of FRs such as identifying introgressions in yeast that aid in alcohol tolerance, and show that FRs are useful for classification of yeast strains by industrial use and visualizing pan-genomic space.

Stat Seminars
Predictive Modeling and the Fragile Families Challenge
Nicole Carnegie - Department of Mathematical Sciences, MSU
When: Tuesday, October 24, 2017 04:10PM to 05:00PM
Where: Roberts Hall 208
Details: We describe our approach to predictive modeling in the Fragile Families Challenge. Our aim was to develop a "hands-off" approach to variable selection and modeling that would be readily transferable to other outcomes and settings. To this end, we compare the results of a variety of variable selection methods, as well as tuning parameters for the predictive model fitting. The model we used for fitting was Bayesian Additive Regression Trees (BART), to take advantage of the model's flexibility in fitting surfaces and minimal assumptions. We find that the approach is effective for developing a strong predictive model across outcomes in the challenge. Variable selection method had less impact on the final performance than the tuning of the BART fit.

Math Seminars
Leveraging the dynamics of an aggregation equation to extract community structure
Adam Wilander - Department of Mathematical Sciences, MSU
When: Thursday, October 19, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Swarming and aggregation are natural phenomena that occur in a variety of contexts, from schooling in fish, flocking in birds, to bacterial colonization. This behavior often results from simple underlying rules for each particle-particle interaction. In this talk, we examine an aggregation model with a random underlying network topology between particles. We review some past results on the subject and extend it to incorporate latent community structure. We then explore the community structured model's dynamics as the network topology varies, offering simple heuristics for its behavior. Finally, we evaluate a potential application for community detection.
Risk-based Prognostics and Health Management: Probabilistic Methods for Continuous-time Hazard Analysis and Risk Mitigation
John Sheppard - Department of Computer Science, MSU
When: Thursday, October 12, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: To date, most practical implementations of Prognostics and Health Management (PHM) have focused on the health management aspects with only minor attention being given to fault prediction. Commercial and military aerospace systems often employ a wide variety of embedded and on-board sensors to track and estimate the health of systems, and this information is being employed in frameworks such as reliability centered maintenance and condition based maintenance. Recently, organizations such as NASA and the US Army have started to explore incorporating formal methods for online risk assessment to guide interpreting health assessments and making system maintenance decisions. In this talk, I will introduce our work in risk based PHM where we are coupling traditional model-based diagnostic and health assessment methodologies with continuous-time probabilistic methods to track and predict the impact of emerging hazards in a system using real-time, condition assessments of system health and the emergence of likely faults. Specifically, I will address how we have integrated dependency-based methods for fault diagnosis with fault tree analysis to derive and use continuous-time Bayesian networks as an end-to-end approach in real-time monitoring, tracking, predicting, and mitigating risks associated with system failure.

Math Seminars
An Introduction to QFT in the BV Formalism
Ryan Grady - Department of Mathematical Sciences, MSU
When: Monday, October 09, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: These talks will be aimed at interested graduate students. The aim is to introduce the Batalin-Vilkovisky (BV) formalism for quantum field theory (QFT) starting from a basic understanding of smooth manifolds. In addition to describing several examples, we will illustrate how QFT feeds back into topology/geometry via manifold invariants.

Math Seminars
EEG Source Imaging Based on Spatial and Temporal Graph Structures
Jing Qin - Department of Mathematical Sciences, MSU
When: Thursday, October 05, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Electroencephalogram (EEG) serves as an essential tool for brain source localization due to its high temporal resolution. However, the inference of brain activities from the EEG data is a challenging ill-posed inverse problem. To better retrieve task
related discriminative source patches from strong spontaneous background signals, we propose a novel EEG source imaging model based on spatial and temporal graph structures. In particular, graph fractional-order total variation (gFOTV) is used to enhance spatial smoothness, and the label information of brain state is enclosed in a temporal graph regularization term to guarantee intra-class consistency of estimated sources. The proposed model is efficiently solved by the alternating direction method of multipliers (ADMM). A two-stage algorithm is proposed as well to further improve the result. Numerical experiments have shown that our method localizes source extents more effectively than the benchmark methods.

Stat Seminars
Generating Space-Filling Sets of Experimental Design Points
John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, October 03, 2017 03:10PM to 04:00PM
Where: Roberts Hall 208
Details: Suppose a researcher wants to be able to design an experiment that will allow the fitting many potential models (e.g., polynomial (linear) models or nonlinear models found in the scientific literature). Suppose also the researcher only has enough time and money to collect N experimental combinations of the design variables, such as process temperature and time. What a statistician could do is find a good N-point "space-filling" design. That is, the N points provide good coverage of the design space for combinations of the experimental variables. One approach for generating a good space filling design in two variables is to first consider the unit square $U = [0, 1] \times [0, 1]$. The goal is to generate a set of N points $(x_1, x_2)$ in $U$ that are space-filling. That is, the N points should appear throughout the square $U$ with no points near each other. These points are then transformed back to the scale of the original design variables to generate the design the researcher will implement. The same principle holds for generating designs in a k-dimensional regions for k>2 design variables. Four methods for generating these sets of points that are based on simple mathematical principles (such as modular arithmetic and decimal expansions of trig functions) will be presented. A simple application of how these sets of points are related to statistical design and analysis of experiments will be given. Finally, extensions of this research to other types of design regions (e.g., a hypersphere or a simplex) will be discussed.

Math Seminars
The neural basis of stable attentional targeting during natural vision.
James Mazer - Department of Cell Biology & Neuroscience, MSU
When: Thursday, September 28, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: During naturally occurring visually guided behaviors eye movements and attention act in concert to efficiently allocate limited neural resources. Attention is generally believed to be mediated by retinotopically organized brain regions, which
means that the specific neurons encoding attended scene features change with each eye movement. So how does the attentional control system compensate for eye movements? We investigated whether oculomotor motor plans trigger predictive shifts in attentional maps in visual cortex in both humans and monkeys. Our data show that both humans and monkeys actively compensate for saccadic eye movements to sustain attention in a world-centered or spatiotopic reference frame. This compensation depends on a predictive handoff of attentional state information between neurons that starts ~150ms before each eye movement, effectively stabilizing attentional topography across eye fixations during natural vision.

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**Math Seminars**

**Poincare'/Koszul duality via calculus**  
David Ayala - Department of Mathematical Sciences, MSU  
**When:** Monday, September 25, 2017 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-144  
**Details:** This talk will be aimed at interested graduate students. It will follow an informal narrative of a multiplicative version of Poincare' duality. The goal of this talk will be to motivate this statement, understand a heuristic description of all terms involved in it, and acquire a taste of the questions and techniques surrounding it.

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**Math Seminars**

**Optimality in microvascular networks**  
Marcus Roper - Department of Mathematics, UCLA  
**When:** Thursday, September 21, 2017 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** In animals, gas exchange between blood and tissues occurs in billions of microvessels. Red blood cells must squeeze to pass through these narrow vessels: but why do the vessels need to be so narrow? Using the embryonic zebrafish trunk as a model, I will show that pressure feedbacks created when red blood cells enter the finest vessels act to uniformly partition red blood cells and prevent the vessels closest to the heart from short circuiting the network. More generally I will describe our new computational algorithms for calculating the optimal wiring of microvascular networks, which are exposing some of the physical principles that underlie these networks, as well as how these physical functions are lost and recovered following disease or damage.

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**Math Seminars**

**Symmetries of higher dimensional holomorphic field theories**  
Brian Williams - Northwestern University  
**When:** Monday, September 18, 2017 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-144  
**Details:** The most well-known examples of holomorphic field theories come from chiral CFTs in complex dimension one. Of the symmetries of these theories, a special role is
played by both the Kac-Moody and Virasoro vertex algebras. In this talk I will discuss
generalizations of these symmetries to higher dimensions in the language of
factorization algebras. For example, holomorphic gauge theories in complex dimension
d (theories depending on the data of a holomorphic connection) generically have the
symmetry of a certain dg Lie algebra studied recently by Faonte, Hennion, and
Kapranov. My talk will focus on this higher Kac-Moody algebra and I will relate it to a
shadow of a richer OPE algebra. Time permitting, I will discuss a similar picture for the
higher Virasoro algebras.

Math Seminars
A Continuum Model and Numerical Simulations for Transcription of a
Crowded Gene -- the RRN Operon
Lisa Davis - Department of Mathematical Sciences, MSU
When: Thursday, September 14, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In fast-transcribing prokaryotic genes, such as an rrn gene, many RNA
polymerases (RNAPs) transcribe the DNA simultaneously. Active elongation of RNAPs
is often interrupted by pauses, which has been observed to cause RNAP traffic jams;
however, some studies indicate that elongation is faster in the presence of multiple
RNAPs than elongation by a single polymerase. Over the course of the project, we have
considered several mathematical models. I will give a brief overview of the essential
biological quantities of interest, and the remainder of the talk will focus on a continuum
model taking the form of a nonlinear conservation law PDE where transcriptional
pausing is incorporating into the flux term with a discontinuous velocity function. The
velocity relation is parametrized according to the user-specified (or randomly generated)
spatial locations and time duration of the pauses. We discuss various algorithms that
were used for model simulation for a series of parameter studies. The most recent
results were obtained using a python implementation of the well-known Clawpack
software which uses a finite volume method with a Riemann solver especially suited for
this type of flux function. The basic ideas behind a Riemann solver will be defined. A
specific PDE formulation that allows easy extraction of important biological quantities is
discussed, and some Clawpack functionalities relevant to the project will be discussed
in the talk also.

Math Seminars
Matt Larson - The National Council of Teachers of Mathematics
When: Monday, September 11, 2017 04:15PM to 05:15PM
Where: The Procrastinator Theater, MSU SUB
Details: We are pleased to have Matt Larson, president of the National Council of
Teachers of Mathematics, participate in the 2017-2018 colloquium series. His talk will
be followed by a brief reception in the Leigh Lounge. Talk Summary: In order to improve
the mathematics learning of students and simultaneously close learning differentials, we
must overcome the obstacles that have traditionally stood in the way of mathematics
working for each and every student. This presentation will engage participants in examining six principles of effective mathematics programs and look at action steps necessary to overcome these obstacles. For more information about Matt Larson, the National Council of Teachers of Mathematics, and the talk, see the press release located at the link below.

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**Math Seminars**

**MODEL REJECTION AND PARAMETER REDUCTION VIA TIME SERIES**  
Tomas Gedeon - Department of Mathematical Sciences, MSU  
*When: Thursday, September 07, 2017 03:10PM to 04:00PM*  
*Where: Wilson Hall 1-144*  
*Details:* We introduce a new approach to Dynamic Signatures Generated by Regulatory Networks (DSGRN) that provides a query-able description of global dynamics over the entire parameter space. We perform a model validation within this class of dynamical systems. We show how a graph algorithm for finding matching labeled paths in pairs of labeled directed graphs can be used to reject models that do not match experimental time series. In particular, we extract a partial order of events describing local minima and local maxima of observed quantities from experimental time-series data from which we produce a labeled directed graph we call the pattern graph for which every path from root to leaf corresponds to a plausible sequence of events. We then consider the regulatory network model, which can be itself rendered into a labeled directed graph we call the search graph via techniques previously developed in computational dynamics. Labels on the pattern graph correspond to experimentally observed events, while labels on the search graph correspond to mathematical facts about the model. We give a theoretical guarantee that failing to find a match invalidates the model. As an application we consider gene regulatory models for the yeast S. cerevisiae.

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**Math Seminars**

**Min-max formulas for nonlocal elliptic operators and applications**  
Nestor Guillen - University of Massachusetts, Amherst  
*When: Thursday, August 31, 2017 03:10PM to 04:00PM*  
*Where: Wilson Hall 1-144*  
*Details:* A mapping $F$ between spaces of real valued functions is said to have the "global comparison property" (GCP) if $u \leq v$ everywhere with $u=v$ at some point $x$, means that $F(u) \leq F(v)$ at this point $x$. A classical result of Courrège says that a continuous linear map from $C^2(\mathbb{R}^d)$ to $C^0(\mathbb{R}^d)$ has the GCP if and only if it is a sum of jump and drift-diffusion operators. In work with Russell Schwab, we characterize nonlinear maps having the GCP as those given by a min-max of linear operators having the GCP. This result provides representation formulas for the Dirichlet-to-Neumann map of nonlinear elliptic equations, and for the interface velocity for various free boundary problems, respective applications will be discussed along with a list of related questions which are open.
Math Seminars
Random Walks on the Fundamental Group of the Once-Punctured Torus
Adam Holeman - Department of Mathematical Sciences, MSU
When: Monday, August 28, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The talk will begin with an introduction to random walks on groups. We will focus on the long term behavior of a random walk on the fundamental group of the punctured torus; in particular, the average amount of time a random walk spends near the puncture. By introducing a systematic way of symbolically encoding geodesics in the universal covering space of the punctured torus, we aim to better understand the asymptotic behavior of random walks. The talk will also cover connections between the symbolic encoding of geodesics mentioned earlier and the theory of Diophantine approximation, before ending with one or more conjectures.

Math Seminars
On Homotopy Groups of 3-Dimensional Contact Manifolds
Dan Perry - Department of Mathematical Sciences, MSU
When: Monday, May 01, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-141
Details: Restrictions of motion in a smooth manifold may be captured by a distribution, a subbundle of the tangent bundle. Considerations of distributions, along with the Lie Bracket, allow for interpretation and definition of certain structures, foliations and contact manifolds, along with an appropriate sense of mapping, contact maps. These contact maps are used to define homotopy groups on contact manifolds. An indication as to what these groups are will be provided.

Math Seminars
Modelling floc and biofilm formation for wastewater treatment
Jinju (Vicky) Chen - School of Mechanical and Systems Engineering, Newcastle University, UK
When: Wednesday, April 26, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Engineered biological systems for the treatment of polluted or contaminated water are important for sustainable development in both established and developing countries. These technologies have been mainly developed empirically. In general, there are two types of wastewater treatment systems: suspended-growth and fixed-film systems. Suspended-growth systems are comprised of biological flocs, whilst, fixed growth systems involve the formation of biofilms attached to solid surfaces. The formation of the flocs or biofilms play a key role in the functioning and efficiency of wastewater treatment. The complex network of biological reactions in bioreactor that characterize wastewater treatment are not optimized because there are lack of understanding of biological processes. Therefore, in this study we employed an
adaptive modelling approach to study the formation of the flocs in activated sludge wastewater treatment and biofilm formation for fixed-film wastewater treatment. In addition, we also investigated how surface properties of carrier materials would affect bacteria community, biofilm formation and biofilm mechanics.

**Math Seminars**

**Approaches to Fixing our Cartilage and Joints: Metabolomics and Modeling**
Ron June - Department of Mechanical and Industrial Engineering, MSU

*When: Thursday, April 20, 2017 03:10PM to 04:00PM*

*Where: Wilson Hall 1-144*

*Details:* Our lab studies the most common joint disease, osteoarthritis. This disease affects more than 50% of people older than age 65, and is the most common cause of joint pain and disability. Our research is both basic and applied. In this presentation, we will discuss a novel modeling approach to understand how cartilage cells alter their energy metabolism in response to mechanical loading. We will also discuss preliminary studies seeking to find biomarkers of osteoarthritis using metabolomics profiling. Metabolomics profiling is a technique to quantify thousands of small molecule metabolites in biological samples. Our lab has been one of the first to apply this technique to understanding and treating cartilage and joints such as the knee and the hip.

**Math Seminars**

**From hyperbolic to algebraic geometry through character varieties**
Charlie Katerba - University of Montana

*When: Monday, April 17, 2017 04:10PM to 05:00PM*

*Where: Wilson Hall 1-144 Details:*

**Math Seminars**

**Analysis of the effect of short term plasticity on information processing in hippocampal interneuron synapses**
Emily Stone - Department of Mathematical Sciences, University of Montana

*When: Thursday, April 13, 2017 03:10PM to 04:00PM*

*Where: Wilson Hall 1-144 Details:*

Neurons in a microcircuit connected by chemical synapses can have their connectivity affected by the prior activity of the cells. The number of synapses available for releasing neurotransmitter can be decreased by repetitive activation through depletion of readily releasable neurotransmitter, or increased through facilitation, where the probability of release of neurotransmitter is increased by prior activation. These competing effects can create a complicated and subtle range of time dependent connectivity. Here we investigate the probabilistic properties of facilitation and
depression (FD) for a presynaptic neuron that is receiving a Poisson spike train of input. We use a model of FD that was parameterized with experimental data from a basket cell and pyramidal cell connection (roughly 8-10 synapses were counted), for fixed frequency input spikes. Hence our results will apply to micro circuits in the hippocampus that are responsible for the gamma rhythms associated with learning and memory.

**Math Seminars**

**Folds, Intersections, and Inflections: Seven Ways to Distinguish a Cylinder from a Möbius Band**

Tom Banchoff - Brown University

**When:** Monday, April 10, 2017 04:10PM to 05:00PM

**Where:** Barnard Hall 103

**Details:** This talk develops seven different visual ways to distinguish whether a strip neighborhood of a curve on a surface is an oriented cylinder or a non-orientable Möbius band. Computer graphics illustrations will explore fold curves of projections of surfaces into planes, self-intersection curves of surfaces in three space, and a new criterion in terms of surface inflections.

**Math Seminars**

**Multi-model inference beyond model averaging: Model Projections in Model Space**

Mark L. Taper - Department of Ecology, MSU

**When:** Thursday, April 06, 2017 03:10PM to 04:00PM

**Where:** Wilson Hall 1-144

**Details:** There is a growing recognition that model miss-specification is generally the major source of error in statistical analysis (Chatfield 1995). Model averaging (e.g. Burnham and Anderson 2002) is an attempt to deal with this problem. Unfortunately, model averaging is flawed both philosophically and practically. Model Projections in Model Space (MPMS) is a new approach to multi-model inference (Taper and Ponciano 2016). MPMS is a direct extension of Akaike's original highly geometric derivation of the AIC. MPMS is able to extract more kinds of information from a model set than can standardize model identification and model averaging. Not only can we estimate relative distances of candidate models to the generating process, we can estimate absolute distances. Further, we can locate the best projection of the generating process to the space created by the candidate model set and estimate the distance from this best projection to the generating process.

**Math Seminars**

**Modeling light propagation in optical fibers using Lie group theory**

Ioannis (John) Roudas - Department of Electrical & Computer Engineering, MSU

**When:** Thursday, March 30, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The role of the fiber-optic internet backbone network in recent economic development is irrefutable. The tremendous growth of the information technology sector witnessed during the past decades was fueled by continuous innovations in optical fiber communications. High-speed optical communication systems based on single-mode fibers form the backbone of the current telecommunications network. New optical fibers with increased transmission capacity need to be adopted in the future to accommodate data traffic demands. Currently, promising candidates to address this need are few mode, multimode, and multicore optical fibers, which can be used to increase capacity almost proportionally to the number of modes/cores. Significant research effort is dedicated recently to the development of analytical and numerical models that describe light propagation in the aforementioned fiber types. In this invited talk, we will review several phenomenological propagation models which are based on the concatenation of NxN random unitary matrices. In particular, we will discuss generalized Jones vectors and matrices, the expansion of the latter in the basis of the generalized Gell-Mann matrices, the transition between the generalized Jones and Stokes spaces using the above expansion, and the properties of the vector dot products in both spaces.

Math Seminars
Markov Partitions and Tilings
Eric Fink - Department of Mathematical Sciences, MSU
When: Monday, March 27, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The ability to encode the information of an auto morphism on a manifold by using a Markov partition allows us to study the map in the simpler context of symbolic dynamics. In this talk, we will explore the construction of Markov partitions for hyperbolic toral automorphisms. The method we will use was originally proposed by Thurston & Kenyon for the construction of self-similar aperiodic tilings. We will conclude with defining automorphisms of nilmanifolds and infra-nilmanifolds and indicating how the construction might extend to these contexts.

Math Seminars
On numbers, germs and series
Matthias Aschenbrenner - Department of Mathematics, UCLA
When: Thursday, March 23, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I will outline three approaches to enrich the real continuum by infinitesimal and infinite quantities: surreal numbers, differential fields of germs of real-valued functions (Hardy fields), and transseries. Surreal numbers have a combinatorial flavor and encompass Cantor’s ordinal numbers; they were introduced by J. H. Conway in the 1970s in connection with game theory. Hardy fields model the growth rates of functions at infinity; they originate in du Bois-Reymond’s “orders of infinity” in the 19th century. Transseries are formal objects that encode the asymptotic behavior of functions in
Hardy fields; they arose in both analysis and logic during the 1980s. I will explain how methods from mathematical logic can be used to establish connections between these approaches, with the differential field of transseries emerging as a key object.

Math Seminars
Building a Network of Statistical Collaboration Laboratories
Eric Vance - University of Colorado Boulder
When: Tuesday, March 07, 2017 12:15PM to 01:15PM
Where: Byker Auditorium, Chemistry/Biochemistry Building
Details: Statistics, analytics, and data science provide powerful methods, tools, and ways of thinking for solving problems and making decisions, but not everyone who could benefit from applying statistics and data science to their research has the knowledge or skills to apply it correctly. The Laboratory for Interdisciplinary Statistical Analysis (LISA) is a statistical collaboration laboratory recently moved from Virginia Tech to the University of Colorado Boulder that generates, applies, and spreads new knowledge throughout the state, the nation, and the world. LISA’s mission is to train statisticians to become interdisciplinary collaborators, provide research infrastructure to enable and accelerate high impact research, and engage with the community in outreach activities to improve statistical literacy. LISA has learned how to create statistical collaboration laboratories to train students to become effective statistical collaborators and to provide research infrastructure for the university. LISA is spreading this knowledge globally through the LISA 2020 Program to help scientists, government officials, businesses, and NGOs in developing countries discover local solutions to local problems through collaborations with statisticians from newly created statistical collaboration laboratories. The LISA 2020 goal is to build a global network of 20 statistical collaboration laboratories in developing countries by 2020. So far five stat labs have been created in developing countries to train students to become effective interdisciplinary collaborators and enable researchers and government officials to solve problems and make better decisions.

Math Seminars
K-Theory and Traces
Aaron Mazel-Gee - The Ohio State University
When: Monday, March 06, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details:

Math Seminars
Developing Theory of Collaboration for Data Science
Eric Vance - University of Colorado Boulder
When: Monday, March 06, 2017 03:10PM to 04:00PM
Where: SUB Ballrooms C and D
Details: The emerging field of Data Science is, by construction, an interdisciplinary, collaborative field. Statisticians, Mathematicians, and Computer Scientists work together (ideally) to create theoretically sound methods for domain experts and data scientists to apply to solve real problems. To be effective, applied data scientists must collaborate with the domain experts who “own” the data and the problems to be solved. Is there a theory describing what components contribute to effective collaboration or how an individual data scientist can become a more effective interdisciplinary collaborator? Where is the theory that describes how to train data scientists at scale to become effective collaborators? In this talk I will highlight past, present, and future steps to create a theory of collaboration for Data Science.

Math Seminars

Brauer groups and their essential dimension
Kelly McKinnie - University of Montana
When: Monday, February 27, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: In this talk I will give an introduction to Brauer groups and essential dimension. Most work in this areas has been done in the “good characteristic” case; that where the characteristic of the ground field does not divide the exponent of the Brauer class. In recent work I looked at the bad characteristic case. I will discuss the challenges of bad characteristic along with a new lower bound on certain general linear groups.

Other

Data-Driven Discovery of Physical Laws and Principles
Nathan Kutz - Department of Applied Mathematics, University of Washington
When: Thursday, February 23, 2017 03:30PM to 04:30PM
Where: Procrastinator Theater
Details: In the last decade, the emergence of data methods for the sciences has been enabled by the plummeting costs of sensors, computational power and data storage. Such vast quantities of data afford us new opportunities for data-driven discovery, which has been referred to as the 4th paradigm of scientific discovery. Dr. Kutz will demonstrate how we can use emerging, large-scale time-series data from modern sensors to directly construct, in an adaptive manner, governing equations, even nonlinear dynamics, that best model the system being measured using modern regression techniques. Recent innovations also allow for handling multi-scale physics phenomenon and control protocols in an adaptive and robust way. The overall architecture is equation-free in that the dynamics and control protocols are discovered directly from data acquired from sensors. The theory being developed will be demonstrated with a number of canonical example problems from physics and engineering.
Math Seminars
A Topological Approach to Data Science
Elizabeth Munch - University of Albany - SUNY
When: Monday, February 13, 2017 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Topological Data Analysis (TDA) encompasses a suite of techniques which are capable of finding structure in data where traditional methods may fail. Recently, TDA has found success in many disparate applications including sensor networks, image processing, genetics, and atmospheric science, to name a few. With the rise of its use on noisy data sets, it is necessary to build a solid mathematical foundation in order to use these powerful tools in conjunction with methods from statistics and machine learning. This talk will address the mathematical underpinnings of TDA, particularly with respect to statistical and machine learning methods. We will use this theory to investigate an innovative framework for time series analysis, and show examples of its application to machining dynamics and hurricane evolution.

Math Seminars
Evolution of cooperation in microbial communities
Diana Schepens - Department of Mathematical Sciences, MSU
When: Thursday, February 09, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Metabolic cross-feeding between microbes is observed in many microbial communities. It has been experimentally observed that synthetic cross-feeding communities have an increased level of fitness and cell growth as compared to wildtype cells. We have developed a model to analyze the effects that metabolite production cost, transport cost, and overall fitness of various strategies have on the evolution of cross-feeding in a microbial community.

Math Seminars
Knot Theory and Algebraic Curves
Matt Hedden - Michigan State
When: Thursday, February 02, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Consider the intersection of an algebraic curve in $\mathbb{C}^2$ with the unit 3-dimensional sphere. If the intersection is transverse, then it is an embedded 1-
manifold in the 3-sphere, i.e., a knot or link. This talk will address the question: which knots arise in this way? I will discuss the history of the question, the current state of knowledge, some interesting questions and conjectures, and some work in progress generalizing the problem to other settings.

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**Math Seminars**

**Symmetries of the closed 5-disk**

David Ayala - Department of Mathematical Sciences, MSU  
When: Monday, January 30, 2017 04:10PM to 05:00PM  
Where: Wilson Hall 1-144  
Details: There is a sense in which the collection of smooth symmetries of Euclidean 5-space is simply the collection of orthogonal 5x5 matrices. In contrast, the collection of smooth symmetries of the closed unit 5-disk is more exotic: it is 4-periodic, in a precise sense. In this talk, I'll explain this peculiar fact as an excuse to tour through some wonderful and deep results in high-dimensional manifold topology. This fact is premised on joint work with John Francis, prompted by Jacob Lurie.

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**Math Seminars**

**Intelligent tracking of moving objects by cracking the neural code for visual motion**

Neda Nategh - Electrical & Computer Engineering Department, MSU  
When: Thursday, January 26, 2017 03:10PM to 04:00PM  
Where: Wilson Hall 1-144  
Details: A particularly difficult aspect of object tracking in artificial vision systems occurs when the observer itself is moving producing a confounded motion pattern that must be disentangled to reliably signal the object motion. While machine vision systems have improved manifold in their capabilities, they are still challenged by a trade-off between runtime, efficiency, accuracy, robustness, and flexibility, especially to handle real-world complexities such as object occlusions, multiple moving objects, and varying scene statistics. At other hand, our biological visual system is capable of performing similar motion detection and discrimination task reliably every moment that we are awake to compensate for constant eye movements of different sorts. Employing a statistical model-based approach driven by data, we are able to characterize the time-varying information conveyed by retinal and cortical spike responses during an eye movement task (encoding) and understand a readout mechanism by which downstream neurons can extract relevant motion information in the scene (decoding), all in a statistically optimal computational framework. Moreover, employing deep convolutional neural networks (CNN) whose computational units and connectivity are set to mimic the biophysical properties of our statistically optimal model, we will be able to generalize to real-world motion stimuli. This model-based approach to understand the neural code of visual motion may ultimately lead to intelligent motion computing schemes that will advance the state-of-the-art machine vision from a moving platform including
autonomous vehicles, mobile robotic systems, and assistive technology for visually impaired people.

Math Seminars
Dynamics of gene regulatory networks under perturbations of network topology
Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, January 19, 2017 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Experimental data on gene regulation is mostly qualitative, where the only information available about pairwise interactions is the presence of either up-or down-regulation. Quantitative data is often subject to large uncertainty and is mostly in terms of fold differences. Given these realities, it is very difficult to make reliable predictions using mathematical models. The current approach of choosing reasonable parameter values, a few initial conditions and then making predictions based on resulting solutions is severely subsampling both the parameter and phase space. In addition, this approach does not provide provable predictions about the dynamics. We present a new approach that uses continuous time Boolean networks as a platform for qualitative studies of gene regulation. We compute Dynamics Signatures Generated by Regulatory Networks (DSGRN) Database that provides a query able description of global dynamics over the entire parameter space. The results obtained by this method provably capture the dynamics at a predetermined spatial scale. We apply our approach to study a neighborhood of a given network in the space of networks. We start with an E2F-Rb network underlying the mammalian cell cycle restriction point and show that a large portion of the parameters support either the proliferative state, quiescent state, or bistability between these two states. We sample perturbations of this network and study robustness of this dynamics in the network space. We also show how to use our approach to propose, based on time series data, a network responsible for cyclical emergence of malaria parasite from red blood cells.

Math Seminars
Non-local minimal surfaces: an arranged marriage
Dominique Zosso - Department of Mathematical Sciences, MSU
When: Monday, December 05, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Minimal surfaces are a popular theme in mathematics, and without surprise they have their value in many applied problems. In the context of image processing, the concept is used in the Beltrami framework (Sochen Kimmel Malladi 1998). Instead of considering an image to be a map from space to features, we see it as a manifold within the combined (space, feature)-space (Monge surface). The area of the manifold can be understood as a measure of image regularity, and its minimization be used as regularity criterion in inverse problems. On the other hand, exploiting non-local information has become commonplace in imaging; Instead of local image geometry, only, we consider
similarities between pixels that are much further apart. In the continuum this is achieved through non-local calculus (non-local derivatives); and discretized equivalent notions on graphs. In this highly speculative talk, I will present a very rough outline of a program that tries to marry the two ideas: minimal surfaces from differential geometry with nonlocality through non-local derivatives, to yield a notion of non-local minimal surfaces.

Math Seminars
Evolution of cooperation à in microbial communities
Diana Schepens - Department of Mathematical Sciences, MSU
When: Thursday, December 01, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Metabolic cross-feeding between microbes is observed in many microbial communities. It has been experimentally observed that synthetic cross-feeding communities have an increased level of fitness and cell growth as compared to wildtype cells. We have developed a model to analyze the effects that metabolite production cost, transport cost, and overall fitness of various strategies have on the evolution of cross-feeding in a microbial community.

Math Seminars
Periodic point multipliers for polynomials and rational maps
Lukas Geyer - Department of Mathematical Sciences, MSU
When: Monday, November 28, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The multiplier of a periodic point of an analytic map is the derivative of the first return map, or equivalently the product of the derivatives along the periodic orbit. It is the most important analytic dynamical invariant associated to a periodic point. A natural question in complex dynamics is whether one can use multipliers of a collection of fixed points or periodic points as (local) coordinates on parameter space. Equivalently, the question is whether these multipliers are independent as functions on the parameter space of polynomials or rational maps of a given degree. In this talk I will make these notions rigorous, give an overview of what is known and what questions still remain open. Most of this talk will consist of relatively elementary complex analysis and algebraic geometry.

Math Seminars
Studying Data through the Lens of (Persistent) Homology
Brittany Terese Fasy - Department of Computer Science, MSU
When: Thursday, November 17, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Topology studies the structure of shapes. Topological data analysis (TDA) is the study of the shape of (often large high-dimensional, and noisy) data. Often, in TDA,
the data set is transformed into a concise descriptor, such as a persistence diagram or a dendogram, which can then be used to (indirectly) compare or classify data sets. In this talk, we will define a persistence diagram and confidence sets for persistence diagrams. Then, we will discuss how we can use these confidence sets to perform statistical hypothesis testing, and provide a few examples of where we've applied (or are applying) these methods.

Math Seminars
Trace
David Ayala - Department of Mathematical Sciences, MSU
When: Monday, November 14, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: This talk is framed around this question "How much can one recover about a square matrix from its trace?" We'll articulate the following answer to this question, which is a theorem due to Dundas-McCarthy, as well as a host of others. Theorem: The cyclic nature of trace recovers everything about square matrices, at least up to block sum. The precise statement is phrased in terms of K-Theory and Factorization Homology. Much of this talk will be devoted to motivating this phrasing, and explaining the statement of this theorem. This is mostly a survey talk, though I'll mention some new results that are joint with Aaron Mazel-Gee.

Math Seminars
Turbulent Rayleigh-Benard Convection in Near- and Super-Critical Fluids: Superstatistics and Direct Measurement of the Kolmogorov Scale by NMR
Joseph D. Seymour - Chemical and Biological Engineering, MSU
When: Thursday, November 10, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Convection of a fluid near its critical point is marked by the divergence of several transport parameters, which results in exceptionally high sensitivity to variations in temperature and pressure. For measurement techniques that rely on invasive probes, this means that undesirable perturbations may be amplified, while the phenomenon of critical opalescence may confound optical methods. However, the near-critical divergence also permits “tuning” of the Rayleigh number up to very large values (≈ 10^14), providing model systems for the study of strong turbulence. NMR provides noninvasive characterization of the flow dynamics. Specifically, PGSE methods yield both 1) spatially-resolved, 3-D maps of the velocity convection pattern and 2) ensemble averaged statistics of molecular/turbulent motion. The latter is of particular interest due to the "filtering" of velocities with correlation times longer than the inter-pulse delay (Δ) in the double-PGSE sequence. This permits isolation of the smallest scales of turbulence. The double-PGSE propagators provide an advection-insensitive measure of velocity fluctuations. In turbulent flows, velocity fluctuations occur over a continuum of
scales that range from the integral scale of the mean flow to the Kolmogorov microscale ($\eta$) at which viscous dissipation occurs. The $\Delta$-dependence of the propagators reveals a progression from Gaussian statistics (characteristic of pure-diffusion) toward non-Gaussian distributions with high-velocity "wings" (characteristic of turbulence). In recent literature concerning turbulence models, stretched exponential and super statistical models related to Tsallis distributions have been used to describe turbulent statistics and such models will be discussed.

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**Math Seminars**

**Universal sigma models and the BV-formalism**

Brian Williams - Northwestern University

**When:** Monday, November 07, 2016 04:10PM to 05:00PM

**Where:** Wilson Hall 1-144

**Details:** This talk will be concerned with a class of quantum field theories called sigma models that are both natural from the perspective of mathematics and also have large impacts in physics, for instance in string theory. The basic idea is that we are studying maps from a source manifold equipped with some geometry to a target manifold equipped with some possibly different geometry. For instance, smooth, complex, symplectic, etc... Using ideas of formal geometry, developed by Gelfand, Kazhdan, Fuks and others, I will discuss a rigorous and constructive way of quantizing, in a universal way, various flavors of sigma models that is closely tied in with the geometry of the target manifold.

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**Math Seminars**

**Numerical posterior distribution error control and expected Bayes factors in the Bayesian Uncertainty Quantification of inverse problems**

J Andrés Christen - CIMAT, Guanajuato, Mexico

**When:** Wednesday, November 02, 2016 04:10PM to 05:00PM

**Where:** Wilson Hall 1-144

**Details:** In the Bayesian analysis of Inverse Problems, in most relevant cases the forward maps (FM, or regressor function) are defined in terms of a system of (O, P)DE's with intractable solutions. These necessarily involve a numerical method to find approximate versions of such solutions and lead to a numerical/approximate posterior distribution. Recently several results have been published on the regularity conditions required on such numerical methods to ensure converge of the numerical to the theoretical posterior. However, more practical guidelines are needed to ensure a suitable working numerical posterior. Recently Capistrán, Christen and Donnet (2016) prove for ODE's that the Bayes Factor of the approximate vs the theoretical model tends to 1 in the same order as the numerical method order. In this work we generalize the latter paper in that we consider 1) also PDE's, 2) correlated observations, 3) practical guidelines in a multidimensional setting and 4) explore the use of expected Bayes Factors. This permits us to obtain bounds on the absolute global errors to be tolerated by the FM numerical solver, which we illustrate with some examples. Since the Bayes
Factor is kept above 0.95 we expect that the resulting numerical posterior is basically indistinguishable from the theoretical posterior, even though we are using an approximate numerical FM. The method is illustrated with some examples using synthetic data.

**Math Seminars**

**Matching time series of gene expression to hypothesized gene regulation networks**

Bree Cummins - Department of Mathematical Sciences, MSU

When: **Thursday, October 27, 2016 03:10PM to 04:00PM**

Where: Wilson Hall 1-144

Details: Recently, my collaborators and I introduced a computational tool called DSGRN for partitioning the global parameter space of a system of piecewise linear ODES into regions with homogeneous dynamics. Each partition in parameter space is associated to a Morse graph, which is a directed acyclic graph showing the flow between potential invariant regions in phase space. This is a coarse description of the long-term dynamics of switching systems, and predicts whether there is a single stable fixed point, bistability, stable cycles, unstable cycles, etc. in that region of parameter space. The quantitative values of the fixed points and cycles will change with different realizations of parameters in the partition; however, the large scale qualitative description of the dynamics does not change. Moreover, we can describe trajectories through phase space as a sequence of abstract symbols (symbolic dynamics) that is uniform over the partition. A challenge remains to match these symbolic trajectories through phase space to experimental data, especially taking into account uncertainty in the data. I present a method in which we first transform time series into a qualitative series of features incorporating uncertainty, then we search for that pattern in the symbolic dynamics produced by DSGRN. This qualitative approach to matching time series and model output over regions of parameter space is an alternative to traditional quantitative parameter estimation techniques.

**Math Seminars**

**Dissertation Defense: Investigating the Teaching of Statistics with Technology at the High School Level Through the Use of Annotated Lesson Plans**

Elizabeth Arnold - Department of Mathematical Sciences, MSU

When: **Tuesday, October 25, 2016 02:10PM to 03:00PM**

Where: Byker Auditorium (Chemistry Building)

Details: Throughout the last twenty years, data analysis and statistics content, together with the integration of technology in the mathematics classroom, have gained increasing attention in the United States at the K-12 level. National and state standards now emphasize statistics concepts throughout high school and there is a growing motivation to shift from a traditional formula-based style of teaching statistics to a more data
oriented approach emphasizing conceptual understanding and statistical literacy. To implement this approach in the classroom, it is necessary to integrate technology into the teaching of statistics. However, many in-service high school mathematics teachers are not familiar with this process, and statistics is still a relatively new subject for most. This discrepancy highlights the need to help foster and develop in-service high school mathematics teachers’ ability to effectively use technology when teaching statistics. The general goal of this study was to investigate how specially annotated lesson plans influence and guide in-service high school teachers’ use of technology when teaching statistical concepts. I developed a completely randomized block experiment, using quantitative and qualitative measurements and methods of analysis. High school teachers were randomly assigned to receive an annotated or non-annotated statistics unit that included technology-based activities; four lessons were observed. The results of this study demonstrated how the process of helping teachers effectively use technology in the instruction of statistics is not straightforward; there was a large amount of variation in how teachers integrated technology and no observable differences between the annotated and non-annotated group in this regard. All teachers, regardless of received unit, integrated technology more effectively when they were provided with a technology-based activity employing simulation. Teachers’ use of technology was most influenced by their awareness of the use of inquiry.

Math Seminars

The geometry of 2-bridge links
Eric Chesebro - University of Montana
When: Monday, October 24, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: We will discuss a curious family of one variable polynomials which determine the unique complete finite volume hyperbolic structure on the complement of a 2-bridge link.

Math Seminars

Stress Tensor Symmetry Preserving Model Applied to the 2-D Viscoelastic Flow of a Biofilm
Daniel Kanewske - Department of Mathematical Sciences, MSU
When: Thursday, October 20, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The viscoelastic behavior of biofilms is well documented. Also, the symmetry of the numeric representation of the stress tensor has been shown to be important for maintaining stability, in the sense of Hadamard, of the numeric method. A 2D model for the viscoelastic flow of a biofilm using a modified Navier-Stokes equation (NSE) with a novel elastic stress term are presented. The elastic stress is modeled using a numeric stress tensor symmetry preserving scheme that is based on the numeric solution to the Lie derivative and its equivalent counterpart in the form of a symmetric matrix Riccati differential equation. In addition, a coupled advection-diffusion equation (ADE) is
applied to the biofilm volume fraction. Solutions to the NSE and ADE are found by applying the finite element method to the Eulerian-Lagrangian method (ELM). The ELM is solved by first determining the “characteristic foot” for each Gaussian quadrature point and node point in the mesh. The advection-diffusion equation is solved using a modified Galerkin Least Squares method. Computations are made using the Trilinos iterative sparse matrix solver library called AztecOO which has built in matrix preconditioners. The resulting model is used to predict the elastic deformation of a biofilm in a 2D channel. The accompanying distribution of the pressure and stresses over the evolving velocity field is also presented.

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**Math Seminars**

**Algebras and Modules as Observables**  
Ryan Grady - Department of Mathematical Sciences, MSU  
*When:* Monday, October 17, 2016 04:10PM to 05:00PM  
*Where:* Wilson Hall 1-144  
*Details:* I will explain a bit about the structure of observables (things one can measure) in a particular mathematical formulation of classical/(perturbative) quantum field theory. Moreover, I will explain how classical algebraic objects, e.g., algebras and their modules appear in this set up.

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**Math Seminars**

**Variational Mode Decomposition: From time-frequency analysis to crystal grain boundary segmentation**  
Dominique Zosso - Department of Mathematical Sciences, MSU  
*When:* Thursday, October 13, 2016 03:10PM to 04:00PM  
*Where:* Wilson Hall 1-144  
*Details:* Decomposing a signal into its constituents of different frequency makes these components accessible for further downstream analysis, such as time-frequency analysis, demodulation, texture analysis, or denoising. Our "Variational Mode Decomposition" model decomposes the input signal into modes with narrow Fourier bandwidth. To cope with sharp region boundaries, incompatible with narrow bandwidth, we introduce binary support functions that act as masks on the narrow-band mode. L1 and TV-terms promote sparsity and spatial compactness. Constraining the support functions to partitions of the signal domain, we effectively get an image segmentation model. By coupling several sub-modes together with a single support function we are able to decompose an image into crystal grains. Our algorithm is based on variable splitting and alternate direction optimization; we employ Merriman-Bence-Osher-like (MBO) threshold dynamics to handle the motion by mean curvature of the support function boundaries under the sparsity promoting terms.

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**Math Seminars**

**Modern Math in Medieval Islamic Architecture**
Details: The conventional view holds that girih (geometric star-and-polygon) patterns in medieval Islamic architecture were conceived by their designers as a network of zigzagging lines, and drafted directly with a straightedge and compass. I will describe recent findings that, by 1200 C.E., a conceptual breakthrough occurred in which girih patterns were reconceived as tessellations of a special set of equilateral polygons (girih tiles) decorated with lines. These girih tiles enabled the creation of increasingly complex periodic girih patterns, and by the 15th century, the tessellation approach was combined with self-similar transformations to construct nearly-perfect quasicrystalline patterns. Quasicrystal patterns have remarkable properties: they do not repeat periodically, and have special symmetry--and were not understood in the West until the 1970s. I will discuss some of the properties of Islamic quasicrystalline tilings, and their relation to the Penrose tiling, perhaps the best known quasicrystal pattern.

Math Seminars
Approximating Conformal Dimension of Sierpinski Carpet, Part 2
Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Monday, September 26, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: In part 1 I gave a brief introduction to (Ahlfors regular) conformal dimension and its role in finding nice representations of fractal metric spaces (so called "uniformization"). In part 2 I will focus on the simplest unyielding example, the Sierpinski carpet, and present numerical approximations to its conformal dimension and the uniformizing map. The methods used readily generalize and lead to a new concept of dimension of a sequence of graphs. This may be of practical interest in problems of clustering of very large data sets.

Math Seminars
Understanding p-values and the controversy surrounding them
Jessica Utts - Department of Statistics, University of California, Irvine
When: Monday, September 26, 2016 03:10PM to 04:00PM
Where: Procrastinator
Details: Most researchers and journals rely heavily on p-values for determining whether the results of a study are worthy of publication. But recently p-values have come under attack, and one social science journal has gone as far as banning their use for papers submitted to the journal. These developments led the American Statistical Association (ASA) to issue a "Statement on Statistical Significance and p-values." In this talk, Dr. Utts will discuss the ASA statement in the context of what p-values really measure, some pitfalls related to their use, what steps you can take to make sure your use of them is appropriate, and some possible alternatives.
Math Seminars

Graph Fractional-Order Total Variation EEG Source Reconstruction
Jing Qin - Department of Mathematical Sciences, MSU

When: Thursday, September 22, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-144

Details: EEG source imaging is able to reconstruct sources on the brain from scalp measurements with high temporal resolution. Due to the limited number of sensors, it is very challenging to locate the source accurately with high spatial resolution. Recently, several total variation (TV) based methods have been proposed to explore sparsity of the source spatial gradients, which is based on the assumption that the source is constant at each sub-region. However, since the sources have more complex structures in practice, these methods have difficulty in recovering the current density variation and locating source peaks. To overcome this limitation, we propose a graph Fractional Order Total Variation (gFOTV) based method, which provides the freedom to choose the smoothness order by imposing sparsity of the spatial fractional derivatives so that it locates source peaks accurately. The performance of gFOTV and various state-of-the-art methods is compared using a large amount of realistic simulations and evaluated with several quantitative criteria. The results demonstrate the superior performance of gFOTV not only in high spatial resolution but also in high localization accuracy and total reconstruction accuracy.

Math Seminars

Is Model Averaging the Solution For Dealing with Model Uncertainty?
Katharine Banner - Department of Mathematical Sciences, MSU

When: Tuesday, September 20, 2016 02:00PM to 03:00PM
Where: Byker Auditorium

Details: Model averaging (MA) was developed as a way to combine predictions from many models, with the goal of reducing bias and incorporating model uncertainty into final predictive inferences. A new flavor of MA, focused on averaging partial regression coefficients over multiple models, has gained traction in fields such as Ecology, Biology, and Political Science, with motivation stemming from the concern that inferences based on single model are too "naive" (i.e., do not fairly reflect sources of substantial uncertainty). However, coefficients appearing in multiple models do not necessarily hold the same interpretation across models, and averaging over them has the potential to result in inferences that are difficult to interpret. A gap exists between the theoretical development of MA and its current use in practice, potentially leaving well-intentioned researchers with unclear inferences, or difficulties justifying decisions to use (or not use) MA. Furthermore, it is questionable whether the perceived benefit of accounting for an additional source of uncertainty is realized in terms of increased variance for quantities of interest. In this work, we revisit relevant foundations of regression modeling, suggest more explicit notation and graphical tools, and discuss how individual model results are combined to obtain a MA result, with the goal of helping researchers make informed
decisions about MA. We present a new package for R Statistical Software providing plotting functions for visualizing components going into the MA posterior distribution, meant to be used to assess the implicit assumptions made by using MA for regression coefficients, complete with guidelines for use and examples. We also design and conduct a simulation study to investigate how the variance for a partial regression coefficient of interest is different for the three different approaches used within multmodel inference (MA using all models, MA using a subset of models, and conditioning inferences on one model). We assess whether the perceived benefit of accounting for model uncertainty is actually realized when more models are used for final inference, with the goal of helping researchers weigh tradeoffs between using variants of MA in place of one well thought out model.

Math Seminars

Approximating Conformal Dimension of Sierpinski Carpet
Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Monday, September 19, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: I will give a brief introduction to (Ahlfors regular) conformal dimension and its role in finding nice representations of fractal metric spaces (so called "uniformization"). I will focus on the simplest unyielding example, the Sierpinski carpet, and present numerical approximations to its conformal dimension and the uniformizing map. The methods used readily generalize and lead to a new concept of dimension of a sequence of graphs. This may be of practical interest in problems of clustering of very large data sets.

Math Seminars

Statistics in the Presence of Cost: Cost-Considerate Variable Selection and MCMC Convergence Diagnostics
Michael Lerch - Department of Mathematical Sciences, MSU
When: Monday, September 19, 2016 02:10PM to 03:00PM
Where: Reid 452
Details: The overarching objective of this research is to address and recognize the cost-benefit trade-off inherent in much of statistics. We identify two places where such a balance is present for researchers: variable selection and Markov chain Monte Carlo (MCMC) sampling. An easily identifiable source of cost in science is taking measurements. Researchers measure variables to estimate another quantity based on a model. At model building time, researchers may have access to a large number of variables to include in the model and may consider using a subset of the variables so that future uses of the model need only measure this subset rather than all variables. The researchers are incentivized to proceed in this manner if some variables are prohibitively expensive to measure for future uses of the model. In this research, we present a new algorithm for cost-considerate variable selection in linear modeling when confronted with this problem. Since overfitting may be a danger when many variables at
the disposal of the researcher, we build on the LARS and Lasso algorithms to perform cost-based variable selection in concert with model regularization. In MCMC sampling for Bayesian statistics, the cost-benefit trade-off is unavoidable. Researchers sampling from a posterior distribution must run a sampler for some number of iterations before finally stopping the sampler to make inference on the finite number of samples drawn. In this situation, the cost to be reduced is time to run the sampler while realizing the longer the sampler is run, the better the convergence. Time may not be as tangible a cost as a dollar figure, but increased wait time to perform analyses incurs the cost of running a computer and any negative effects associated with a delay as the researcher waits until the sampler has finished running. In this research, we introduce new convergence assessment tools in a diagnostic and plot. Unlike commonly used convergence diagnostics, these new tools focus explicitly on posterior quantiles and probabilities which are common inferential objectives in Bayesian statistics. Additionally, we introduce equivalence testing to the convergence assessment domain by using it as the framework of the diagnostic.

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**Math Seminars**

**Advancing Mathematics Education within a STEM Climate**

Lyn English - Professor of Education at the Queensland University of Technology in Brisbane, Australia

**When:** Tuesday, September 13, 2016 04:30PM to 05:30PM

**Where:** Procrastinator Theater

**Details:** Lyn English’s talk will address the current status of STEM education, including various perspectives on what such education entails, the urgency with which nations are addressing it, and suggested reasons for the rise of a "STEM crisis." In exploring the last issue, consideration will be given to an apparent inequitable discipline focus, with the profile of mathematics education needing attention. With one explanation for the current "crisis" residing in students' lack of STEM literacy, suggestions for elevating the profile of mathematics will be offered. One approach lies in promoting mathematical (and statistical) literacy through modeling with data. Classroom examples include developing models for solving engineering-based problems and for investigating international sports events.

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**Math Seminars**

**Lorentz-Poincaré inequalities via isoperimetry**

Kevin Wildrick - Department of Mathematical Sciences, MSU

**When:** Monday, September 12, 2016 04:10PM to 05:00PM

**Where:** Wilson Hall 1-144

**Details:** Analysis is possible on metric spaces that contain "enough" curves. What constitutes "enough" depends on the results in which one is interested, and is often formulated in analytic rather than geometric terms. For a very nice set of results regarding analogues of absolutely continuous functions, the definition of "enough" curves is formulated in terms of Lorentz-Poincaré inequalities, which are analytic in
nature and rather complicated. We show how to replace these inequalities with a simple, geometric assumption: the underlying space should have an isoperimetric profile similar to that of Euclidean space. The isoperimetric profile measures the relationship between the volume of sets and the volume of their boundaries. This is joint work with Thomas Zürcher.

Math Seminars
When do high school math teachers have the opportunity to learn to apply mathematics to teaching?
Yvonne Lai - Department of Mathematics, University of Nebraska-Lincoln
When: Thursday, September 08, 2016 02:10PM to 03:00PM
Where: Wilson Hall 1-133
Details: A well-prepared teacher should be able to help her students see mathematics as ideas that develop over time. Mathematics courses designed specifically for prospective secondary teachers aim for prospective teachers to see and find connections across elementary, secondary, and disciplinary mathematics, and beyond that to be able to use those connections in their future teaching. While there is broad agreement with these aims, it is difficult to come to consensus on how to carry them out. I will discuss why there may be less consensus at the secondary level than at the elementary level, and also discuss the results of a recent study that suggest that theories about knowledge for teaching developed at the elementary level can extend to theories at the secondary level, with appropriate adaptation. I will then invite the audience to contribute ways they have engaged in the challenge of designing opportunities for teachers to learn to apply mathematics to teaching.

Math Seminars
The Topology of Schizophrenia
Tegan Emerson - Department of Mathematics at Colorado State University
When: Tuesday, September 06, 2016 10:30AM to 11:30AM
Where: COBH 429
Details: The human brain can be studied using networks. One can define the nodes to be different brain regions and the edges between them to be weighted by a measure of similarity of time series of the brain regions to create a so-called functional network. This can then be studied using ideas from computational topology a set of algorithmic methods that characterizes topological invariants such as connectedness, loops, or holes in high-dimensional data structures. These methods go beyond pairwise connections and enable one to understand global low-dimensional structures in networks, which is difficult for existing methods. In particular, persistent homology, a method that consists of a mathematical formalism to explore the persistence of such structures, has led to promising results on neuronal networks. We analyze task-based fMRI data from schizophrenia patients, controls and siblings of schizophrenia patients using persistence images. Persistence Images are a stable vector representation of homological features identified from persistent homology. Persistence images can
detect differences between the three subgroups and provide a list of brain regions with discriminating features between the three groups. Using persistence images we are able to identify differentiating brain node involvement between the populations and provide evidence of a possible adaptation of rigidity in brain node involvement across the subject types.

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Math Seminars

Marstrand's theorem on hyperbolic space
Annina Iseli - Mathematics Institute, University of Bern
When: Monday, August 29, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: A theorem of Marstrand states that for a given compact set A in the Euclidean plane of Hausdorff dimension smaller or equal to 1, the orthogonal projection onto a generic line doesn't decrease the dimension of A. In this talk I will recall a proof of Marstrand's theorem and give an overview of more general (Mattila, Kaufman, Falconer) and much stronger (Peres-Schlag) versions. Finally, I will discuss the possibility of achieving analogous results in other metric spaces, in particular on hyperbolic space.

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Math Seminars

Separating the EPS in a Biofilm: Models and Simulations of Movement of the EPS Within
Nathan McClanahan - Department of Mathematical Sciences, MSU
When: Tuesday, July 26, 2016 10:00AM to 11:00AM
Where: Wilson Hall 1-144
Details: Biofilms are attached microbial communities made up of many different components. Biofilms are found throughout nature as well as in industrial and medical settings. Understanding how these biofilms spread is important in helping the prevention and treatment of diseases and to prevent contamination. In this talk I will present a summary of my research from my dissertation. This research consisted of two different models used to simulate movement of the extracellular polymeric substances (EPS) within the biofilm. The first model is used to simulate the movement of the different components within a biofilm due to growth, erosion, and expansion of the biofilm. This was done by using a system of partial differential equations to describe a biofilm in 1D. This system is solved using a finite difference method with an upwind scheme. There are ways to still improve this model but the results do provide valuable insight for how to proceed. The second model is an energy based model, using physics and chemistry properties to determine the outcome. We created an energy based model of a flow channel using partial differential equations, first in 1D and later in 2D. We solved this system using a finite difference method in C++. Results for various parameter values and initial conditions will be discussed as well.
**Math Seminars**

**A Dual-Flux Conservation Law for Plume Migration in Carbon Sequestration**

Elizabeth Brown - PhD Candidate NC State University  
*When:* Thursday, July 21, 2016 02:10PM to 03:00PM  
*Where:* Wilson Hall 1-144  
*Details:* (Elizabeth got an undergraduate degree from MSU few years ago and so she is a returning alum) A quasi-linear hyperbolic partial differential equation with a discontinuous flux models geologic carbon dioxide (CO2) migration and storage. Dual flux curves emerge in this model, giving rise to flux discontinuities. One flux describes the invasion of the plume into pore space, and the other captures the flow as the plume leaves CO2 bubbles behind, which are then trapped in the pore space. Flux functions with discontinuities in space have been previously studied; the flux in this model depends on how the unknown is changing at any position and time. We prove the existence of an entropy solution of the Cauchy problem for any initial CO2 plume using wave-front tracking. During our analysis, we introduce a new construction with crosshatch characteristics in regions of the characteristic plane where the solution is constant, and the characteristic speed depends on which flux is invoked. Some wave interactions yield novel phenomena due to the dual flux, such as shock-rarefaction interactions that would persist for all time with a single flux, here are completed in finite time.

**Math Seminars**

**Persistent homology and circular coordinates**

Vin da Silva - Department of Mathematics, Pomona College  
*When:* Tuesday, May 24, 2016 11:00AM to 11:50AM  
*Where:* Roberts Hall 218  
*Details:* High-dimensional data sets often carry meaningful low-dimensional structures. There are different ways of extracting such structural information. The classic (circa 2000, with some anticipation in the 1990s) strategy of nonlinear dimensionality reduction (NLDR) involves exploiting geometric structure (geodesics, local linear geometry, harmonic forms etc.) to find a small set of useful real-valued coordinates. The classic (circa 2000, with some anticipation in the 1990s) strategy of persistent topology calculates robust topological invariants based on a parametrized modification of homology theory. In this talk, I will describe a marriage between these two strategies, and show how persistent co-homology can be used to find circle-valued coordinate functions. This is joint work with Dmitry Morozov, Primoz Skraba, and Mikael VejdemoJohansson.

**Math Seminars**

**A Dirichlet Energy Criterion for Graph-Partitioning (and Graph-Based Image Segmentation)**
Dominique Zosso - Department of Mathematics, UCLA
When: Wednesday, April 27, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: We propose a graph-partitioning criterion based on the Dirichlet Energy of partition components. This criterion has interesting random-walk interpretations and can also be understood as a linearized version of a minimal-surface clustering. We use an efficient primal-dual method for computing the Dirichlet energy ground state of partition components and a rearrangement algorithm is used to improve graph partitions. The resulting algorithm bears strong similarities with motion-by-mean-curvature / MBO-like threshold dynamics. While the proposed method in principle applies to generic graph partitioning problems, we then consider a graph-based approach for image segmentation. We introduce several novel graph construction models which are based on graph-based segmentation criteria extending beyond---and bridging the gap between---segmentation approaches based on edges and homogeneous regions alone. The method is applied to a number of example segmentation problems. We demonstrate the method on a variety of region-, edge-, hybrid, and texture-based image segmentation experiments. Our method seamlessly generalizes region- and edge-based image segmentation to the multi-phase case and can intrinsically deal with image bias as well as more interesting image features such as texture descriptors. (Joint work with B. Osting (Utah) and S. Osher (UCLA)).

Math Seminars
Modulus as a graph-theoretic quantity
Pietro Poggi-Corradini - Department of Mathematics, Kansas State University
When: Monday, April 25, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: This will be an informal ``study-seminar'' style talk discussing modulus on graphs. It will be an open ended discussion and questions, interruptions, and digressions will be encouraged.

Math Seminars
Modulus as a Tool for Network Science
Pietro Poggi-Corradini - Department of Mathematics, Kansas State University
When: Monday, April 25, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-134
Details: Arising from complex analysis and electrical engineering, p-modulus provides a method for quantifying the richness of a family of curves, in the sense that a family with many short curves will have a larger modulus than a family with fewer and longer curves. The parameter p tends to favor the ``many curves'' aspect when p is close to 1 and the ``short curves'' aspect as p becomes large. Our goal is to develop the theory of p-modulus as a graph-theoretic quantity, with an eye to finding applications, for instance to the study of epidemics, broadcasting communication, and centrality measures. In this talk, Prof. Poggi-Corradini will present an overview of ongoing research being done by
the NODE research group at Kansas State University. The NODE group is an interdisciplinary team of researchers from the department of Mathematics and the department of Electrical and Computer Engineering. This talk should be accessible to a general (mathematical) audience.

**Math Seminars**

### Metabolite cross-feeding and evolution of cooperation in microbial communities

Diana Schepens - Department of Mathematical Sciences, MSU  
**When:** Thursday, April 21, 2016 02:10PM to 03:00PM  
**Where:** Hurst room Wilson 2-244  
**Details:** (PLEASE NOTE EARLIER TIME AND DIFFERENT ROOM) Metabolic cross feeding between microbes is observed in many microbial communities. It has been experimentally observed that cross-feeding synthetic communities have increased level of fitness and cell growth as compared to wild type cells. There are also numerous examples of cross-feeding communities in nature. Our goal is to develop a model to analyze the effects that resource investment into metabolite, transportation cost, and ability to produce excess metabolite have on evolution of cross-feeding in a microbial community. We first analyze the investment into the metabolite itself, as well as enzymes that produce the metabolite in metabolic pathways, to formulate a cost of producing the metabolite. We then combine this cost together with each phenotype growth rate to evaluate fitness of various phenotypes. Finally, we use replicator equations to study the changes in phenotype distribution in the population.

### Math Seminars

**Embeddings into Hilbert space**

Kevin Wildrick - Department of Mathematical Sciences, MSU  
**When:** Tuesday, April 19, 2016 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-144  
**Details:** Embedding an abstract metric space into a space with more structure while distorting the notion of distance in a controlled way is a useful tool in situations ranging from classical Riemannian geometry to data science. We will discuss a few results about such embeddings and focus on the problem of embedding a metric space in Hilbert space with very weak control on the metric distortion. Metric co-type, a key tool introduced by Mendel and Naor, will play an important role.

### Math Seminars

**Some examples of Communication within Bacterial Communities**

Jack Dockery - Department of Mathematical Sciences, MSU  
**When:** Thursday, April 14, 2016 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144
Details: We will talk about Quorum sensing, Short-Circuiting in Quorum Sensing Systems, and some interesting recent experimental results from the Suel lab on electrical communication within bacterial communities.

Math Seminars
The Gromov-Witten/Hurwitz correspondence in classical and tropical geometry.
Renzo Cavalieri - Colorado State University
When: Thursday, April 07, 2016 03:00PM to 04:00PM
Where: Wilson Hall 1-134
Details: (Notice: this talk is *in addition* to the colloquium on Wednesday offered by the same speaker.)

Math Seminars
Tropical Enumerative Geometry
Renzo Cavalieri - Department of Math, Colorado State University
When: Wednesday, April 06, 2016 04:00PM to 05:00PM
Where: 301 Roberts Hall
Details: Everyone answers their first enumerative geometric question in grade school: there is one line in the plane (geometric object) passing through two points (constrains). These kind of questions quickly become very difficult, as the geometric objects and the constrains become more sophisticated. In the last fifteen years or so tropical geometry provided a new tool to tackle certain classes of enumerative geometric problems. Tropicalization is a degeneration of a classical geometric object into a piecewise linear object. Often the "tropicalized" version of an enumerative geometric question can be solved. The question is whether the answer obtained is the correct one for the classical problem. In this colloquium I will explain why and when the answer is "yes", using as guiding examples curve counting problems.

Math Seminars
Transcription of DNA: Stochastic Model with Torque, and Diffusive Transport Model
Tamra Heberling - Department of Mathematical Sciences, MSU
When: Thursday, March 31, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In fast-transcribing prokaryotic genes, like an rrrn gene in Escherichia coli, many RNA polymerases (RNAPs) transcribe the DNA simultaneously. Active elongation of RNAPs is often interrupted by pauses. We describe two mathematical models for DNA transcription with pausing. One is a stochastic model that incorporates torque produced by RNAPs. Simulation results illustrate that the torque causes shorter pause durations and fewer collisions between polymerases than transcription simulated without torque.
The second model is a diffusive transport model. We investigate elongation as diffusive particle transport in a tilted periodic potential. To incorporate the RNAP pauses, a second periodic potential is added to the first. We present a formula for the mean escape time from a periodic potential composed of multiple periodic functions as the product of the mean escape time from each individual periodic function.

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**Math Seminars**

**Abstract Tiling Actions, Expansiveness, and Local Structure**  
**Hannah Bergren - Department of Mathematical Sciences, MSU**  
**When:** Monday, March 28, 2016 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** A significant amount of literature is devoted to the study of the dynamical properties of the translation action on self-affine tilings or Delone sets. A natural step is to axiomatize these essential properties among all $\mathbb{R}^d$-actions on compact metric spaces. We propose a set of purely topological dynamical axioms which guarantees a topological conjugacy of the given $\mathbb{R}^d$-action and the translation action associated to a self-affine repetitive aperiodic tiling. In the process, we construct an expanding metric on the local cross-section of the phase space and prove that the cross-section is a Cantor set. We also study in detail the local structure of a tiling space which contains non-FLC tilings and does not admit an abstract tiling action.

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**Math Seminars**

**Structuring Drugs with Colloidal Templates**  
**Jim Wilking - Department of Biological and Chemical Engineering, MSU**  
**When:** Thursday, March 24, 2016 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** Many pharmaceutical compounds are poorly soluble in water. This is problematic because most pharmaceuticals are delivered orally and must dissolve in the gastrointestinal fluid in order to be taken up by the body. I will discuss a simple method for increasing the dissolution rates of poorly water-soluble organic actives. We demonstrate that by structuring the compounds within the interconnected, nanoscale pore space of a colloidal packing we create composites which rapidly disintegrate in water, exposing the nanostructured organic active and leading to improved dissolution rates. The breakup of these composites appears to be driven by the growth of crystals.

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**Math Seminars**

**2D Modeling of Biofilm as a Viscoelastic Fluid Using an Interative Sparse Solver and Parallel Processing**  
**Dan Kanewske - Department of Mathematical Sciences, MSU**  
**When:** Thursday, March 03, 2016 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144
Details: We are modeling the viscoelastic flow of biofilms using a modified Navier-Stokes equation. The solution is determined, using AztecOO, a Trilinos sparse matrix solver. Computation time is made more efficient by implementing parallel processing using Message Passing Interface (MPI). We choose to use, as our foundation, the algorithm developed by Dr. YoungJu Lee and Dr. Jinchao Xu, which preserves the symmetry of the stress tensor, in order to reduce the effect of the High Weissenberg Number Problem (HWNP). We will also describe the implementation of Dr. YoungJu Lee’s algorithm and conclude with a description of biofilm deformation and the accompanying distribution of the pressure and stresses over the evolving velocity field.

Math Seminars

A MULTIVARIATE SPATIAL ANALYSIS FOR ANTICIPATING NEW FIRM COUNTS
Yiyi Wang - Civil Engineering Department, MSU
When: Thursday, February 25, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This paper analyzes county-level firm births across the U.S. using a spatial count model that permits spatial dependence, cross-correlation among different industry types, and over-dispersion commonly found in empirical count data. Results confirm the presence of spatial autocorrelation (which can arise from agglomeration effects and missing variables), industry-specific over-dispersion, and positive, significant cross correlations. After controlling for existing firm counts in 2008 (as an exposure term), parameter estimates and inference suggest that a younger (and possibly more vital) work force and/or clientele (as quantified using each county’s median-age values) are associated with more firm births (in 2009). Higher population densities are associated with more new basic-sector firms, while reducing retail-firm starts. The modeling framework demonstrated here can be adopted for a variety of settings, harnessing very local, detailed data to evaluate the effectiveness of investments and policies, in terms of generating business establishments and promoting economic gains.

Math Seminars

Deconstructing the orthogonal group (again)
David Ayala - Department of Mathematical Sciences, MSU
When: Monday, February 22, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: In this talk I will define a partially ordered finite set that codifies the collection of linear isometries of Euclidean space. I will explain how to recover composition of linear isometries through this codification. This examination will make repeated use of a formula of Leibniz’s for calculating determinants, as well as row reduction to upper triangular matrices. No knowledge of last week’s talk will be assumed.
Math Seminars
Deconstructing the orthogonal group
David Ayala - Department of Mathematical Sciences, MSU
When: Tuesday, February 16, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-134
Details: This talk will be a concrete examination of the orthogonal group, which consists of linear isometries of Euclidean space. Specifically, I'll state a recent result that articulates how, ultimately, the orthogonal group is purely combinatorial. The first quarter of this talk will motivate this result: its statement as well as how it relates to a larger program. The rest of the talk will dwell on a stratification of the orthogonal group, and two supporting calculations involving determinants. This talk will be accessible to anybody with a background in linear algebra and some topology.

Math Seminars
Gromov's Hölder Equivalence Problem
Kevin Wildrick - Department of Mathematical Sciences, MSU
When: Monday, February 08, 2016 04:10PM to 05:10PM
Where: Wilson Hall 1-144
Details: The metric geometry of sub-Riemannian Lie groups is a wonderful mixture of smooth and non-smooth analysis. One of the motivating problems in this area was popularized by Gromov: what metric properties must a homeomorphism between a Riemannian manifold and a given sub-Riemannian space have? Even in the simplest case of $\mathbb{R}^3$ and the Heisenberg group, this question has been actively studied for the past 20 years. In January, Roger Züst announced an elegant solution, while others have talked of a counter-example. We will give an introduction to this problem, and indicate the tools employed by Züst.

Math Seminars
Challenging Linear Algebra Problems Arising from Computational Fluid Dynamics
Minghao W. Rostami - Department of Mathematical Sciences, Worcester Polytechnic Institute
When: Thursday, January 28, 2016 04:10PM to 05:00PM
Where: Byker auditorium, Chemistry Building
Details: Computational Fluid Dynamics (CFD) gives rise to many challenging linear algebra problems. In this talk, we will discuss efficient numerical methods for pseudo spectral analysis of large, sparse matrices as well as for matrix-vector product with large, dense matrices. Their performance on models of incompressible flow will be demonstrated. It is well-known that pseudo spectral analysis is more robust than eigenvalue analysis since the eigenvalues of a matrix can be very sensitive to small perturbations introduced to its entries, which are inevitable in real-world applications. We propose new algorithms for investigating the stability of a matrix under
perturbations, which are suitable for large, sparse matrices arising from spatial discretization of PDEs. Regularized Stokes formulation has been shown to be very effective at modeling fluid-structure interactions when viscous effects dominate. It boils down to a matrix-vector product whose computational cost grows quadratically with the number of particles immersed in the fluid. We demonstrate how to accelerate this computation using fast multipole method and present numerical results for simulating the dynamics of a large number of microorganisms immersed in a 3D Stokes flow.

Math Seminars
Changes in Large Lake Aquatic Communities following Zooplankton Invasions
Dr. Dave Staples - Minnesota Fish, Wildlife, and Parks
When: Tuesday, January 26, 2016 04:10PM to 05:00PM
Where: Wilson Hall 1-134
Details: David is a past graduate of the Mathematical Sciences (M.S.) and Ecology (Ph.D.) Departments at Montana State University, and has worked the last 10 years as a statistical consultant for the Fisheries Section in the MN Department of Natural Resources. The presentation will examine data from Minnesota large lakes for evidence about aquatic community responses to spiny water flea, an invasive predatory zooplankton from Eurasia. Spiny water flea has been documented to decrease summer biomass in zooplankton, which has the potential for trophic cascading interactions throughout the food webs, from changes in primary production to effects on top-level piscivores. A variety of analyses are used to evaluate changes, and their reliability and practical implications are discussed.

Math Seminars
An integrative, multi-scale, computational model of a swimming lamprey driven by a central pattern generator with sensory feedback
Christina Hamlet - Department of Mathematics, Tulane University
When: Wednesday, January 13, 2016 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The swimming of a simple vertebrate, the lamprey, can shed light on how a flexible body can couple with its fluid environment to swim rapidly and efficiently, as well as on the physical constraints of biological development. Animals use proprioceptive (body sensing) information from edge cells to sense how their bodies are bending, and then adjust the neural signals to their muscles to improve performance. I will discuss the development of a computational model of a lamprey swimming in a Navier-Stokes fluid where a simple central pattern generator model, based on phase oscillators, is coupled to the evolving body dynamics of the swimmer through curvature feedback. Such feedback can be positive (frequency increasing), negative (frequency decreasing), or mixed (positive to one side of the body and negative to the other, or vice versa). I will
Math Seminars
A stochastic model for tropical rainfall
Scott Hottovy - Department of Mathematics, University of Wisconsin
When: Monday, January 11, 2016 11:00AM to 12:00PM
Where: Wilson Hall 1-144
Details: In this talk, I will describe the differences between the dynamics of tropical rainfall and the rainfall we are used to in the mid-latitudes. I will present a linear stochastic model for the dynamics of water vapor and tropical convection. Despite its linear formulation, the model reproduces a wide variety of observational statistics from disparate perspectives, including (i) a cloud cluster area distribution with an approximate power law; (ii) a power spectrum of spatiotemporal red noise, as in the “background spectrum” of tropical convection; and (iii) a suite of statistics that resemble the statistical physics concepts of critical phenomena and phase transitions. Exact analytical solutions are available for many statistics, and numerical realizations can be generated for minimal computational cost and for any desired time step. Given the simple form of the model, the results suggest that tropical convection may behave in a relatively simple, random way. I will also touch on similarities the model has with the Ising model, the Edwards–Wilkinson model, the Gaussian free field, and the Schramm–Loewner evolution and its possible connection with cloud cluster statistics. Potential applications of the model include several situations where realistic cloud fields must be generated for minimal cost, such as cloud parameterizations for climate models or radiative transfer models.

Math Seminars
The Role of Calculus in the STEM "Gender Filter"
Dr. Jess Ellis - Department of Mathematics, Colorado State University
When: Monday, December 07, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-133
Details: Abstract: The substantial gender gap in the science, technology, engineering, and mathematics (STEM) workforce can be traced back to the underrepresentation of women at various milestones in the career pathway. Calculus is a necessary step in this pathway and has been shown to often dissuade people from pursuing STEM fields. In this presentation, I first examine the characteristics of students who begin college interested in STEM and either persist or switch out of the calculus sequence after taking Calculus I, and hence either continue to pursue a STEM major or are dissuaded from STEM disciplines. The data come from a unique, national survey focused on mainstream college calculus. Statistical analyses show that, while controlling for academic preparedness, career intentions, and instruction, the odds of a woman being dissuaded from continuing in calculus is 1.5 times greater than that for a man. Furthermore, women report they do not understand the course material well enough to
continue significantly more often than men. When comparing women and men with above-average mathematical abilities and preparedness, we find women start and end the term with significantly lower mathematical confidence than men. This suggests a lack of mathematical confidence, rather than a lack of mathematically ability, may be responsible for the high departure rate of women. To better understand these trends and the relationship between gender, confidence, and persistence in calculus, I then examine responses from 522 Calculus I students to the open-ended question: Is there anything else you want to tell us about your experience in Calculus I? Qualitative analyses of these responses indicate that female students report negative affect and a desire for authentic learning more often than males. Student preparation also plays a role in changes in confidence and student persistence. Together, the quantitative and qualitative analyses paint a more complete picture of the role of gender in the leaking STEM-pipeline or what others have dubbed the STEM gender filter (Blickenstaff, 2005).

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**Math Seminars**

**Arrested fronts and nonlocality in biological pattern formation**

Scott McCalla - Department of Mathematical Sciences, MSU  
**When:** Thursday, December 03, 2015 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** Biological pattern formation has been extensively studied using reaction diffusion models. These models are inherently local, however many biological systems are known to exhibit nonlocality. In this talk I will discuss pattern forming mechanisms, both local and nonlocal, in the contact of zebrafish skin striping and bacterial colony formation. This will lead to a nonlocal framework to understand arrested fronts in biological systems.

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**Math Seminars**

**Small divisors in complex dynamics, part 2**

Lukas Geyer - Department of Mathematical Sciences, MSU  
**When:** Tuesday, December 01, 2015 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-144  
**Details:** This talk will be a continuation of last week's talk. I will focus on applications of quasiconformal surgery to small divisor problems. One major application, using polynomial-like maps, is Yoccoz’s result that quadratic polynomials are in a certain sense the "hardest" to linearize among all analytic maps. This result motivated Douady’s conjecture that the Brjuno condition is necessary for linearizability of all rational maps of degree at least 2. I will present some partial results towards this conjecture. Another application I will present in this talk, using a different type of quasiconformal surgery invented by Ghys, is a connection between fixed points of analytic maps and analytic circle diffeomorphisms.
Math Seminars

Small divisors in complex dynamics
Lukas Geyer - Department of Mathematical Sciences, MSU
When: Monday, November 23, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: One of the most fundamental question in investigating dynamics of the iterates of a map is to classify local stability and normal forms near fixed points. In one-dimensional complex dynamics, the linear part of a map is given by multiplication with a complex number, and "small divisors" appear when this is an irrational rotation of infinite order. This case turns out to be the most complicated to handle, and many of the answers depend on number-theoretic properties of the associated rotation number. One of the main goals of this talk is to give a non-technical introduction to the powerful quasiconformal surgery and renormalization techniques which have led to great advances in these questions as well as in the whole field of complex dynamics. Apart from presenting some results obtained by these techniques, I will also talk about some of my favorite conjectures and open questions. If time allows, I will also talk about connections to similar problems about analytic circle diffeomorphisms, and about size and geometry of rotation domains.

Math Seminars

A New Computationally Efficient Data Assimilation Approach for Finite Element Models
Prathish Kumar Rajaraman - Department of Chemical and Biological Engineering, MSU
When: Thursday, November 19, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Recent advancements in the field of echocardiography have introduced various methods to image blood flow in the heart [1]. Our particular interest is in the left ventricle (LV) of the heart, which pumps oxygenated blood from the lungs out through the aorta. One method for imaging blood flow is injecting FDA-approved micro-bubbles into the left ventricle, and then, using the motion of the micro-bubbles and the frame rate of the ultrasound scan (i.e., using Particle Imagining Velocimetry or echo-PIV), the blood velocity can be calculated. In addition to blood velocity, echo cardiologists are also interested in calculating pressure gradients and other flow properties, but this is not currently possible because the velocity data obtained is two-dimensional and noisy. Our goal is to assimilate two-dimensional velocity data from micro-bubble ultrasound experiments into a three-dimensional computer model. In order to achieve this objective a numerical method is needed that can approximate the solution of a system of differential equation and assimilate an arbitrary number of noisy experimental data points at arbitrary locations within the domain of interests to provide a most probable approximate solution that is properly influenced by the experimental data [2]. We propose a new numerical method for combing two-dimensional noisy echo-PIV data, which is computationally cheaper than previous approaches [3]. The approximate
solution is calculated using continuous interior penalty finite element method (IPFEM) coupled with a least-squares finite element method (LSFEM) for integrating the noisy echo-PIV data. This framework allows users with the flexibility of using existing numerical approaches for differential equation and complement the solution using LSFEM framework for data assimilation. The choice of LSFEM approach is due the flexibility when assimilating noisy echo-PIV data since the method can weight more accurate echo-PIV data and use a lower weight for less accurate data. The new numerical approach have been used to predict the 3-dimensional LV blood flow. Results from the current method clearly shows the impact of matching the echo-PIV data and visualizing the 3-dimensional velocity field. 

REFERENCES

**Math Seminars**

**An introduction to elliptic cohomology**

Aaron Mazel-Gee - University of California, Berkeley

**When:** Monday, November 16, 2015 04:10PM to 05:00PM

**Where:** Wilson Hall 1-144

**Details:** We algebraic topologists would like to study topological spaces, but this turns out to be quite hard. To make our task easier, we simplify and linearize (in a precise sense) to obtain the "stable homotopy category". Elliptic cohomology arises naturally in the quest to understand the global structure of the stable homotopy category, and gives rise to surprising and deep connections with number theory and arithmetic geometry. It is also intimately connected to String manifolds (and conjecturally to supersymmetric field theories), and thus also sits at the interface between algebraic topology and mathematical physics. In this talk, I'll give a leisurely introduction to the stable homotopy category, and I'll explain in broad strokes how elliptic cohomology inexorably appears. Depending on audience interest and if time permits, I'll also say a few words about its various relationships with arithmetic geometry, or physics, or some of my own recent work.

**Math Seminars**

**Matching gene transcription data with proposed mechanisms of gene regulation**

Bree Cummins - Department of Mathematical Sciences, MSU

**When:** Thursday, November 12, 2015 03:10PM to 04:00PM

**Where:** Wilson Hall 1-144
Details: We are using switching models of gene regulatory networks to propose mechanisms of gene regulation given time series data. Often, little to nothing is known about the interactions between gene products and DNA. Moreover, the number of experiments needed to discover interactions grows combinatorically with the number of genes. The purpose of our research is to narrow the potential number of experiments by identifying networks that can reproduce features of the time series data. Switching models have the property that they are analytically solvable, and so the exploration of parameter space is relatively cheap. Our collaborators have written a software tool called Dynamic Signatures of Gene Regulatory Networks (DSGRN) that can analyze the switching model of a gene regulatory network over all of parameter space. The output is a coarse but global characterization of the dynamics, from which we can identify the presence and general location of stable fixed points and stable and unstable periodic orbits. Often, the coarse dynamics of gene regulation can be identified from the data, and so desirable parameterizations of a model can be selected for further examination. I will briefly introduce these ideas in more detail, and then describe the process of taking output from DSGRN and matching it against the original time series data to discover which parameterizations are reasonable matches for the experimental observations. I will frame this task in terms of matching a partial order against a labeled graph, and I will demonstrate using data from the malarial parasite Plasmodium falciparum.

Math Seminars
Differentiability and the lower Lipschitz constant (continued)
Kevin Wildrick - Department of Mathematical Sciences, MSU
When: Monday, November 09, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: This will be a continuation of last week's talk. Rademacher's theorem states that a Lipschitz function f:R^n \to R^m is differentiable at almost every point in the domain. This fundamental result was enormously generalized by Cheeger, who proved that a wide class of metric spaces possess a measurable differentiable structure with respect to which every Lipschitz function is differentiable almost everywhere. This structure can provide an obstruction to bi-Lipschitzly embedding a given metric space into many nice Banach spaces. We will give an introduction to this theory, and give a result on the largest known class of obstructed mappings. This is joint work with Thomas Zurcher.

Math Seminars
Differentiability and the lower Lipschitz constant
Kevin Wildrick - Department of Mathematical Sciences, MSU
When: Monday, November 02, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Rademacher's theorem states that a Lipschitz function f:R^n \to R^m is differentiable at almost every point in the domain. This fundamental result was
enormously generalized by Cheeger, who proved that a wide class of metric spaces possess a measurable differentiable structure with respect to which every Lipschitz function is differentiable almost everywhere. This structure can provide an obstruction to bi-Lipschitzly embedding a given metric space into many nice Banach spaces. We will give an introduction to this theory, and give a result on the largest known class of obstructed mappings. This is joint work with Thomas Z"urcher.

**Math Seminars**

**Algebraic Topological Tools for High Dimensional Data and the Dynamics of Spatial Structures**

Konstantin Mischaikow - Department of Mathematics, Rutgers University

*When:* Friday, October 30, 2015 04:10PM to 05:00PM  
*Where:* Wilson Hall 1-144

**Details:** It is almost cliché at this point to note that high dimensional data is being collected from experiments or generated through numerical simulation at an unprecedented rate and that this rate will continue rising extremely rapidly for the foreseeable future. Our interest is in data associated with nonlinear dynamics involving spatial structures. The focus of this talk is on our efforts to use techniques based on algebraic topology as a data reduction tool and as a means of classifying dynamics. The long term goal is to develop robust efficient techniques for comparing experimental work against numerical simulation. I will introduce the necessary mathematical theory and provide examples arising from fluid flow.

**Math Seminars**

**Real World Mathematics: Applications of Mathematical and Numerical Methods in Pharmaceutical Product and Wearable Technology Development**

Amber Broadbent, TJ Brodeur, John Schmitt - Bend Research

*When:* Thursday, October 29, 2015 03:10PM to 04:00PM  
*Where:* Wilson Hall 1-144

**Details:** For more than 40 years, Bend Research has worked with clients to create value by advancing new medicines that improve human health and to solve their most difficult scientific and technical problems. This success is based on the company’s ability to develop, advance, and commercialize pharmaceutical and health-enhancing products, which grow from a solid base of scientific and engineering fundamental understanding. This seminar will provide a brief introduction to Bend Research followed by a survey of applications of mathematical and numerical methods in pharmaceutical product and wearable technology development. Specific examples will include, 1.) Developing data-driven human energy expenditure algorithms for wearable technology products, 2.) Understanding fate of pharmaceutical products in vivo via pharmacokinetic (PK) analysis and modeling, and 3.) De-risking process scale-up through computational fluid dynamics (CFD) modeling.
A proposal for cost-considerate variable selection in statistical models
Michael Lerch - Department of Mathematical Sciences, MSU
When: Thursday, October 29, 2015 09:00AM to 09:50AM
Where: AJM 233
Details: In statistical modeling, an important step is often variable selection: what variables are to be included in the final model. Naturally, there is no single best strategy to perform variable selection and the number of strategies abound. However, one of the most practically important aspects often goes unconsidered: cost of data collection. Researchers may ask the intuitive question: “How good must this variable be to justify the cost of measurement?” Regularization is becoming more and more important for model fitting (especially when prediction is the goal) as datasets become larger and wider. Regularization includes pruning variables and also coefficient shrinkage. Without regularization, models can easily become overfit. Variable selection can help prevent overfitting but it is an all-or-nothing approach to regularization. Techniques that perform coefficient shrinkage may find a balance between variable selection and no regularization. In this talk, I plan to review what literature exists on cost-considerate variable selection and to propose a new approach to cost-considerate variable selection for linear models that also performs coefficient shrinkage. The inspiration is the Lasso, the Least Angle Shrinkage and Selection Operator. With the new strategy, researchers may be able to perform cost-considerate variable selection and coefficient shrinkage in a computationally efficient way. (This presentation is part of Michael's Ph.D. oral comprehensive exam)

Local structures on stratified spaces (again)
David Ayala - Department of Mathematical Sciences, MSU
When: Tuesday, October 27, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Last time we discussed a classification of `locally constant sheaves' as representations of fundamental groups. In the presence of singularities, natural examples of sheaves tend to not be locally constant. Even so, I'll explain that a larger class of sheaves, the `constructible' ones, are representations of `exit-path categories' -- entities that generalize fundamental groups. I'll indicate that the association of a singular space to its exit-path category is so robust that every infinity-category can be characterized as a local invariant of stratified spaces. If we get far enough along, I'll indicate the differential topological example that prompted these developments.

HYBRID ELECTRIC VEHICLE OWNERSHIP AND FUEL ECONOMY ACROSS TEXAS: APPLICATION OF SPATIAL MODELS
Policymakers and automobile industries are quite interested in understanding the factors affecting adoption rates of fuel efficient vehicles and hybrid electric vehicles (HEVs). In an effort to answer these potential policy questions, this study investigates the demographic characteristics such as age, gender, race, education, household size, and income, affecting the propensities of the individuals (at census tract level) towards buying vehicles with different fuel economy levels or HEVs across four highly populous counties in Texas (Bexar, Dallas, Harris, and Travis counties) of Texas. Accounting for the spatial autocorrelation, and local (aspatial) and spatially-lagged cross-response correlation, the census tract level adoption rates of HEVs and vehicles with different fuel economy levels are estimated by bivariate (response levels: HEV and non-HEV counts) and trivariate (response levels: fuel efficient, regular and fuel inefficient vehicle counts) Poisson-lognormal conditional autoregressive models. Response variables are extracted from vehicle registration data (for the year 2010) maintained by the Texas Department of Motor Vehicles, and demographic characteristics are obtained from the U.S. Census 2010 database and American Community Survey estimates. The high spatial autocorrelations and local cross-response correlations as well as higher incidence of more educated males and higher income, but smaller households in owning HEVs and other fuel-efficient vehicles are found to be consistent in both models and across all counties. Considering a hypothesis that the early adopters of HEVs might have high inclination towards purchasing plug-in HEVs, the findings of study may also be valuable in spatial planning of charging infrastructure for plug-in HEVs.

Math Seminars
Simulation of a Hypervelocity Impact Experiment with PAGOSA Hydrocode
Yiyi Wang - Department of Civil Engineering, MSU
When: Thursday, October 22, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Seminar of Yiyi Wang today is CANCELLED. She got sick last night. We will reschedule for next semester.

Math Seminars
Teaching and learning of mathematics using technology: opportunities and pitfalls
Dr. Gerrit Stols - Fulbright Scholar, University of Pretoria
When: Wednesday, October 21, 2015 02:10PM to 03:00PM
Where: Wilson Hall 1-133
Details: In this talk, I will reflect on the use of technology for teaching and learning of mathematics. The use of technology creates new opportunities, but if used incorrectly,
students’ conceptual development. I will therefore reflect on the importance and limitations of technology use. Lastly I will focus on the question: Why do teachers and lecturers use or not use technology in their classrooms?

**Math Seminars**

**The Zen of infinity-categories**

Aaron Mazel-Gee - University of California, Berkeley

**When:** Monday, October 19, 2015 04:10PM to 05:00PM

**Where:** Wilson Hall 1-144

**Details:** By releasing our fear and embracing uncertainty, we become more powerful than we could ever have imagined. In this talk, I'll illustrate how this maxim plays out in algebraic topology, in the passage from model categories to infinity-categories. I will not assume any knowledge of category theory.

**Math Seminars**

**Measurement of Photovoltaic Device Performance via Model Parameter Inference**

Mark Campanelli - Workiva, Bozeman

**When:** Thursday, October 15, 2015 04:10PM to 05:00PM

**Where:** Wilson Hall 1-144

**Details:** Photovoltaic (PV) devices convert light into electricity without direct carbon emissions. This talk describes an alternative to the traditional method for measuring the performance of a PV device under standard test conditions (STC). We use Bayesian inference to infer, with quantified uncertainty, the 5 parameters of a lumped-parameter, single-diode circuit-model for PV devices with series and shunt resistance. For reasonably good PV devices and a sufficiently good measurement system, model discrepancy near STC is negligible for this single-diode model. This approach is advantageous because it eliminates irradiance-based corrections to the current values that can introduce voltage-dependent measurement artifacts. However, in addition to measurement noise, the uncertainty from both the measurement-calibration chain and any systematic-error corrections must be considered, and this leads to the simultaneous inference of additional parameters and the potential for parameter non-identifiability. Non-identifiability may not ultimately be an issue for prediction of quantities of interest, but can be problematic in the exchange of supposed unique “best” model parameter values for use in device performance modeling.

**Math Seminars**

**Local structures on stratified spaces**

David Ayala - Department of Mathematical Sciences, MSU

**When:** Monday, October 12, 2015 04:10PM to 05:00PM

**Where:** Wilson Hall 1-144
The larger goal of this talk is to discuss a result that articulates a sense in which infinity-categories are inherently geometric: they are parametrized by stratified spaces. This discussion will emphasize geometric notions over categorical ones, and will go something like this: I'll begin by pointing out that orientations, as well as solutions to partial differential relations, are examples of `sheaves'. I'll highlight a simplified class of sheaves, the `locally constant' ones, and explain that these are simply representations of fundamental groups. In the presence of singularities, natural examples of sheaves tend to not be locally constant. Even so, I'll explain that a larger class of sheaves, the `constructible' ones, are representations of `exit-path categories' -- entities that generalize fundamental groups. I'll indicate that the association of a singular space to its exit-path category is so robust that it generates all categories. As so, each category can be interpreted as a local invariant of stratified spaces. Depending on where we get, I might finish by explaining how this approach to category theory offers examples of categories that are unattainable through other means, and that encode a considerable amount of differential topology.

Math Seminars

Ghost-Hunting: Finding Extra Modes in Gaussian Mixture Models
Brittany Terese Fasy - Department of Computer Science, MSU
When: Thursday, October 08, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The sum of finitely many isotropic Gaussian kernels in 2- or higher-dimensional Euclidean space can have more modes than kernels. Even more surprising is the fact that the sum (also known as a Gaussian Mixture Model or GMM) can have an exponential number of critical values. In this talk, I provide an analytical description of these critical points for a particular arrangement of kernels, focusing attention on the extra "ghost" mode.

Math Seminars

Inferring the timing of gene duplications: Statistical issues, modeling, and data analysis - NOTE new time.
Dr. Snehelata Huzurbazar - Department of Statistics; University of Wyoming
When: Thursday, October 01, 2015 04:10PM to 05:00PM
Where: Procrastinator Theatre, SUB
Details: NOTE new time. Gene duplication is the key mechanism for evolutionary change. To infer the timing and nature of gene duplication, the 'data' used are the end result of various pipelines. In this talk, I will summarize how the 'data' are obtained, explore the shortcomings of analyses in the literature, and end with current work on overcoming these shortcomings. The interesting statistical problems are that the 'data' are maximum likelihood estimates, and that the biological process (saturation effects) presents complications in data modeling. A secondary but important issue is the exploration of effects of decisions made at various stages of the pipeline on the final
Math Seminars

Modeling the population dynamics of infectious disease - NEW LOCATION
Kezia Manlove - Department of Microbiology and Immunology, MSU
When: Thursday, October 01, 2015 03:10PM to 04:00PM
Where: SUB - Procrastinator Theatre
Details: NOTE new location. Mathematical models play an important role in guiding epidemiological field strategies, biomedical research, wildlife conservation, and agricultural production design. In this talk, I will introduce the basic between-host disease transmission model, and cover important results associated with the model's equilibrium (used to guide vaccination planning) and transient dynamics (used to guide epidemic interventions). I will emphasize the role that stochasticity plays in shaping epidemic progressions, and briefly discuss emerging inferential frameworks for estimating epidemiologically relevant parameters. Finally, I will describe two areas of active research in mathematical epidemiology: cross-scale interactions linking pathogen growth and host immune defenses to disease-induced mortality and transmission; and network approaches that describe the social landscape upon which disease transmission operates.

Math Seminars

Bounding the number of relative equilibrium states
John Antonioli - Department of Mathematical Sciences, MSU
When: Monday, September 28, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: One of the foundational results of thermodynamic formalism is that in symbolic settings with some synchronizing property, functions with enough regularity have unique equilibrium states. We will try to get our hands around a heuristic for why this is true. Then, we will use the same idea to bound the number of equilibrium states in the presence of a factor map, when we restrict to a single fiber. This is joint work with Mahsa Allahbakhshi and Jisang Yoo.

Math Seminars

How physics impacts biology, and biology impacts physics, in Pseudomonas biofilms
Vernita Gordon - Center for Nonlinear Dynamics at UT Austin
When: Thursday, September 24, 2015 04:10PM to 05:00PM
Where: ROBH 321

data. Refreshments at 1500, presentation at 1510. This presentation is cosponsored by the Mountain West Clinical and Translational Research Network (MW CTRIN).
Math Seminars
Incorporating Data Science into the Undergraduate Curriculum
Dr. Christopher Malone - Winona State University
When: Monday, September 21, 2015 03:10PM to 04:00PM
Where: Byker Auditorium
Details: ABSTRACT: A modern and dynamic curriculum is important to the success of any academic program. Curriculum should evolve over time so that the knowledge and skill-set acquired by students ensure success in their forthcoming career. The Computer Science and Statistics programs at Winona State University worked collaboratively to create a comprehensive data science program to meet the increasing demand for individuals who retain the skills necessary to work as a data scientists. Details regarding the rationale, development, and implementation of an undergraduate data science program will be presented. ABOUT SPEAKER: Dr. Malone is a Professor of Statistics and Data Science in the Department of Mathematics and Statistics at Winona State University. He is an active leader in the Statistics Education community and was instrumental in the development of the undergraduate Data Science program at Winona State. Dr. Malone is Director of the Statistical Consulting Center and has co-organized the Midwest Undergraduate Data Analytics Competition for the past four years.

Math Seminars
Database for Dynamics: a new approach to model gene regulatory networks
Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, September 17, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Experimental data on gene regulation is mostly qualitative, where the only information available about pairwise interactions is the presence of either up-or down-regulation. Quantitative data is often subject to large uncertainty and is mostly in terms of fold differences. Given these realities, it is very difficult to make reliable predictions using mathematical models. The current approach of choosing reasonable parameter values, a few initial conditions and then making predictions based on resulting solutions is severely subsampling both the parameter and phase space. This approach does not produce provable and reliable predictions. We present a new approach that uses continuous time Boolean networks as a platform for qualitative studies of gene regulation. We compute a Database for Dynamics, which rigorously approximates global dynamics over entire parameter space. The results obtained by this method provably capture the dynamics at a predetermined spatial scale.
Quasiconformal mappings that highly distort foliations
Kevin Wildrick - Department of Mathematical Sciences, MSU
When: Monday, September 14, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Quasiconformal mappings are (possibly non-smooth) mappings that distort infinitesimal balls to infinitesimal ellipses of uniformly bounded eccentricity. They are ubiquitous in mathematics: they measure the distance between conformal structures, their existence solves problems in the calculus of variations and elliptic PDE, and they have even been used to give a mathematical formalism for impedance tomography. We will discuss some fundamental regularity results for quasiconformal mappings, and show how they imply smoothness on most fibers of a foliated space. We will then construct quasiconformal mappings that distort as many fibers as possible as much as possible.

Math Seminars
Simulation of a Hypervelocity Impact Experiment with PAGOSA Hydrocode
Tamra Heberling - Department of Mathematical Sciences, MSU
When: Thursday, September 10, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This work investigates how the Eulerian hydrocode PAGOSA performs while simulating a hypervelocity impact experiment of stainless steel 304-L into aluminum 6061-T6. The specifications of the simulation were established in a paper detailing an experiment conducted at the Atomic Weapons Establishment (AWE) in the UK and the Centre d'Etudes de Gramet (CEG) in France. A variety of strength models and equations of state were employed under several different mesh sizes. The results display an excellent comparison with the experimental data and demonstrate dramatic differences in impacted crater geometries over various strength models and mesh sizes. This was a project I worked on over the summer as a GRA at Los Alamos National Laboratory (LANL). I will also talk a little bit about LANL in general, what it is like to work there, and the basic ins and outs of the lab. If you are thinking about working at LANL or would like to cross it off your list, please bring any questions you may have and I'll do my best to answer them.

Math Seminars
Developing a New Undergraduate Program in Data Science
Dr. Stacey Hancock - University of California, Irvine
When: Tuesday, September 01, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-134
Details: Abstract: Statistics undergraduate programs are on the rise, and the number of students majoring in statistics has dramatically increased in recent years. At the same time, data science is becoming increasingly popular, and colleges and universities are beginning to develop undergraduate programs in data science. The Department of
Statistics, housed in the Donald Bren School of Information and Computer Sciences at the University of California, Irvine, has an undergraduate minor in statistics and will be starting an undergraduate major in data science this fall. This talk will focus on the development of the data science major at UCI, and how the newly adopted American Statistical Association Undergraduate Curriculum Guidelines were used in the process. I will also discuss differences and similarities in the curriculum between statistics and data science undergraduate majors and our rationale for focusing on curriculum at the undergraduate level.

Math Seminars
Devil avoiding Starfish: new examples of integrable families of circle maps
Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Monday, August 31, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: This is a story involving dynamics on the circle, a non-linear PDE, a (cohomological) functional equation, and some multivalued analytic maps. It is elementary and can be understood with undergraduate level notions.

Math Seminars
Connecting School Mathematics and Science: Insights from a Year in the U.K.
Beth Burroughs - Department of Mathematical Sciences, MSU
When: Thursday, June 25, 2015 01:00PM to 01:50PM
Where: Wilson Hall 1-133
Details: In this talk I will propose three ideas that connect school mathematics and science: proportional reasoning, mathematical modeling, and statistical inference. I will consider how science and mathematics teaching and research can connect and reinforce these three ideas. I will also share some insights about education from living and working in the U.K.

Math Seminars
Influences of Allee effects in the spreading of malignant tumor
Petrus van Heijster - Mathematical Sciences School, QUT
When: Thursday, May 14, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We discuss the influence of Allee effects, or growth thresholds, on the existence of travelling wave solutions in a reaction-advection-diffusion-type model describing the invasion of malignant tumor cells. Using geometric singular perturbation theory and canard theory, the existence of travelling wave solutions with semi-compact support is shown. Moreover, the relationship between the speed of the travelling wave
solution and the background state of the extracellular matrix is biphasic. In earlier work, the spread of cancer cells was modelled by logistic growth and this biphasic relationship, which is observed experimentally, was not present. Also, the logistic model supports unrealistic stable travelling wave solutions. Concluding that the Allee model is superior to the logistic model in qualitatively capturing biological realism. This is joint work with Lotte Sewalt, Kristen Harley, and Sanjeeva Balasuriya.

Math Seminars

Coherent structures in nonlocal equations
Arnd Scheel - Department of Mathematics, University of Minnesota
When: Friday, May 01, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I'll present recent work on pulses and fronts in systems with nonlocal coupling. I'll first discuss pinning and unpinning of fronts. Near the Maxwell point, that is, when potential energies of the asymptotic equilibria are close, interfaces are often discontinuous and cannot propagate: they are pinned. I'll describe results that characterize pinning regions in parameter space and show that speeds obey an unusual but universal $\mu^{3/2}$ asymptotic which is different from conventional $\mu^{1/2}$ asymptotic in discrete systems. I'll also give some motivation and speculation how speed asymptotics may depend in a universal fashion on kernel regularity properties. In the second part of the talk, I'll explore some of the techniques involved in the study of such traveling wave problems. In particular, I'll explain how "spatial dynamics" can be "translated" to traveling-wave problems that cannot be cast as differential equations in a spatial variable. As an application, I'll describe the construction of an excitation pulse in a nonlocal FitzHugh-Nagumo equation.

Math Seminars

Universal operations on differential forms
Joseph Hirsh - MIT
When: Monday, April 27, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: There are various algebraic structures on the vector space of differential forms on a manifold, depending on the kind of manifold (smooth produces deRham d and wedge product, a volume form produces a Lie bracket, a Riemannian metric produces an adjoint differential operator that satisfies certain identities with respect to the other structures). A question one might ask is: how would one determine whether all operators and relations have been discovered? In 1959 Richard Palais proved that there is a two dimensional vector space of operators (in one variable) that respect all smooth maps, and it is spanned by the deRham differential and the identity. I plan to describe some of Palais' work and an approach to extend these computations to characterize all operations with more than one variable.
Cohort Formation in Cell Cycle Dynamics
Jacob Brown - Department of Mathematical Sciences, MSU
When: Thursday, April 23, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Two kinds of periodic behavior have been characterized in slowly growing yeast cultures. The first, the classical cell division cycle (CDC), consists of four phases that are easily distinguished by morphological criteria. The second kind of cycle, the yeast metabolic cycle (YMC), similarly can be divided into two phases based on oxygen consumption. Previous experimentation has discovered that cultures of yeast growing in glucose or phosphate limited medium synchronize spontaneously and go through multiple metabolic cycles during a single cell division cycle. Additionally, in a continuous YMC culture, a fraction of the culture (a cohort) divided synchronously during each YMC period, indicating a coupling between the YMC and the CDC. We will present and explore a cell-cycle dependent feedback model for the CDC that exhibits cohort development as well as postulate the link and a model for the relationship between the YMC and the CDC.

Is model averaging the solution for dealing with model uncertainty?
Methodological insights and considerations for its practical use
Katharine Banner - Department of Mathematical Sciences, MSU
When: Thursday, April 23, 2015 03:00PM to 03:50PM
Where: Wilson Hall 1-134
Details: Methods accounting for model uncertainty in regression problems have received a lot of recent attention. Model averaging (MA) is often used to average posterior distributions of regression coefficients over a set of plausible regression models. This method implicitly assumes the same parameters exist in multiple models. However, in the context of regression, coefficients of particular explanatory variables appearing in multiple models do not necessarily hold equivalent interpretations across those models. The meaning of a model averaged regression coefficient is then completely dependent on the context of the problem as well as the estimated posterior model probabilities, making explanatory inference difficult. Perpetuating this problem in practice is the accessibility to easily implementable software for model averaging without diagnostic tools or guidelines for assessing its appropriateness. This gap between methods and practice can leave well-intentioned researchers with unclear inferences. In this talk I will propose a set of considerations including explicit notation and two graphical tools to aid researchers in making informed decisions when considering model averaging. To conclude, I will propose areas of future research and discuss why I think they are open and important subjects to consider.
On the genus, the slice genus, and the Alexander polynomial of knots
Peter Feller - Boston College
When: **Wednesday, April 22, 2015 04:10PM to 05:00PM**
Where: Wilson Hall 1-144
Details: We provide a short introduction to knot theory and three classical knot invariants: the genus, the slice genus, and the Alexander polynomial. Using Freedman's disk Theorem, we establish that the degree of the Alexander polynomial is an upper bound for the topological slice genus and we determine the topological slice genus for small torus knots. Finally, we discuss the smooth slice genus of torus knots and connected sums of torus knots.

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Math Seminars
The apparent gender gap in scientific computing, why it matters, and strategies for change
Kezia Manlove - Ph.D. Candidate and Academic Computing Fellow, Penn State Pennsylvania State University
When: **Thursday, April 16, 2015 04:10PM to 05:00PM**
Where: Linfield 125
Details: Women are awarded an increasingly large proportion of graduate degrees in STEM, but they continue to be digitally quiet, with lower-than-expected contributions to discipline-specific software development and computational discussion, online, in print, and at conferences. This is problematic because digital participation improves computational acumen and also signals competencies outside the traditional science curricula. In this talk, I will review the evidence for an apparent gender gap in scientific computation. I'll illustrate this gap's relevance, both for the individual and for the broader scientific community. Finally, I'll provide a computational competency checklist for researchers doing data analysis, and review strategies for improving computational skills. More info: My name is Kezia Manlove, and I'm an alum of the MSU stats program. I'm giving a talk this Thursday at 4:10 in Linfield 125 on computing reputations for female statisticians, mathematicians, and scientists, and steps women (and other people) can take to strengthen computational skills and reputations. I've been chasing this question since Dr. Golbeck's seminar on women in statistics in March, and the story I've uncovered is pretty stark. While more and more Ph.Ds in math and stat go to women, women remain essentially silent in the scientific software community. For example, there are NO women on the R core development team (an elected body, by the way), and there never have been. R acknowledges another 61 individuals as major contributors on CRAN, and one of them is female. SAS has one female vice president, and she's the VP of human resources. I'm worried that women (and also men who remain digitally silent) are getting left out of a huge piece of modern quantitative science. I've got a bunch of data on why this is a problem, ideas on competencies we as quantitative scientists should strive to develop, and strategies to gain those skills. I'm very curious to get feedback and hear other perspectives. ALSO - feel free to come late if need be.
Math Seminars
2D Modeling of Biofilm as a Visco-Elastic Fluid Using an Iterative Sparse Solver and Parallel Processing.
Dan Kanewske - Department of Mathematical Sciences, MSU
When: Thursday, April 16, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We are modeling the viscoelastic flow of biofilms using a modified NaviorStokes equation. The solution is determined using AztecOO, a Trilinos sparse matrix solver. Computation time is made more efficient by implementing parallel processing using Message Passing Interface (MPI). We choose to use the algorithm developed by Dr. YoungJu Lee and Dr. Jinchao Xu which preserves the symmetry of the stress tensor in order to reduce the effect of the High Weissenberg Number Problem (HWNP). We will also describe the implementation of Dr. YoungJu Lee's algorithm and conclude with a description of biofilm deformation and the accompanying distribution of the pressure and stresses over the evolving velocity field.

Math Seminars
Abstract Tiling Actions, Expansiveness, and Local Structure
Hannah Bergren - Department of Mathematical Sciences, MSU
When: Monday, April 13, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-117
Details: A significant amount of literature is devoted to the study of the dynamical properties of the translation action on self-affine tilings or Delone sets. A natural step is to axiomatize these essential properties among all R^d-actions on compact metric spaces. We propose a set of purely topological dynamical axioms which guarantees a topological conjugacy of the given R^d action and the translation action associated to a self-affine repetitive aperiodic tiling. In the process, we construct an expanding metric on the local cross-section of the phase space and prove that the cross-section is a Cantor set.

Math Seminars
Siegel disks and rotation numbers for rational maps
Joe Manlove - Department of Mathematical Sciences, MSU
When: Friday, April 10, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The possible rotation numbers for Siegel disks of rational maps have proven to be counter-intuitive and slightly mysterious. Intuitively, all fixed points with irrationally indifferent multipliers should give rise to a local conjugation to irrational rotation, but this is not the case. Classic results indicate that the appropriate condition has much to do
with how closely approximated the rotation number is by rationals. In some sense, one could consider the existence of a Siegel disk a dynamical litmus test for stronger irrationality. The results presented here answers in part a conjecture of Douady about sharpness of the Brjuno condition. Douady hypothesized that a Siegel disk exists if and only if the Brjuno condition is satisfied by the rotation number. It is known that the Brjuno condition is sharp for quadratic polynomials and many special families. We focus on a large class of rational functions, many of which have not been considered previously. This will be part of Joe’s thesis defense.

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**Math Seminars**

**The Role of Interleukin-2 in Immune Response Regulation**

Ryan Waters - Department of Mathematical Sciences, MSU  
**When:** Thursday, April 09, 2015 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** The immune system is made up of many adaptive and dynamic components that must be delicately regulated to ensure appropriate, precise, and rapid response to a foreign pathogen. A delayed or inadequate immune response can lead to prolonged disease, while an excessive or under-regulated response can lead to autoimmunity. We are interested in the role cytokines, in particular Interleukin-2 (IL-2), play in maintaining this balance. Through the use of several deterministic models, we try to understand how IL-2 signaling might play a role in T cell differentiation as well as in maintaining the balance between under-response and autoimmunity. Additionally, we will look at how Daclizumab, a monoclonal antibody against one component of the IL-2 receptor, might affect this equilibrium. We will also briefly review our work on the CRISPR system, channeling in metabolic pathways, and the design of a multiple sclerosis diagnostic/progression tool.

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**Math Seminars**

**Poincare duality continued**

David Ayala - Department of Mathematical Sciences, MSU  
**When:** Monday, April 06, 2015 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-144  
**Details:** I'll remind us of the point of view on (co)homology we arrived at in my previous seminar. Then I'll motivate another point of view, along the lines of observables of a physical theory. Along these lines, I'll outline a form of Poincare duality. I'll emphasize a key geometric result supporting this duality.

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**Math Seminars**

**Bi-Lipschitz Embeddings of Metric Spaces**

Jeremy Tyson - University of Illinois Urbana Champaign  
**When:** Thursday, April 02, 2015 04:10PM to 05:00PM
Where: Procrastinator Theater
Details: A mapping between metric spaces is said to be bi-Lipschitz if it distorts
distances by at most a fixed multiplicative factor. Which metric spaces admit bi-Lipschitz
embeddings into finite-dimensional Euclidean spaces? This challenging question
remains one of the central open problems of analysis in metric spaces. I will give a
broad survey of the history of and motivation for this question, focusing especially on
biLipschitz embeddability and non-embeddability of the Heisenberg group and other
subRiemannian spaces. Bi-Lipschitz nonembeddability of metric spaces is closely
related to the differentiability of Lipschitz functions. I will discuss this connection and its
relevance for sub-Riemannian geometry. A reception will be held at 3:30 in Hurst.

Math Seminars
Quorum Sensing and Short-circuiting in Pseudomonas aeruginosa
Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, April 02, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Bacterial cell-cell communication, also termed quorum sensing (QS) is a
widespread process that coordinates multicellular behaviors such as virulence, biofilm
formation, and nutrient acquisition in response to cell density, population structure and
environmental viscosity. There has been an explosion in research directed at
understanding the molecular mechanisms of QS, but there is a paucity of information on
the ecophysiological implications and on the emergent properties of QS regulatory
networks. Short-circuiting, or self-induction, is a major unanswered question in bacterial
QS: How is it that diffusible quorum-signals do not immediately bind to their cognate
receptors in the same cell in which they are produced and activate gene expression
independent of cell density? We will investigate the roles of antiactivation and lasR
regulation in modulating the quorum response and in preventing short-circuiting.

Math Seminars
Removable sets for homogeneous linear PDE in Carnot groups
Jeremy Tyson - University of Illinois Urbana Champaign
When: Wednesday, April 01, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We will discuss removable sets for solutions of homogeneous linear PDE in
nilpotent stratified Lie groups (also known as Carnot groups) equipped with a
subRiemannian metric. We quantify the relationship between the regularity of solutions,
the degree of the equation, and the size (Hausdorff dimension) of allowed removable
sets. We pay particular attention to the Lipschitz harmonic case, whose analysis uses
recent advances in the theory of sub-Riemannian rectifiability. This talk is based on joint
work with Vasilis Chousionis (University of Helsinki) and Valentino Magnani (University
of Pisa).
Math Seminars
The Mapping Class Group of the Torus
Anna Cepek - Department of Mathematical Sciences, MSU
When: Monday, March 30, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The Mapping Class Group of the 2-Torus is the space of homeomorphisms of the Torus up to isotopy equivalence. In this talk I will use first homology to show that the Mapping Class Group of the Torus is isomorphic to the General Linear Group of 2x2 matrices with integer coefficients.

Math Seminars
One is the Loneliest Number: From Single-Molecule Transcription Experiments to Multi-Molecule Modeling
Tamra Heberling - Department of Mathematical Sciences, MSU
When: Thursday, March 26, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Recent advances in technology have allowed scientists to measure transcription of DNA to base pair accuracy. This has created many new discoveries about the mechanisms that govern this process that were previously unknown. One of these mechanisms is torque applied by an RNA polymerase to the DNA strand, both assisting and resisting the movement of the polymerases. A challenge has been how to incorporate these breakthroughs measured for single-molecules into our mathematical models for multiple molecules. I will discuss the incorporation of the effects of torque into a basic stochastic model, the simulation results for the model, and I will describe future goals for this project. (THIS TALK IS A PART OF TAMRA'S PH.D. DEFENSE)
future goals for this project. (Mistake on my last email: This is a part of Tamra’s PhD oral exam)

Math Seminars
Introduction to Poisson Processes
Tamra Heberling - Department of Mathematical Sciences, MSU
When: Monday, March 23, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: There are two probability distributions associated with a Poisson process; a Poisson distribution and an exponential distribution. I'll cover how to derive the Poisson distribution from a binomial distribution, how to derive the exponential distribution from the Poisson distribution, and how you really only need the exponential distribution to simulate your process. Absolutely no knowledge of probability, distributions, or anything of the sort is required.

Math Seminars
Observing and Participating Within the Implicit Bias Matrix: Women in Statistics
Amanda Golbeck - School of Public Health and Community Health Sciences, University of Montana
When: Tuesday, March 17, 2015 03:10PM to 04:00PM
Where: Procrastinator Theatre
Details: In 1968, when only 3 percent of tenure ladder faculty members at UC-Berkeley were women, their Academic Senate Policy Committee formed a subcommittee to study the status of academic women. When Amanda Golbeck asked why the issue hadn’t been investigated previously, she was told the committee just hadn’t given it any thought. Likewise, when 44 years later there were no women pictured in the 2012 Joint Statistical Meetings Registration Guide, many attendees failed to take notice, even though over a third of American Statistical Association (ASA) members are women. Observations such as these, which point to implicit gender-career bias, catalyzed Dr. Golbeck to take a closer look at three aspects of the statistics profession that she will report on in this talk: professional awards, career pathways and leadership.

Math Seminars
Understanding something about curvature using only Calc III and Linear Algebra
Kevin Wildrick - Department of Mathematical Sciences, MSU
When: Monday, March 16, 2015 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Curvature is a notoriously tricky concept to understand, especially in higher dimensions. Luckily for us there is a connection between many notions of curvature and
simpler concepts like distance, volume, and surface area. We will discuss Steiner's formula, which relates the volume of a neighborhood of a (sufficiently nice) subset of Euclidean space to its intrinsic volumes, the first and last of which are integrals of the mean curvature and Gaussian curvature, respectively.

Math Seminars

Topology, Tangling and Fluid Mixing
Philip Boyland - Department of Mathematics, University of Florida
When: Thursday, March 05, 2015 03:10PM to 04:00PM
Where: Byker Auditorium, Chemistry Building
Details: Flowing water has complicated patterns, swirls, eddies and flow lines that change and evolve, but also maintain a kind of constancy. These images and structures have fascinated artists and scientists for millennia. This lecture will begin with a description of some of the morphology and mathematics of these structures, followed by a discussion of their application to fluid mixing. Ideas and theorems from topology and chaotic dynamical systems will yield principles to design efficient mixers. The main mathematical idea is that the topological constraints give rise to the exponential growth of material lines and thus of the gradients of transported quantities. The lecture will conclude with a discussion of how the same collection of topological/dynamical ideas can be used to quantify the entangling of such diverse entities as hair, ocean floats and individual motion in crowds.

Math Seminars

New Rotation Sets in a Family of Torus Homeomorphisms
Philip Boyland - University of Florida, Gainesville
When: Wednesday, March 04, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We construct a family $\{\Phi_t\}$ of homeomorphisms of the two-torus and analyze the bifurcations and typical behavior of rotation sets. We show that there is a full measure subset on which the rotation set mode locks to a constant polygon with rational vertices; that the generic rotation set in the Hausdorff topology has infinitely many extreme points, accumulating on a single totally irrational extreme point at which there is a unique supporting line; and that, although $\rho(t)$ varies continuously with $t$, the set of extreme points of $\rho(t)$ does not. The family also provides examples of rotation sets for which an extreme point is not represented by any minimal invariant set, or by any directional ergodic measure. (Joint with de Carvalho and Hall).

Math Seminars

Using a Genetic Algorithm to Generate Exact Small Response Surface Designs
John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, March 03, 2015 04:10PM to 05:00PM
A genetic algorithm (GA) is an evolutionary search strategy based on simplified rules of biological population genetics and theories of evolution. A GA maintains a population of candidate solutions for a problem, and then selects those candidates most fit to solve the problem. After the selection process, the most fit candidate solutions are combined and/or altered by reproduction operators to produce new solutions for the next generation. The process continues, with each generation evolving more fit solutions until an acceptable solution is evolved. In this research, a GA is developed to generate optimal and near-optimal D, A, G, and IV exact N-point response surface designs in the hypercube. A catalog of designs is generated for 1, 2, and 3 design factors.

**Math Seminars**

**Stochastic Modeling of Wavefront Aberrations in Aero-Optics**  
Curtis Vogel - Department of Mathematical Sciences (Emeritus), MSU  
**When:** Thursday, February 26, 2015 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** Aero-Optics refers to turbulence induced by flow over an aircraft and its effects on the propagation of light. In this talk we will discuss a modeling approach involving spatial-temporal covariances, and its application to analysis, simulation, and predictive control.

**Math Seminars**

**Discover Poincare duality**  
David Ayala - Department of Mathematical Sciences, MSU  
**When:** Monday, February 23, 2015 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-144  
**Details:** I'll motivate, then articulate, Poincare duality. In doing so I'll emphasize the special feature of manifolds as those topological spaces that admit tangent spaces (so that deformations of any point therein can be averaged). Nearly all the content in this talk will be ~70 years old. This will be the first part of a two-part series. In the sequel I'll enhance this duality from the point of view of deformations, motivated by some mathematical physics.

**Math Seminars**

**Commensalism in an Idealized Microbial Community**  
Patrick Murphy - Department of Mathematical Sciences, MSU  
**When:** Thursday, February 19, 2015 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** Natural microbial consortia are often organized either as syntrophic or commensal consortia. We will develop a general theory for a syntrophic and commensal food web of arbitrary size, where the product of one species is consumed by another
species. We show under very general assumptions that a 2n-dimensional consortium model which includes n species and n essential resources has an n-dimensional invariant manifold. After narrowing to a subclass of simple food webs with no competition, we will show that there is at most one equilibrium with a given set of species surviving, and we provide a condition in terms of available resources that guarantees the survival of a particular species.

Math Seminars
When Outer Space behaves like Teichmuller space (or hyperbolic spaces) & how we can use this to understand Out(F_n) Catherine Pfaff - Department of Mathematics, Universitat Bielefield
When: Thursday, February 12, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Out(F_n) is one of the most intriguing groups to study because of its natural action on a space, Culler-Vogtmann Outer Space, which both strongly resembles and intricately differs from some of the most well-known and studied spaces, such as Teichmuller space and hyperbolic spaces. In this talk I will present several dynamical results about when Outer Space behaves like these other spaces and explain how we have used them to help understand Out(F_n). This is joint work with Yael Algom-Kfir, Ilya Kapovich, and Lee Mosher.

Math Seminars
Gluing of Geometric PDEs: Obstructions vs. Constructions for Minimal Surfaces & Mean Curvature Flow Solitons
Niels Moeller - Department of Mathematics, Princeton University
When: Monday, February 09, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: For nonlinear PDEs, where no easy superposition principle holds, concrete examples of (global) solutions can be sporadic and hard to come about. In certain very geometric situations, for example for equations of mean curvature type, one can still very often combine two or more surfaces satisfying the PDE - as long as certain global obstructions are observed: The key to a successful gluing procedure is then to understand the global obstructions from a more local perspective, and to allow certain global deformations to take place. In the talk I will introduce some of the basic ideas and techniques (and pictures) in the gluing theory for mean curvature equations. Then I will explain two recent applications, one to the study of solitons in the singularity theory of mean curvature flow (Ilmanen's numerical "planosphere" self-shrinkers), and another one to the non-compactness of the moduli spaces of minimal surfaces of fixed genus in R^3 (a problem posed by Ros-Hoffmann-Meeks). Some of the work is joint w/ Steve Kleene and Nicos Kapouleas.

Math Seminars
Graphical Motives
Susama Agarwala - Department of Mathematics, Oxford University, UK
When: Monday, February 02, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk I introduce a graphical representation for a (sub)category of Mixed Tate Motives, approached via the Bloch-Kriz algebraic cycle complex. The graphical point of view for gives great insight into calculating and identifying concrete elements of the category. Time permitting, I will present advances in calculating periods associated to these algebraic cycle.

Math Seminars
Topological Data Analysis and Road Network Comparison
Brittany Fasy - Tulane University
When: Friday, January 30, 2015 04:10PM to 05:00PM
Where: Roberts 301
Details: THIS IS A CANDIDATE FOR AN ASSISTANT PROFESSOR IN CS DEPARTMENT, WHO IS WORKING IN TOPOLOGICAL DATA ANALYSIS (NOTE DIFFERENT DATA AND PLACE) vast amount of data are routinely collected, and analyzing them effectively has become a central challenge we face across science and engineering. Topological data analysis (TDA) is a field that has recently emerged in order to tackle this challenge. This talk will focus on the problem of comparing two road networks (for example, to detect where and by how much a road network has changed over the course of a year). Surprisingly, only recently have distance measures between embedded graphs (representing road networks) been studied. We will see how one of the tools from TDA, namely, persistent homology, can be used to define a local distance measure between two graphs. Persistent homology describes the homology (in particular, the number of connected components and loops) of a data set, at different scales. An example to keep in mind is impressionistic paintings: at one scale, all that is seen are brush strokes; at a larger scale, the brush strokes blur together to form the subject of the painting. The (local) persistent homology distance measure is one of the first theoretically justified approaches to road network comparison. This talk should be accessible to both students and faculty.

Math Seminars
Some applications of quantum field theory in geometry and topology
Ryan Grady - Department of Mathematics, Boston University
When: Thursday, January 29, 2015 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk I will explain a program of using mathematical formulations of quantum field theory (QFT) as tools in geometry, topology, and representation theory. No familiarity with QFT will be assumed; in fact, I will develop the notion of factorization algebra (an "observable" approach to QFT) in the course of the talk. Factorization
algebras encompass/extend many algebraic notions: associative algebras, $E_{n}$algebras, vertex algebras, etc. Finally, I will explain some applications to geometry: positive curvature and Ricci flow, topology: index theory, and if time allows, geometric representation theory.

Math Seminars
Robust Response Surface Designs Against Missing Observations
Patchanok Srisuradetchai - Department of Mathematical Sciences, MSU
When: Tuesday, December 09, 2014 09:00AM to 10:00AM
Where: Wilson Hall 1-144
Details: Abstract: Although good experiments are most carefully planned, some observations may be lost during the process of collecting data or are suspicious in some way. In chemical processes, a certain combination of chemical levels may be volatile so the response of interest is not collectible or the equipment may malfunction. In ecological studies, an arbitrary treatment in the experimental plot can be consumed or contaminated by animals. Because the risk of losing observations usually cannot be ignored in practice, it might be preferable to use designs less than optimal according to a particular criterion in exchange for being insensitive to missing observations. In this dissertation proposal, five topics will be proposed. First, the effects of a missing trial will be studied in response surface designs including the central composite designs, Hartley's small composite designs, Plackett-Burman composite designs, exact D-optimal designs, and Box-Behnken designs. A R package has been developed to make fraction of design space plots and variance dispersion graph in both cuboidal and spherical regions. Second, the axial distance that makes CCDs with one center point in a spherical region robust to a missing point will be determined, and the behaviors of A-, D-, G-, and E-efficiencies will be examined in a presence of missing data. In the third topic, we will propose new robust alphabetic optimality criteria and implement a modified point-exchange algorithm to generate optimal robust exact designs. Fourth, the problem of missing data in mixture experiments will be explored, and optimal robust exact designs will be generated for mixtures with or without component constraints. Finally, the idea of adaptive experiments which allow real-time design augmentation when missing data situations arise will be introduced.

Math Seminars
A Two Species Competition and Mutation Model within a Biofilm
Michael P. Broome - Department of Mathematical Sciences, MSU
When: Thursday, December 04, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: A progression of models for microbes existing inside a biofilm are studied. Mutation from one species to another is discussed as a deterministic process, and future work in the introduction of stochasticity is considered.
Math Seminars
A Relatively Short Introduction to Relative Equilibrium States
John Antonioli - Department of Mathematical Sciences, MSU
When: Monday, November 24, 2014 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: In information theory, we can view transmission of information as a factor map between two symbolic dynamical systems. The gap between what is known about finite to-one factors and infinite-to-one factors (where the transmission is lossy) is historically quite large. Recently there have been results that give a much clearer picture of the topological and ergodic properties of fibers in this infinite-to-one case. Most of these results involve thermodynamic formalism, so I will try to outline the basic objects of thermodynamic formalism, and state some of these results. In particular, a clever trick involving entropy is at the heart of the recent progress, so I will give at least a heuristic for how the trick works.

Math Seminars
Crimes with undergraduates
Scott McCalla - Department of Mathematical Sciences, MSU
When: Thursday, November 20, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk, I will discuss two undergraduate research projects on modeling crime. The first part of the talk will concentrate on extending a model for burglary hotspot formation. Most animals, including humans, are known to make large changes in area when foraging for resources. Our extension assumes criminals will do the same when looking for possible targets to burgle. The second part will concentrate on understanding seasonal variations in crime rates. Many law enforcement personal believe simple statements like "when the temperature heats up, so does my job". We examine this ideology by extracting seasonal variations in crime rates from noisy data in the Los Angeles and Houston metropolitan areas, and then modeling this data with a stochastic differential equation.

Math Seminars
On the Ellis semigroup for quasicrystals
Johannes Kellendonk - Institut Camille Jordan, Lyon
When: Monday, November 17, 2014 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The Ellis semigroup is a construction in topological dynamical systems which leads to algebraic characterizations of such systems. Applied to the dynamical system of a tiling model for a quasicrystal the idempotents of the semigroup are related to phason flips. Phason flips are collective motions of atoms preserving the quasicrystalline structure. I'll try to explain that.
Math Seminars

Seminar today November 13th is cancelled
Michael P. Broome - Department of Mathematical Sciences, MSU
When: Sunday, November 16, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144 Details:

Math Seminars

A Two Species Competition and Mutation Model within a Biofilm
Michael P. Broome - Department of Mathematical Sciences, MSU
When: Thursday, November 13, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144 Details: A progression of models for microbes existing inside a biofilm are studied. Mutation from one species to another is discussed as a deterministic process, and future work in the introduction of stochasticity is considered.

Math Seminars

Invitation to the Pisot Conjecture
Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Monday, November 10, 2014 04:10PM to 05:00PM
Where: Wilson Hall 1-144 Details: I will explain how simple geometric considerations lead from a substitution rule on strings (replacing each letter by a word) to two dynamical systems (with continuous and discrete time, respectively). The dynamics will be spatially periodic, so they live on a torus. The question whether (under certain natural assumptions) the torus adequately captures the original curiosity about the substitutions is the object of a 30+ years old conjecture. [Most of the talk will be elementary and require only basic matrix theory.]

Math Seminars

Some Old and Less Old Items in Numerical Analysis
John Lund - Department of Mathematical Sciences, MSU
When: Monday, November 10, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144 Details: A discussion of some classic approximation techniques used in Numerical Analysis will be discussed with a parabolic partial differential equation providing the analytic motivator. Topics arising include finite differences, polynomial interpolation and quadrature (numerical integration). Interest will focus on the underlying boundary value problem. An error estimate leads to a brief look at the eigenvalues for Toeplitz matrices. The finite difference approximation of this problem is contrasted with the Galerkin method. This competitor to (complementor of) the finite difference approach provides an opportunity to propagandize some numerical methods based on Sinc function
Math Seminars
A Paradoxical Result in Regression Estimation Arising from Constructing Moderators of Treatment Response
Thaddeus Tarpey - Department of Mathematics and Statistics, Wright State University
When: Thursday, November 06, 2014 04:30PM to 05:20PM
Where: Wilson Hall 1-131
Details: In personalized medicine, one goal is to discover baseline predictors that affect outcomes differently depending on the type of treatment a patient receives. In regression models for the outcome, such predictors create an interaction and are called effect modifiers. Typically, baseline predictors have small modifying effects. The first part of this talk focuses on methods of combining several baseline predictors to form a single powerful Generated Effect Modifier (GEM). An example from a randomized clinical trial is provided to illustrate the results. In the course of this work, a paradoxical result in regression was encountered. This counter-intuitive result is the focus of the second part of the talk where it is shown that the precision of the slope estimator in regression can deteriorate when additional information is used to estimate its value. (This is joint work with Eva Petkova (NYU), Todd Ogden (Columbia), Zhe Su (NYU), and Ron Christensen (U. of N. Mexico).)

Math Seminars
Development of Microscale Biomedical Assays
Stephanie McCalla - Department of Chemical and Biological Engineering, MSU
When: Thursday, November 06, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This talk will focus on two new microscale techniques to detect and quantify clinically relevant molecules for two different biomedical assays. The first technique harnesses previously unused information in epifluorescent images of 3D cellular constructs to calculate the penetration of a model pharmaceutical into tissue; information that is indicative of the absorption, distribution, and excretion of clinically important drugs. This high-throughput assay is used to characterize the response of multidrug resistant protein 1 (MDR1) expressing ovarian cancer cells to multiple MDR1 inhibitors. The second technique uses large arrays of small volume wells that can be split and recombined within the platform. Each well contains an average of less than one molecule, allowing amplification and subsequent detection of single molecules in each well. This creates a digital (yes/no) readout of molecule concentration. This method was applied to study an isothermal HIV RNA amplification reaction, which can be used to detect and quantify small quantities of RNA.
Calling Models Wrong for the Wrong Reasons
Thaddeus Tarpey - Department of Mathematics and Statistics, Wright State University
When: Wednesday, November 05, 2014 04:10PM to 05:00PM
Where: Procrastinator Theater
Details: Perhaps the best known quote from statistics is all models are wrong, some are useful by George Box (1919-2013). Although useful, this quote can lead one to label a perfectly good model as wrong and hence defective. A model is simply an approximation to the truth and it usually does not make sense to call an approximation wrong. In this talk, examples are provided where models are called wrong due to misconceptions about the meaning of the parameters that define the model. Examples are also provided of models that appear useful but can actually lead to incorrect conclusions.

An introduction to the Ellis semigroup
Marcy Barge - Department of Mathematical Sciences, MSU
When: Monday, November 03, 2014 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The Ellis semigroup is an invariant attached to a topological dynamical system - it's particularly effective as a way of encoding recurrence properties of minimal systems. I'll calculate the semigroup for some simple systems and present the first (to my knowledge) complete description of the semigroup for a system that is not almost automorphic.

Challenges and Opportunities for Modeling of Cartilage and Osteoarthritis
Ron June - Department of Mechanical Engineering, MSU
When: Thursday, October 30, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Cartilage is a multi-phasic soft material that lines the surfaces of joints such as the knee and the hip. Cartilage-on-cartilage friction is extremely low, and healthy cartilage can withstand decades of wear in a loading environment with stresses as large as 20,000 PSI. This seminar will focus on opportunities for modeling of cartilage and osteoarthritis. Cartilage exhibits nonlinear viscoelastic mechanical behavior. Experimental data and recent modeling approaches offer the potential to both improve prediction of mechanical behavior and test the relevance of novel mechanisms of cartilage mechanical behavior. The anatomy of the joints presents a challenge for delivering therapeutic compounds to the joint, and modeling transport to cartilage has the potential to enable design optimization of therapeutics. Finally, cartilage changes its biology in response to mechanical loads. Such as walking and running. Using advanced
techniques from analytical chemistry, it is possible to quantify these changes in high dimensional space. Development of a model to predict biological changes in response to load may provide a foundation for a true systems understanding of cartilage mechanobiology.

Math Seminars
The Tiling Space Associated with a Substitution
Hannah Bergren - Department of Mathematical Sciences, MSU
When: Monday, October 27, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk we will explore a dynamical property of the tiling space associated with a substitution by using 2-dimensional strands. We will develop some theory on the strand space and after we refine this space we will see that it is minimal under translation.

Math Seminars
Fuel Cell and Stack Degradation Modeling
Steve Shaw - Department of Electrical Engineering, MSU
When: Thursday, October 23, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The presentation will summarize a decade of experimental work with fuel cells and stack systems, culminating in our hypothesis on cell / stack interactions and degradation. With these observations and hypothesis in mind, the limitations of making inferences about system behavior in the presence of large model uncertainties will be considered in the context of a simple but unrelated nonlinear dynamic system. Returning to the problem, important physical effects in cells and stacks will be reviewed and modeled, salient features of the Modelica standard will be presented, and a preliminary Modelica model of a unit cell presented. The talk will conclude by speculating on a roadmap for research to address outstanding questions, including opportunities for interdisciplinary collaboration in the design and control of fuel cell and related energy systems.

Math Seminars
Adaptive Cluster Sampling
John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, October 21, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: With an adaptive sampling scheme the procedure for selecting units to include in a sample may depend on values of the variable of interest as it is observed during the implementation of the survey. That is, the sampling protocol is "adapted" the data. Adaptive cluster sampling (ACS) is a specific type of an adaptive sampling scheme.
Unlike classical sampling plans (such as simple random or stratified random sampling), ACS operates under the rule that if an observed value of a sampling unit satisfies some condition of interest C, then additional units in a researcher-defined neighborhood are adaptively added to the sample. Then, if any of the additional units satisfy C, units in their corresponding neighborhoods are added to the sample as well. This adaptive process continues until no additional units satisfying C are encountered. The primary application of ACS is when sampling from populations whose members are found in spatially-aggregated clusters (for example, herds of animals, schools of fish, nesting birds ...), and the goal is to estimate a population total or density. This talk will provide an introduction to ACS, including estimation methods and extensions that address common sampling problems.

Math Seminars
A Grab Bag of Complex Dynamics
Joe Manlove - Department of Mathematical Sciences, MSU
When: Monday, October 20, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk we'll explore some cool pictures and the intuition behind several major results. We'll wave our hands at some basics and then our arms at the big theorems. Those big items discussed will include the classification theorem, the no wandering domains theorem, the Fatou-Shishikura inequality, and the Douady Conjecture. There will also be discussion of current research directions and algorithms for generating pictures.

Math Seminars
Flux in Human Chondrocyte Central Energy Metabolism in Response to Applied Compression
Daniel Salinas - Department of Computer Science, MSU
When: Thursday, October 16, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Physical activity has been demonstrated to be strongly linked to joint health. Chondrocytes are the sole cell type of articular cartilage. We hypothesized that mechanical loading (such as physical activity) stimulates chondrocytes to produce materials used in its extracellular matrix, particularly collagen types II and VI. Examining the pathways of central energy metabolism (CEM) provides key insight into whether a cell has shifted to producing more collagen since a subset of the reactions in CEM are used to produce collagen precursors. Thus our hypothesis is that this shift should be reflected in reaction rates of chondrocyte cells when they are compressed. We approximated the rates applying metabolic flux analysis (MFA) to a set of measurements of the concentrations of metabolites over time. Solving the linear system $Sx = b$, where $S$ is the stoichiometric matrix representing CEM and $b$ is the amount of metabolite produced per unit time yields $x$, a vector of reaction rates that produces $b$. We used the Moore-Penrose pseudoinverse of $S$ to solve the system since it was
inconsistent and underdetermined. The fluxes for the first 15 minutes were consistent with increased collagen production, unlike the ones for 30.

Math Seminars
Arts and Crafts in the Mathematics for K-8 Teachers Courses: Why does the Moon have Phases?
Danielle Pettry - Department of Mathematical Sciences, MSU
When: Monday, October 13, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: You may often walk by the mathematics education classroom in Wilson Hall and wonder why the students are sitting in groups and seemingly working on arts and crafts. It is common to see scissors, tape, and manipulatives being passed around the room, but these items are being used to learn about the mathematics they will need to teach. In one particular lesson in M 133 (the second course in the three course sequence of Mathematics for K-8 Teachers), the students build "moon pops" and learn about the phases of the moon. While this may seem like an astronomy lesson, the focus is on the Geometry behind the moon phases. Join us for this hands-on approach to learn about the Geometry behind why the moon has phases, and even more about the lunar eclipse that we saw last week!

Math Seminars
Analysis of the effects of the division of labor in microbial communities
Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, October 09, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Microbial communities are commonly observed in nature. It has been observed that such communities seem to be more efficient in use of resources as well as more robust, than monocultures. We study a simple synthetic microbial community, where two metabolic pathways of E.coli are split into two different strains of E.coli. Thorough analysis of a model shows that the total biomass of the consortium must be smaller than that of monoculture under very general conditions on the shape of the growth curves. This contradicts the experimental observations. We discuss what adaptations could have occurred in the members of the consortium to explain this discrepancy.

Math Seminars
Conformal dimension and graph approximation of fractals
Lukas Geyer - Department of Mathematical Sciences, MSU
When: Monday, October 06, 2014 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The conformal dimension of a metric space is a quasisymmetrically invariant version of Hausdorff dimension. It has proved to be very useful in studying ideal
boundaries of negatively curved spaces. In the first half of the talk I will try to explain what conformal dimension is, and give a short overview of some results and open questions about conformal dimension of a few well-known fractals, like the standard Cantor set, Sierpinski gasket, and Sierpinski carpet. In the second half of the talk I will describe an explicit (if not easy to implement) way to calculate conformal dimensions of fractals from a sequence of graph approximations, based on recent work of Matias Piaggio, Stephen Keith, and Bruce Kleiner. This is partly joint work with Rob Malo.

Math Seminars

An Introduction to Knitting R and LaTeX.

Chris Barbour - Department of Mathematical Sciences, MSU

When: Monday, October 06, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144

Details: Rstudio and the package knitR are powerful tools to incorporate the flexible statistical computing power of R and the reporting tools of LaTeX. In this talk I will go over the basics of creating an .rnw file that can bring together R code (included in chunks), its output, and the resulting conclusions together into a pdf. This talk will benefit those who no little to nothing about knitting, but even those that are experienced knitters may learn a thing or two and can bring their experiences and what they have found useful to the talk. If anyone wants to download the software beforehand visit the following link (Jim R-C's STAT 505 webpage):

http://www.math.montana.edu/~jimrc/classes/stat505/index.html

Math Seminars

Numerical methods for gas-liquid multiphase flows with a focus on fuel atomization systems

Mark Owkes - Department of Mechanical Engineering, MSU

When: Thursday, October 02, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144

Details: In response to climate change and society’s continuously growing energy demand, combustion systems are being redesigned to be more fuel efficient while reducing pollutant emissions. One of the most intriguing (and difficult) aspects in improving our understanding of combustion is the breakup of liquid jets into fuel droplets via atomization. Atomization has a direct effect on combustion efficiency and pollutant formation, yet a fundamental understanding of the complex process is absent. Laboratory experiments are inherently difficult to conduct because atomizing jets produce a large number of opaque droplets that hinder optical access to the breakup dynamics. With increasing computational resources and advancements in numerical methods, computational fluid dynamics (CFD) has emerged as a promising tool to investigate the fundamental nature of atomization. In this presentation, I will show how CFD can be used to simulate atomization in realistic configurations. These simulations are challenging to perform for many reasons; most notably is the presence of a large discontinuity in density at the gas-liquid interface. This challenge is met by using a novel
numerical method that ensures discrete conservation of mass and momentum. The method is based on the geometric volume-of-fluid (VOF) scheme of Owkes and Desjardins (JCP 2013, under review) which is used to consistently transport both the gas-liquid interface and momentum in the vicinity of the interface. An additional challenge for numerical methods is the calculation of the interface curvature which is needed to compute the surface tension force. This challenge is met by using a height function methodology that has been extended to be robust for under resolved interface features. Details of the numerical methodologies are provided in this talk followed by an example of a realistic atomization problem.

Math Seminars

Determining causal networks in nonlinear dynamical systems
Bree Cummins, Tomas Gedeon, Kelly Spendlove - Department of Mathematical Sciences, MSU
When: Monday, September 29, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We would like to be able to deduce the causal, or mechanistic, relationships between quantities in the environment. For example, it would be useful to know if changes in the climate are causing changes in things like species populations, species biodiversity, or disease incidence. In general, the best measure of causality involves perturbing one variable in a system, and then tracking the propagation of perturbation into other variables. In many cases, such as large, complex, and delicate dynamical structures like ecosystems, we cannot experimentally perturb one variable in the system. We instead must resort to data analysis to discover hypotheses for causal relationships. There are many techniques that attempt to do this through the analysis of time series, which are simply measurements taken at (usually uniform) time intervals. I will discuss one technique that is appropriate for analyzing deterministic nonlinear systems of ordinary differential equations that are weakly coupled and that exist on an attractor. By this I mean that the variables are not completely synchronized - they maintain some independent dynamics - and they have an invariant character over time, but may be unpredictable due to the existence of a chaotic attractor.

Math Seminars

Combining a Continuum Model with a Statistical Approach to Characterize Trade-offs Among Elongation Rate, Number and Duration Time of Ubiquitous Pauses on the rrn Operon
Lisa Davis - Department of Mathematical Sciences, MSU
When: Thursday, September 25, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We discuss a continuum model for the transcription process in the rrn Operon. Fast growth in bacteria requires high production of proteins. To accomplish this, bacteria need to make many ribosomes, the key part of which is a copy of an rrn gene.
It has been experimentally observed that while copying the rrn gene during transcription, RNA polymerases experience many short pauses that can lead to traffic jams on the DNA strand. We consider a continuum model and then introduce the element of stochasticity through the temporal and spatial location of the pauses as well as their average duration time. Combining numerical simulations of the model with a statistical analysis, we study the limitations that the traffic jams and the transcriptional pauses impose on elongation speed and the number of competed transcriptions. Results suggest that in order to accomplish the average speed observed experimentally, the RNA polymerases must be modified in a way that allows them to pause less, and for a shorter time. In addition, more pauses as well as longer pauses cause higher variability in the average time it takes to transcribe the gene: some polymerases finish faster, some slower. The statistical analysis attempts to quantify the tradeoffs that must be made among the various parameters in order to maintain an average transcription time that is consistent with data taken from the literature.

Math Seminars
Recent progress in planar geometry
Kevin Wildrick - Department of Mathematical Sciences, MSU
When: Monday, September 22, 2014 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The geometry of the plane is very special, and in many ways much simpler than that of higher dimensional Euclidean space. There are no "wild" phenomena (thanks to the strong form of the Jordan Curve Theorem, the Schnflies theorem), and there is a vast supply of conformal mappings (thanks to the Riemann mapping theorem). This gives us hope to solve problems in the plane that are unapproachable in higher dimensions. We will discuss a class of such problems - and I hope to convince you that despite the many tools and special features available in the plane, there are still very hard problems left to solve.

Math Seminars
An introduction to the Heisenberg group
Kevin Wildrick - Department of Mathematical Sciences, MSU
When: Monday, September 22, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The Heisenberg group is a non-commutative group structure on Euclidean space that arises naturally in many different contexts: quantum mechanics (most famously), optimal control theory (as in Prof. Ayala’s talk two weeks ago), algebra (as the group of upper triangular matrices with ones on the diagonal), symplectic and contact geometry (don't worry about these), hyperbolic geometry and rigidity theory (ditto), and even theoretical computer science (?!). We will give some basic definitions and see how they lead naturally to "fractal" geometry.
Math Seminars
Bistability and the emergence of oscillations in repressilator models with quorum sensing
Mark Pernarowski - Department of Mathematical Sciences, MSU
When: Thursday, September 18, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Metabolic pathways of E. coli have been genetically engineered to exhibit cyclic expression patterns (Ellowitz et al 2000). Repressillator models for such networks include mRNA and transcribed protein concentrations as well as (extracellular) autoinducer concentrations which drive the various quorum sensing behaviors. We present a unified analytical approach for predicting monostability and bistability within the networks. The type of stability depends largely on which protein the autoinducer positively feeds back to. When one can prove monostability, synchronous network stability is independent of the number of cells and can only change via Hopf bifurcations. In the bistable case, equilibria existence is explicit but more complex.

Math Seminars
LaTeX Talk
Eric Fink - Department of Mathematical Sciences, MSU
When: Monday, September 15, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: LaTeX is the most common language used to create technical and mathematical documents, with applications ranging from preparing a thesis to making a quiz look fancy. The seminar will be especially beneficial for those just starting with LaTeX, but even veterans should be able to pick up some tips and tricks. The exact topics covered will depend on the experience of the audience that attends.

Math Seminars
Some Geometry from Those Two-wheeled Airport Bags
David Ayala - Department of Mathematical Sciences, MSU
When: Monday, September 08, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I'll bring two pieces of luggage to this talk. We will make a number of physically obvious observations about the motions of these objects. We will invent some mathematics that supports these observations -- some infinitesimal geometry. I will emphasize the process we will undergo: develop intuitions, make definitions to address these, answer harder questions offered through these definitions.

Math Seminars
Teacher Learning and the Practice of Teaching
Mary Alice Carlson - Department of Mathematical Sciences, MSU
Details: Recent work in mathematics teacher education has led to the identification of mathematical tasks of teaching and inquiry into the knowledge base needed for carrying the tasks out in classrooms (e.g. Ball, Thames & Phelps, 2008). Drawing on data from my analysis of mathematics teaching in elementary schools, I propose that teachers must also engage in tasks that support their own learning in practice. I discuss these tasks of learning while teaching and explore their implications for teaching practice, math coaching, and teacher education.

Math Seminars
Towards more active (and consistent) learning in STAT 217
Mark Greenwood - Department of Mathematical Sciences, MSU
When: Friday, June 20, 2014 09:00AM to 10:00AM
Where: Wilson Hall 1-144
Details: STAT 217 is a second semester introductory statistics course, currently serving 10 sections and nearly 300 students per year at MSU. It has undergone major changes over the last decade with the introduction and ever-deeper integration of the statistical software R into the course. In Fall 2013, a new textbook was developed (Greenwood and Banner, 2014) and randomization techniques were employed in the course for the first time. The past, present, and future of the course will be discussed. Results of data collected from students in Fall 2013 will also be summarized. Of particular interest, higher levels of reading the book were related to increased knowledge gains in students.

Math Seminars
Building a Community of All Math Teachers and Professionalizing Math Teaching at All Levels
Dr. Sybilla Beckmann - University of Georgia
When: Monday, May 12, 2014 04:10PM to 05:00PM
Where: Procrastinator Theater
Details: How do we enact a vision of mathematics teaching in which mathematical reasoning and sense-making play a central role? How do we make mathematics teaching a strong and vibrant profession? In this presentation Dr. Beckmann will argue that widespread improvement in mathematics teaching and learning requires a community of mathematics teachers, from Pre-kindergarten through the college level, who discuss their work in depth, build on each other’s ideas, and work towards a shared view of excellent mathematics teaching. Further, she will argue that opportunities to gain peer recognition and high standing within the community are more likely to be important drivers of excellence in mathematics teaching than are external measures of assessment or oversight. So to professionalize mathematics teaching, we should find ways to communicate across all levels of our discipline, and ways to vet and extend
each other’s work, as in the sciences. This talk is part of the MSU College of Letters & Science Distinguished Speaker Series and the Mathematical Sciences Colloquium Series

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**Math Seminars**

**Approximating C^0 foliations**

William Kazez - University of Georgia

When: **Monday, May 12, 2014 02:10PM to 03:00PM**

Where: Wilson Hall 1-144

Details: Taut foliations and tight contact structures are important topological structures on 3-manifolds that are at opposite ends of the spectrum in the study of 2-plane distributions. One is integrable everywhere, the other is integrable nowhere. Eliashberg and Thurston have shown that they are closely related; in fact, every sufficiently smooth taut foliation can be perturbed to a tight contact structure. In joint work with Rachel Roberts, we show that the smoothness assumptions on the foliation can be removed. This allows the approximation theorem to be applied to a wide range of recent constructions of (non-smooth) foliations.

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**Math Seminars**

**Rational Numbers and the Common Core**

Roger Fischer - Department of Mathematical Sciences, MSU

When: **Friday, May 02, 2014 01:10PM to 02:00PM**

Where: Wilson Hall 1-144

Details: This presents results from Roger Fischer's dissertation results. Middle school teachers were interviewed and observed in classroom settings, and this talk makes recommendations for how to prepare middle school teachers to understand rational number concepts as they appear in middle school classrooms.

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**Math Seminars**

**Putting Professional Development into Practice: How Teachers Process, Implement, and Disseminate Specialized Knowledge of Standards**

Kacey Marie Diemert - Department of Mathematical Sciences, MSU

When: **Thursday, May 01, 2014 10:00AM to 11:00AM**

Where: Wilson Hall Hurst Conference Room

Details: This study provides a detailed account of how teachers disseminate knowledge of the Common Core State Standards for Mathematics to peers through school-based professional development. The design was a qualitative case study of four school district-based cohorts of middle grades teachers who led professional development in their schools and districts. Data was collected using interviews and school-based observations as each cohort was followed for eight months. The findings lead to a suggested framework for how teachers facilitate school-based professional
development after having received professional development themselves, in a teach-the-teachers model. Data analysis produced a variety of results. Among other challenges, a lack of communication among school leaders created a barrier to dissemination. Although challenges were present, every cohort was able to facilitate effective professional development for their peers. The cohort members found that celebration of small successes during the process helped them persevere. The quality and depth of knowledge shared at the school level was diluted compared to the original presentation of the material, especially regarding the Mathematical Practices. This study provides encouraging results for future use of the teach-the-teachers model, which can be improved to maintain the quality of teacher-led, school-based professional development.

Math Seminars
Poincaré Inequalities on Non-Self-Similar Sierpinski Carpets
Dr. Kevin Wildrick - University of Fribourg, Switzerland
When: Friday, April 25, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Poincaré inequalities are generalizations of the fundamental theorem of calculus to the setting of metric measure spaces. The validity of a Poincaré inequality for a given metric measure space has geometric and analytic consequences - under reasonable assumptions, the validity of a suitable Poincaré inequality implies that a large number of results from Euclidean analysis are also valid. However, there are still relatively few classes of examples of metric measure spaces for which such a Poincaré inequality is known to hold. After introducing the basic definitions and ideas, we will discuss a new family of such examples based on the Sierpinski carpet.

Math Seminars
Challenging a Teacher’s Perceptions of Mathematical Smartness through Reflection on Students' Thinking
Megan Wickstrom - Illinois State University and Department of Mathematical Sciences, MSU
When: Friday, April 25, 2014 10:00AM to 10:50AM
Where: Wilson Hall Hurst Room
Details: Creating equitable opportunities for all students to learn and succeed mathematically has been a key focus of mathematics education across several decades. Central to student achievement is students' mathematical identity and their feelings of success during instruction. Researchers (i.e., Boaler & Staples, 2008) have shown that teachers can be particularly powerful in shaping students' beliefs, feelings of success, and achievement, but few studies have investigated how teachers frame what it means to be successful or "smart" in mathematics. Through the social construct of smartness (Hatt, 2009) and the learning perspectives of incremental and entity theories (Blackwell, Trzesnieski, and Dweck, 2007; Yeager and Dweck, 2012), I examine how one teacher, Mrs. Purl, conceptualized what it meant to be "smart" in mathematics and
how this perception changed slowly over time through repeated examination and discussion of individual students' thinking. As Mrs. Purl came to know her students at a personal level, she began to see that her perceptions were not always accurate and warranted reexamination.

Math Seminars

Nano and Biomechanics in Tissue Engineering
Dr. Jinju (Vicky) Chen - School of Mechanical & System Engineering, Newcastle University, UK
When: Thursday, April 24, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Cell mechanics and cell-materials interactions are important for disease diagnosis and tissue engineering. The synergistic combination of computational modelling and experimental approaches allows exploring phenomena in cell mechanics and mechanotransduction that are not easily accessible with experimental methods alone. The first part of talk is focused on using a hybrid modelling nanomechanical testing approach to determine the viscoelastic properties of the living cells, which are useful to quantify the biomechanical effects of drug treatment, diseases and aging. The second part will cover how cell respond to two-dimensional and three-dimensional micromechanical environment, which will help better understanding of mechanotransduction and provide valuable guide for optimizing scaffold design. The third part will cover the nanomechanics of the tissue engineered bone, which will help evaluating the biomaterials. E-mail: Jinju.chen@ncl.ac.uk; http://www.ncl.ac.uk/mech/staff/profile/jinju.chen

Math Seminars

Statistical Inference by Crowd-Sourcing
Dr. Dianne Cook - Department of Statistics and Statistical Laboratory, Iowa State University
When: Monday, April 21, 2014 04:10PM to 05:00PM
Where: Lewis Hall 304
Details: Plots of data often provoke the response is what we see really there. In this talk we will discuss ways to give visual statistical methods an inferential framework. Statistical significance of graphical discoveries is measured by having the human viewer compare the plot of the real data set with collections of plots of null data sets: plots take on the role of test statistics, and human cognition the role of statistical tests, in a process modeled after the lineup, popular from criminal legal procedures. This is a simple but rigorous protocol that provides valid inference, yielding p-values and estimates of the test power, for graphical findings. Amazons Mechanical Turk is used to implement the lineup protocol and crowd-source the inference. Turk is a resource where people are employed to do tasks that are difficult for a computer, in this case, evaluating structure in plots of data. With a suite of experiments, the lineup protocol was run head-to-head against the equivalent conventional test, yielding results that mirror those
produced by classical inference. This talk will describe these results, and show how the lineup protocol is used for assessing graphical findings and designing good data plots.

Math Seminars
Using Class Discussions in a Math Class
Diana Schepens and Hannah Bergren - Department of Mathematical Sciences, MSU
When: Monday, April 21, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: What is there to discuss about math? So much!!! Diana Schepens and Hannah Bergren will describe how they used D2L to get students to discuss applications for the math they learned in class. They will also present results of a survey given to classes with discussions and classes without discussions. Come see how you can make your math class more interesting! This is applicable to TA's of all levels and subjects!

Math Seminars
Biofilms and Biomineralization: Estimating Urea Metabolism in a Bacterial Community
Ben Jackson - Department of Mathematical Sciences, MSU
When: Thursday, April 17, 2014 04:10PM to 05:00PM
Where: ROBERTS 321
Details: (NOTE DIFFERENT TIME AND PLACE) microbially induced calcite precipitation (MICP) is a potentially useful mechanism in the formation of biocement, which has applications in soil stabilization, carbon sequestration, and concrete remediation. MICP can occur via ureolysis, a process in which bacteria break down urea through a series of chemical reactions which raise the pH of the system, allowing for solid calcium carbonate formation when calcium ions are present. MICP takes place in complex systems which often contain communities of bacteria adhering to surfaces -- biofilms -- in which the rates of ureolysis are not well known. We seek to characterize these rates in a biofilm system by combining data from tube reactor experiments conducted at Montana State University's Center for Biofilm Engineering and mathematical modeling. We use a standard diffusion-advection-reaction equation coupled with a 1D Fickian biofilm model to describe the transport and kinetics of urea in a flow channel containing biofilm. Difficulty finding consistent rates using measured biofilm height profiles and urea concentrations from experiments lead to an alternative approach using synthetic data sets for model testing. In this approach, we use basic Bayesian methods to estimate the Michaelis-Menten kinetic rates of urea degradation in biofilm. Our results demonstrate the feasibility of this method for real data and provide a guide for ongoing and future lab work.

Other
Candidate Perspectives on the Industry Job Search
Dr. Sydney Akapame and Ms. Alyssa Peck - Department of Mathematical Sciences, MSU
When: Monday, April 14, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-115
Details: Dr. Sydney Akapame and Ms. Alyssa Peck have recently and successfully navigated the industry job search process, and they have volunteered their time to share their insights with all of you. This will be mostly a Q&A session, but Sydney and Alyssa will each share a brief overview of their job search experiences. They will give particulars about job applications, phone interviews, on site interviews, job offers and their strategies for keeping track of all of it and being successful at it! Come prepared to ask questions about any aspect of the process.

Math Seminars
Surprise Talks
Tamra Heberling, Dan Kanewske, and Ben Jackson - Department of Mathematical Sciences, MSU
When: Monday, April 14, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Tamra, Dan, and Ben will be giving 15 minute presentations this afternoon. They should be short and sweet. The talks will cover a range of applied topics and are at a very understandable level.

Math Seminars
Exploring the Axioms of an Abstract Tiling Action
Hannah Bergren - Department of Mathematical Sciences, MSU
When: Friday, April 11, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I will discuss a set of axioms (and the requisite theorems) that characterize tiling actions among all \( \mathbb{R}^d \) actions on compact metric spaces. I will provide examples of actions that satisfy the axioms and examples that do not satisfy the axioms.

Math Seminars
Application of Topology to Granular Materials
Dr. Miroslav Kramar - Department of Mathematics, Rutgers University
When: Thursday, April 10, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The state of granular media can be represented by a Persistence diagram. This representation provides an interesting insight into the physical properties of the granular media as demonstrated on a system undergoing compression. Time evolution of the system can be seen as a curve in the space of persistence diagrams. Different notions of distance in this space provide a useful tool
for understanding the dynamic. In particular the compressed systems (viewed as a discrete dynamical system) exhibit a few different regimes where dynamics changes from fast to slow. Dependence of the system on its previous state is strongly affected by the sampling rate. We conclude the talk by addressing the problem of determining the “appropriate” sampling rate.

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**Math Seminars**

**Inflations of Self-Affine Tilings are Integral Perron**
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU

*When: Friday, April 04, 2014 03:10PM to 04:00PM*  
*Where: Wilson Hall 1-144*  
*Details:*
Self-affine repetitive tilings can be thought of as mathematical models of quasicrystals. I will chat about a theorem linking such tilings with algebraic number theory. This is a first decisive step towards classification of all (self-affine) quasicrystals.

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**Math Seminars**

**Modeling Stratified Growth of Biofilms**
Dr. Tianyu Zhang - Department of Mathematical Sciences, MSU

*When: Thursday, April 03, 2014 03:10PM to 04:00PM*  
*Where: Wilson Hall 1-144*  
*Details:*
It is well known that reaction-diffusion equations that account for microscale concentration gradients within the biofilm are at the core of modeling the growth of biofilms. In this talk, we further explore this idea by applying the reaction-diffusion type model to two specific cases: (i) the growth rate of a Klebsiella pneumoniae biofilm, (ii) the stratified growth in a three species wound biofilm consisting P. aeruginosa, S. aureus, and C. perfringens. Comparison between model simulations and experimental results will be given. We will also briefly touch the idea of modeling stochastic features of gene expression within biofilms.

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**Math Seminars**

**Spatiotemporal Temperature Distribution and Cell Death in Response to Extracellular Hyperthermia Induced by Gold Nanorods**
Dr. Jeff Heys - Department of Chemical and Biological Engineering, MSU

*When: Thursday, March 27, 2014 03:10PM to 04:00PM*  
*Where: Wilson Hall 1-144*  
*Details:*
This talk will present a model of heat transport and hyperthermal cell death associated with the use of gold nanorods for thermally degrading and killing cancer cells. This model has recently been extended for use in simulating laser tissue welding, also using gold nanorods. This extension has necessitated the transition to a new
Other

Candidate Perspectives on the Academic Job Search
Kacey Diemert and Roger Fischer - Department of Mathematical Sciences, MSU
When: Tuesday, March 25, 2014 02:10PM to 03:00PM
Where: Wilson Hall 2-244
Details: Kacey Diemert and Roger Fischer have recently and successfully navigated the academic job search process, and they have volunteered their time to share their insights with all of you. This will be mostly a Q&A session, but Kacey and Roger will each share a brief overview of their job search experiences. They will give particulars about job applications, phone interviews, campus interviews, job offers and their strategies for keeping track of all of it! Come prepared to ask questions about any aspect of the process.

Math Seminars

Quasisymmetric Modification of the Sierpinski Carpet
Rob Malo - Department of Mathematical Sciences, MSU
When: Friday, March 21, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Jun Kigami released a preprint in which he shows an upper bound on the conformal dimension of the Sierpinski Carpet. A brief introduction to box-counting dimension, Hausdorff dimension, and conformal dimension will be given. We will then look at a result of Kigami’s regarding conditions for metrics being quasisymmetrically equivalent, and finish with Kigami’s construction of a metric on the Sierpinski Carpet which gives an upper bound for the conformal dimension. Expect a large number of pictures, and more hand waving than a beauty queen in a homecoming parade.

Math Seminars

Echocardiographic Particle Image Velocimetry Data Assimilation with Least-Square Finite Element Methods
Prathish Kumar Rajaraman - Department of Chemical and Biological Engineering, MSU
When: Thursday, March 20, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Recent advancements in the field of echocardiography have introduced various methods to image blood flow in the heart [1]. Our particular interest is in the left ventricle (LV) of the heart, which pumps oxygenated blood from the lungs out through the aorta. One method for imaging blood flow is injecting FDA-approved micro-bubbles into the left ventricle, and then, using the motion of the micro-bubbles and the frame rate of the
ultrasound scan (i.e., using Particle Imagining Velocimetry or echo-PIV), the blood velocity can be calculated [2]. In addition to blood velocity, echocardiologists are also interested in calculating pressure gradients and other flow properties, but this is not currently possible because the velocity data obtained is two-dimensional and noisy. Our goal is to assimilate two-dimensional velocity data from micro-bubble ultrasound experiments into a three-dimensional computer model. In order to achieve this objective a numerical method is needed that can approximate the solution of a system of differential equation and assimilate an arbitrary number of noisy experimental data points at arbitrary locations within the domain of interests to provide a `most probable' approximate solution that is properly influenced by the experimental data [2]. Our progress in this particular area over the past few years is to develop a novel data assimilation strategy for combing two-dimensional noisy echo-PIV data in a very flexible and consistent manner for numerically approximating the solution to the Navier-Stokes equation. The approximate solution is calculated using the weighted least-squares finite element method (LSFEM) and this method has been shown to be very flexible when assimilating noisy echo-PIV data [1]. This flexibility is due to the ability of the method to weight the more accurate echo-PIV data and use a lower weight for noisy data. This LSFEM method for assimilating echo-PIV data have been used to predict the 3-dimensional LV blood flow. Results from the current method clearly show the impact of matching the echo-PIV data weakly, and visualize the three-dimensional velocity field.


Math Seminars

Write Quizzes and Tests in Latex

Joe Manlove - Department of Mathematical Sciences, MSU

When: Monday, March 17, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144

Details: The key to pretty quizzes and tests is a working knowledge of Latex. In this hands-on talk we'll be typesetting quizzes you bring. This talk is geared towards those with no knowledge of Latex, but everyone is encouraged to come (people with Tex skills can help others). Everyone will leave with a template for quizzes and tests and an increased knowledge of Latex. You'll also probably finish typesetting the quiz you bring. Bring a quiz you'd like to practice on.

Math Seminars

Niche Character in a Temporally Varying Environment

Shane Nowack - Department of Mathematical Sciences, MSU

When: Friday, March 07, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The magnitude and extent of variation that an organism's niche inherits from its environment was investigated using both mathematical and microbiological approaches. A constrained optimization procedure was applied to a temporally varying chemostat model to predict an organism's optimal fitness response, with respect to different time scales of environmental variation. Representatives of the predominant organisms inhabiting the microbial mats found in the effluent channels of Mushroom Spring, Yellowstone National Park, oxygenic phototrophs belonging to the genus Synechococcus, were cultivated and their ecological adaptations were characterized in the laboratory. To compare the results of the mathematical and microbiological approaches, environmental light data that were collected in the vicinity of Mushroom Spring were incorporated into the mathematical model. The optimal fundamental light niche that was predicted by the model and the measured light niche of one of the cultivated strains exhibited qualitative similarities. Collectively, this interdisciplinary approach has led to the identification of several environmental characteristics that are hypothesized to be important in determining niche structure.

Math Seminars

Computation and Application of the Symmetric Matrix Decomposition
Dr. Nicomedes Alonso - Department of Mathematical Sciences, MSU
When: Thursday, March 06, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Originally discovered by Ferdinand Georg Frobenius in 1910 and rediscovered by Olga Taussky-Todd and Hans Zassenhaus several decades later, the Frobenius-Taussky-Zassenhaus Theorem states that every square matrix is the product of two symmetric matrices. We will outline Olga’s proof of the equivalent result that every square matrix is symmetrically similar to its transpose. Moreover, we’ll show how to construct a linear isomorphism between the solution set of a linear system of equations and the centralizer ring of a matrix, to prove that for any non-derogatory matrix, A, every nonsingular matrix transforming A into its transpose is symmetric. We will then show how the symmetric matrix decomposition may easily be computed by using the Kronecker product and the concatenation operator to solve a large sparse system. Finally, we will apply the principal axis theorem to indicate how any real square matrix is the product of two anisotropic scalings.

Math Seminars

Mapping Gene Expression in a Bacillus subtilis Biofilm
Dr. James Wilking - Department of Chemical and Biological Engineering, MSU
When: Thursday, February 27, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Many bacteria on earth live in surface-attached communities known as biofilms. Gene expression in a biofilm is typically varied, resulting in a variety of phenotypes within a single film. These phenotypes play a critical role in biofilm physiology and largely determine the physical properties of the film. I will present a noninvasive
technique for measuring transition rates between phenotypes in a growing biofilm. We use time-resolved, wide-field fluorescence microscopy to image triple labeled fluorescent Bacillus subtilis colonies grown on agar, and infer transition rates from the resulting spatiotemporal maps of gene expression. Moreover, we correlate these transition rate measurements with local measurements of nutrient concentration to determine the influence of extracellular signals on gene expression.

Math Seminars

Modeling the Direct and Indirect Effect of a Non-Host on Parasite Transmission
Tamra Heberling - Department of Mathematical Sciences, MSU
When: Thursday, February 20, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We present a mathematical model of the Host/Parasite system describing the Myxobolus Cerebralis parasite and the Tubifex worms that cause whirling disease in trout. A Non-Host worm is incorporated which competes with the Host producing a negative effect but also eliminates the parasite spores causing a positive, indirect effect. A second model that incorporates a reservoir for time delay will be discussed.

Other

Topics in Career Building
Dr. Carina Beck - Director of the Career, Internship & Student Employment Services, MSU
When: Wednesday, February 12, 2014 03:00PM to 04:30PM
Where: Wilson Hall 2-244
Details: Dr. Beck will discuss a wide variety of topics to help you to build your future career possibilities. The list of topics includes: preparing to enter the job market, where to apply, building a resume and/or curriculum vitae and interview tactics.

Math Seminars

A New Gene Regulation Modeling Platform: Dynamics Database for Switching Networks
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, February 06, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Experimental data on gene regulation and protein interaction is often very qualitative, with the only information available about pairwise interactions is the presence of either up-or down-regulation. Since majority of the parameters for any model in such a situation are not constrained by data, it is important to understand how different choices of parameters affect the dynamics and, therefore, the predictions of such a model. Continuous time Boolean networks, or switching networks, represent an
attractive platform for qualitative studies of gene regulation, since the dynamics at fixed parameters is relatively easily to compute. However, it is quite difficult to analytically understand how changes of parameters affect dynamics. Database for Dynamics is an excellent tool for studying these models, as it rigorously approximates global dynamics over a parameter space. The results obtained by this method provably capture the dynamics a predetermined spatial scale. We combine these two approaches to present a method to study switching networks over a parameter spaces. We apply our method to experimental data for cell cycle dynamics.

Math Seminars
The Influence of Dynamic and Interactive Technology on Middle, High, and Undergraduate Students Understanding of Rate of Change
Jenna Tague - Ohio State University
When: Tuesday, February 04, 2014 11:00AM to 11:50AM
Where: Wilson Hall 1-133
Details: My work examines the efficacy of an online interactive module on middle school, high school, and undergraduate students (enrolled in a differential equations course) evolving conceptions of the rate of change. This quantitative and qualitative study will provide a much needed picture of students understanding of rate of change at several stages in their educational experiences. Participants understanding of the rate of change is gauged using Zandiehs (1997) framework. The online module utilizes dynamic and interactive technology to address the three overarching aspects of rate of change as identified by Zandieh (1997): difference quotient, limit, and function. The results will add to the literature on students’ concept images of rate of change, how interactive technology may alter students’ concept images. Jenna Tague is a candidate for the open position in Mathematics Education. A reception will be held from 4 - 5 pm on Tuesday, February 4th in the Bradley Room.

Math Seminars
R and R-Studio
Michael Broome - Department of Mathematical Sciences, MSU
When: Monday, February 03, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: These open source programs are usually used for statistical computing and so are usually overlooked by the casual mathematician. I'll discuss the similarities to the popular MATLAB as well as the viability of using it as a complete replacement for that costly commercial program.

Math Seminars
Transport Phenomena Topics in Energy Systems
Dr. Ryan Anderson - Department of Chemical and Biological Engineering, MSU
When: Thursday, January 30, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This seminar will focus on the transport phenomena encountered in three energy-related systems: proton exchange membrane (PEM) fuel cells, high temperature thermal energy storage (TES), and phase change material (PCM) suspensions. PEM fuel cell modeling is a unique challenge as the system contains multiphase flows, electrochemical reaction, and multiple time and length scales. Thermal energy storage systems involve the coupling of fluid and solid heat transfer in a packed bed, materials whose thermophysical properties change greatly as a function of temperature, heat transfer axially and radially, and empirical formula for key parameters such as heat transfer coefficients. PCM suspensions can be utilized as heat transfer fluids, but the systems exhibit non-Newtonian behavior, shear migration, phase change, and subcooling. In each case, the system can be improved by better understanding the fundamental transport phenomena. Dr. Anderson’s lab collects experimental data on these systems and actively seeks out collaboration to model them.

Math Seminars
The Denjoy Example
Hannah Bergren - Department of Mathematical Sciences, MSU
When: Monday, January 27, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Hannah will be talking about an important example in Dynamics. She will show us that the Denjoy diffeomorphism on the circle is an example of an infinite minimal set under an expansive map that has topological dimension of zero.

Other
Active Learning with Clickers and Classroom Voting
Dr. Kelly Cline - Associate Professor of Mathematics & Astronomy, Carroll College, Helena, MT
When: Friday, January 24, 2014 11:00AM to 11:50AM
Where: Wilson Hall 1-134
Details: Classroom voting with clickers is a powerful way to create a highly interactive lesson and to engage students in discussions about mathematics. How do you organize voting to maximize student engagement and learning? What types of questions produce the most dramatic results and memorable discussions? How do you teach all the necessary topics, given the amount of time that classroom voting requires? What are the best ways to guide student discussions after a vote? This talk will report on what we’ve learned while conducting two NSF-funded studies of classroom voting in mathematics. Further, we have developed a free web-based library containing over 2,000 clicker questions designed for classroom voting in mathematics. This library includes questions for courses ranging from college algebra through calculus, statistics, linear algebra, and differential equations. Well explore how you can use the teacher’s edition of this collection, which contains comments and past voting results, in order to help you choose the most powerful and effective questions for your class.
Math Seminars

Marine Hydrokinetic Power: From Conception to Death
Dr. Erick Johnson - Mechanical and Industrial Engineering Department, MSU
When: Thursday, January 23, 2014 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Marine hydrokinetic (MHK) devices generate electricity from the current or wave motion of the water around them. As with many technologies, these devices are designed, tested, manufactured, and sold with the goal of being cost-competitive in comparison to their established competitors (in this case to other energy sources). However, as a nascent industry, there is no obvious device architecture that is best suited to the marine environment and capable of navigating new manufacture, infrastructure, operations & maintenance, and environmental considerations. Developers are in need of tools that can be leveraged to not only optimize device performance, but that can inform siting and array layout, impact upon the environment, and smart controls for efficiency and lifecycle prediction.

Math Seminars

Navigating the Research Terrain as a New Mathematics Educator
Dr. Rejoice Mudzimiri - University of Southern Mississippi
When: Thursday, December 12, 2013 11:00AM to 11:50AM
Where: Wilson Hall 1-133
Details: As a new mathematics educator with one year under my belt, this talk is meant to give an overview of how I have been navigating the research terrain. My dissertation was a case study which focused on examining the development of Technological Pedagogical Content Knowledge (TPACK) in secondary pre-service teachers who were concurrently enrolled in three courses: methods, mathematical modeling for teachers and practicum. Results showed varying degrees of growth in TPACK and I concluded that the development of TPACK in pre-service teachers was complex because there are a number of factors that are at play such as (a) prior experiences with technology, (b) mathematics background and (c) beliefs about the use of technology in mathematics instruction. Beyond my dissertation, I have had some interactions with TPACK experts to discuss some of my findings. Also, I have been involved with the development of three different research proposals and these will be part of my talk as well. Rejoice is a candidate for one of the open positions in mathematics education. Please join us for a reception in the Hurst Room at 2:30 on Thursday afternoon.

Math Seminars

Predictably Unpredictable: Responsive Teaching in the Primary Mathematics Classroom
Mary Alice Carlson - University of Nebraska, Lincoln
When: Wednesday, December 11, 2013 11:00AM to 11:50AM
Where: Wilson Hall 1-133
Details: The math education community has been concerned with helping teachers improve their knowledge of content and pedagogy for some time. To promote lasting, generative change in classroom practice, we must also support teachers in developing new ways of being as they go about their work. As a teacher educator and a researcher, I seek to provide rich description and analysis of teacher’s knowledge and actions by investigating two domains: (1) how teachers function and learn in the complex territories that define their work and (2) how teacher’s classrooms can be contexts for their own professional development. In my presentation I will share findings from a qualitative research project in which I examined the work of teachers who completed an intensive 13-month, 18-credit professional development program. Coursework focused on strengthening teacher’s knowledge of content and pedagogy, and on helping teachers develop ways of being more intentional, planful, observant, and reflective in their work. I claim that being intentional, planful, observant, and reflective are necessary constituents of teaching when children’s mathematical ideas are noticed and taken seriously. Finally, I will discuss what these ways of being look like both in isolation and in relationship to one another, and consider the ways being intentional, planful, observant, and reflective generate opportunities for teachers to learn in and from their own practice. Mary Alice is a candidate for one of the open positions in mathematics education. Please join us for a reception in the Hurst room from 2:30 - 3:20 on Wednesday, December 11.

Math Seminars
An Examination of One Teacher’s Perceptions of Learning Trajectory Based Professional Development in Relation to Student Thinking and Classroom Instruction
Megan Wickstrom - Illinois State University
When: Monday, December 09, 2013 11:00AM to 11:50AM
Where: Wilson Hall 1-133
Details: In mathematics education research, it has been established that knowledge of children’s mathematical thinking influences the work of teachers. To share knowledge of students thinking with teachers, many researchers have developed and shared frameworks and tools that describe and categorize student thinking in different mathematical domains. One such tool is the hypothetical learning trajectory (e.g., Sarama & Clements, 2009). A hypothetical learning trajectory or progression is a theoretical framework that describes how a student may come to know and understand a mathematical concept over time. Initial research on the influence of learning trajectory based professional development has documented that knowledge of students’ thinking informs teacher knowledge and instructional practice as well as benefits students mathematical understanding, as measured by standardized tests. Little research exists, though, from the teachers’ perspective, as to why. It is important to investigate how this relationship unfolds and develops to shed light on best and most useful practices within professional development and teacher preparation. To elucidate this phenomenon, I
used an ethnomethodological approach, across several months, with three fourth grade classrooms in a diverse, high needs school. Each of the teachers had received professional development on using learning trajectories to formatively assess individual student's thinking as a means to inform classroom instruction. This talk will explore one teacher's perceptions of the role of research on students' thinking in practice over time. Using Mathematics Teacher Noticing (Jacobs, Lamb, and Philipp, 2010) as an analytical lens, I explored how teachers use knowledge of individual students, gained from task based interviews, to inform whole classroom instruction and planning. Following this, using a grounded theory approach, I investigated how the teacher referenced research in her noticing and if and how it surfaced in her practices. Initial findings indicate that teachers notice and make sense of student thinking constantly in their daily work, but it is not always clear, to the teacher, what student thinking implies for instruction. In this particular case, mathematical tasks and teaching strategies were critical in the incorporation of knowledge of students' thinking into practice. Findings also indicate that knowledge of an individual student's thinking can inform teachers of student misconceptions and current understandings of a topic, but much of what informs a teacher's instruction comes from a complex framework of past education and daily experiences with students. Lastly, teachers interpret and redefine research in their own ways as well as reject research depending on how well it agrees with their current practices.

Math Seminars
2D Modeling of Biofilm as a Visco-Elastic Fluid
Dan Kanewske - Department of Mathematical Sciences, MSU
When: Thursday, December 05, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We are modeling the visco-elastic flow of biofilms using the Navior-Stokes equation. The so called High Weissenberg Number Problem (HWNP) has made finding solutions to this type of problem difficult for many years. The loss of the stress tensor's symmetry is a known cause of this instability. We choose to use the algorithm developed by Dr. Young-Ju Lee and Dr. Jinchao Xu which preserves the symmetry of the stress tensor. My talk will focus on modeling viscoelastic fluid flow with an emphasis on the underlying physical interpretations of the mathematical components. I will also describe the implementation of Dr. Young-Ju Lee's algorithm which I have employed. My implementation takes advantage of the Trilinos package of solvers.

Math Seminars
Factors Considered by Experienced Elementary Teachers When Developing or Adapting Mathematical Tasks
Michael Fredenberg - San Diego State University & University of California, San Diego
When: Thursday, December 05, 2013 12:00PM to 12:50PM
Where: Wilson Hall 1-133
Recently, mathematics educators and researchers have aligned themselves with John Dewey’s argument to concentrate on characterizing and organizing the knowledge and activities that enable teachers to bridge the gulf between theory and practice. In particular, current efforts in educational research have underscored the importance of decomposing teaching into high-leverage practices, those practices that lead to significant advances in student learning. This study investigates decomposing the teaching practice of developing mathematical tasks into its constituent parts for teaching and learning. The study explores the practices of experienced elementary teachers in the arena of Cognitively Guided Instruction (CGI) as they develop mathematical tasks for their lessons. In addition, the study examines the factors considered by the teachers when they adapt or modify a task during the enactment phase of a mathematics lesson. For this portion of the study, the framework of the professional noticing of children’s mathematical thinking is utilized to unpack what the teachers attend to during an interaction with a student, how the information is interpreted, and how the teachers decide to respond. Particular attention is paid to those classroom moments when a teacher decides to change the numbers within a task for a student, or students.

**Math Seminars**

**The What, Who, and How of School Mathematics**

**Dr. Mathew Felton - Department of Mathematics, University of Arizona**

**When:** Wednesday, December 04, 2013 11:00AM to 11:50AM  
**Where:** Wilson Hall 1-141

**Details:** Mathew Felton will discuss his research on prospective and current teacher’s views of school mathematics, and how these views can be challenged and informed by the practices of academic mathematicians and by perspectives on issues of equity, social justice, and diversity. Mathew frequently studies prospective teachers in the courses he teaches and practicing teachers in professional development settings. He challenges them to consider mathematical practices and has recently been studying prospective secondary teacher’s understandings of mathematical modeling. His primary research focus is on teacher’s views of the social and political dimensions of school mathematics and how these views develop in response to his instruction, with a particular emphasis on the role of reflection. He has recently been studying the mathematics prospective K-8 teacher’s use when analyzing real world issues. He will summarize his recent work, with a particular focus on the What, Who, and How framework he has developed for understanding teachers views of school mathematics. He will then describe a future research agenda that brings together perspectives from academic mathematics with a focus on issues of equity by focusing on the mathematical knowledge involved in investigating complex real world contexts. Dr. Felton is a candidate for the open positions in Mathematics Education in the department. Please join us for the candidate reception from 2:10 - 3:00 on December 4 in the Hurst Room.
**TI NSpire Calculators**

Danielle Pettry - Department of Mathematical Sciences, MSU

When: Monday, November 25, 2013 04:10PM to 05:00PM

Where: Wilson Hall 1-144

Details: Have you been wondering why we're still using TI-84s and they are essentially the same product that was available more than ten years ago? Is drawing 3 dimensional graphs your least favorite part of teaching? Want to break the monotony of lecturing? Do you ever wish your students had clickers (that also allow for free response and other types of questions)? If so, then this presentation is for you! Our department has a classroom set of TI NSpire Calculators that will soon be available for you to borrow for your class. The focus of this talk will be to share with you what I know about the NSpires and explore what else they can do to help your teaching! Statisticians and all Course Supervisors can also benefit from this talk. The calculators have some statistics capabilities that are not available on a TI 84, as well.

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**Math Seminars**

Understanding Modulatory Computations in Sensory Pathways of the Retina

Neda Nategh - Department of Electrical Engineering, MSU

When: Thursday, November 21, 2013 03:10PM to 04:00PM

Where: Wilson Hall 1-144

Details: Higher order sensory neurons receive input through multiple parallel pathways that are influenced by diverse populations of inhibitory interneurons, nearly all of which have unknown function. Understanding the specific contributions of interneuron pathways is difficult because it requires a quantitative model that includes the interneurons input, its output, and its effects on other sensory inputs. In this talk I present an experimental and computational approach to discover all of these relationships together. Retinal ganglion cells, which comprise the optic nerve, receive the majority of their synaptic input from amacrine cells, a diverse class of inhibitory interneurons. To measure how the signals transmitted through individual sustained amacrine cells contribute to retinal output, we recorded intracellularly from and injected current into single amacrine cells while recording spiking activity from the ganglion cell population of the salamander retina using a multielectrode array. We then fit nonlinear models of the ganglion cell response that characterized the responses and the effects of the amacrine pathway on other visual pathways. Our analysis shows how the visual feature conveyed by an amacrine cell influences other visual features, indicating that the amacrine cell population defines a context that modulates the multiple features conveyed by the ganglion cell. Our approach reveals the substantial functional diversity of retinal interneuron pathways, and shows how specific neurons give rise to computations in a complex circuit.

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**Math Seminars**

Reasoning with "if..., then..."
Dr. Warren Esty - Department of Mathematical Sciences, MSU
When: **Wednesday, November 20, 2013 04:10PM to 05:00PM**
Where: Wilson Hall 1-133
Details: Title: Reasoning with "if..., then ..." What students deduce and how the format of the questions affects responses. Warren Esty, Christina Watts, and Norah Esty Math texts write theorems with hypotheses and conclusions--the connective "if..., then ..." is important in mathematics. How do students understand it and reason with it? What can we ask them that would find out? It is not easy to find out. It has long been known that the context of the questions makes a big difference. We propose some questions that avoid the usual context difficulties. Nevertheless, the precise format of the questions makes a big difference in the responses. I will discuss questions and responses from three schools and numerous classes that raise serious concerns about the usual ways of asking questions that are supposedly evaluating students' understanding of "if..., then...".

### Other
**Writing Cover Letters, Teaching Statements and Research Statements**
Dr. Lisa Davis - Department of Mathematical Sciences, MSU
When: **Wednesday, November 20, 2013 02:10PM to 03:00PM**
Where: Wilson Hall 2-244
Details: I will give a brief synopsis of the contents of Cover Letters, Research Statements and Teaching Statements. Some handouts with samples will be given, and Kacey Diemert has volunteered to share an example of a cover letter that she has written. We will look at the job ad that she targeted with this letter and briefly discuss how one can write general letters vs. a letter for a specific position. The remainder of the seminar will consist of a working session where small groups work on their individual materials and give each other some feedback on their first attempts. Participants should feel free to bring your laptops if you prefer to work electronically.

### Math Seminars
**Grad Employees: What are you worth?**
Danielle Ciesielski - Department of Mathematical Sciences, MSU
When: **Monday, November 18, 2013 04:10PM to 05:00PM**
Where: Wilson Hall 1-144
Details: Interested in MSU graduate employee wage distribution across departments? How do we compare to other universities? Join a discussion about how YOU can improve wages and benefits for MSU graduate employees. Graduate Employee Organization of Montana State University [http://msugeo.org](http://msugeo.org)

### Math Seminars
**Deformation of the EPS in a 1D model**
Nathan McClanahan - Department of Mathematical Sciences, MSU
Details: Under conditions such as flow across the biofilm there will be a loss of material from the biofilm. We wanted to create a model of the interior of the biofilm that would show how it can lose some material but not all of it. We started with some initial attempts that turned out to not capture all of the details we wanted. We will briefly review some of these and the issues with them. We will focus mainly on the deformation of the EPS in 1D with the flow and detachment to come later. After changes to the model the results are still consistent with previous results. Future goals of adding multiple components to the EPS and expanding to 2D will be briefly discussed. (This talk will be an oral part of preliminary exam for Nate) Previous Abstract was mangled due to copy-and-paste from a pdf document. Sorry.

Math Seminars
From Cellular Transcription to Traffic Flows: A Case Study in Systems Biology
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, November 07, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Bio-polymerization processes like transcription and translation are central to a proper function of a cell. The speed at which the bio-polymer grows is affected both by number of pauses of elongation machinery, as well their numbers due to crowding effects. In order to quantify these effects in fast transcribing ribosome genes, we rigorously show that a classical traffic flow model is a limit of mean occupancy ODE model. We compare the simulation of this model to a stochastic model and evaluate the combined effect of the polymerase density and the existence of pauses on transcription rate of ribosomal genes. (This will be close to identical talk that I gave a few weeks ago in Molecular Biosciences program)

Math Seminars
A Poisson-Lognormal Conditional-Autoregressive Model for Multivariate Spatial Analysis of Pedestrian Crash Counts across Neighborhoods
Dr. Yiyi Wang - Civil Engineering Dept., MSU
When: Wednesday, November 06, 2013 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: In this talk, I will discuss about a spatial count model for analyzing 3-year pedestrian crash counts across neighborhoods in Austin, Texas. Covariates include land use balance, resident’s access to commercial land uses, sidewalk density, lane mile densities by roadway class, and population and employment densities by type. The model specification allows for region-specific heterogeneity, correlation across response types, and spatial autocorrelation via a Poisson-based multivariate conditional autoregressive (CAR) framework and is estimated using Bayesian Markov chain Monte
Carlo methods. Least-squares regression estimates of walk-miles traveled per zone serve as the exposure measure. Here, the Poisson-lognormal multivariate CAR model outperforms an aspatial Poisson-lognormal multivariate model and a spatial model (without cross-severity correlation), both in terms of fit and inference. Positive spatial autocorrelation emerges across neighborhoods, as expected (due to latent heterogeneity or missing variables that trend in space, resulting in spatial clustering of crash counts). In comparison, the positive aspatial, bivariate cross correlation of severe (fatal or incapacitating) and non-severe crash rates reflects latent covariates that have impacts across severity levels but are more local in nature (like lighting conditions and local sight obstructions), along with spatially-lagged cross correlation. Results also suggest greater mixing of residences and commercial land uses is associated with greater pedestrian crash rates across different severity levels, ceteris paribus, presumably since such access produces more potential conflicts between pedestrian and vehicle movements. Interestingly, network densities show variable effects, and sidewalk provision is associated with lower severe-crash rates.

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**Math Seminars**

**Introduction to LaTeX (Including Tikz)**

Joe Manlove - Department of Mathematical Sciences, MSU  
**When:** Monday, November 04, 2013 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-134  
**Details:** This talk will be an introduction to all the basics of Latex as well as Tikz and Beamer. Tikz is a package for drawing pictures which includes basic computation and iteration functionality. Beamer is the package for making slideshows in Latex, it's much less cumbersome than using PowerPoint and equation editor. Everyone (including Latex experts) can learn something at this talk.

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**Math Seminars**

**The HDG Methods for Partial Differential Equations**

Dr. Bernardo Cockburn - Distinguished McKnight University Professor at the University of Minnesota  
**When:** Thursday, October 31, 2013 04:00PM to 05:00PM  
**Where:** Procrastinator Theatre  
**Details:** The hybridizable discontinuous Galerkin methods constitute a new class of discontinuous Galerkin methods whose distinctive feature is efficient implementation for steady-state problems and implicit time-marching discretizations. In this talk, we introduce these methods in the framework of heat conduction. We show that the HDG methods are obtained as a discrete version of a suitable characterization of the exact solution which is amenable to the efficient implementation of the resulting method. We then show examples of these methods and uncover the special built-in stabilization mechanism they have. We relate to well-known methods for second-order elliptic problems and show that they are actually better than any other discontinuous Galerkin method. We end by giving an overview of the work already done and mention ongoing

Biographical sketch: Professor Cockburn was born in Lima, Peru in 1956, and he received his PhD from the University of Chicago in 1986. He was a postdoc at the Institute for Mathematics and Its Applications for one year before joining the faculty of the School of Mathematics at the University of Minnesota in 1987. He has held the position of Distinguished McKnight University Professor at the University of Minnesota since 2007, and his most recent accolades include being listed among the ranks of the ISI's Highly Cited authors. He was an Invited Speaker at the International Congress of Mathematicians in 2010, and he has held the position of Chair Professor of Mathematics at the King Fahd University of Petroleum and Minerals since 2012.

Math Seminars
Superconvergent HDG Methods for the Stokes Flow
Dr. Bernardo Cockburn - Distinguished McKnight University Professor at the University of Minnesota and Chair Professor of Mathematics at the King Fahd University of Petroleum and Minerals
When: Thursday, October 31, 2013 12:30PM to 01:30PM
Where: Wilson Hall 1-144
Details: We show how to construct superconvergent HDG methods for the Stokes equations of incompressible fluid flow by using the spaces of superconvergent HDG methods for diffusion's building blocks.

Math Seminars
Bifurcations in Spruce Budworm Population Dynamics
Ryan Waters - Department of Mathematical Sciences, MSU
When: Wednesday, October 30, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Ryan will be talking about bifurcations and catastrophes in dynamics. He'll also be talking about the spruce budworm catastrophe. There are no prerequisites to this talk, everyone is invited to attend (this includes the pure, applied, stats, and education groups).

Math Seminars
Transversality and Rigidity in Complex Dynamics II
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Friday, October 25, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This will be the continuation of last week's talk. The goal is to understand Adam Epstein's application of infinitesimal Thurston rigidity to various transversality and rigidity problems in complex dynamics.
Math Seminars

The Role of Interleukin-2 in Immune Response Regulation
Ryan Waters - Department of Mathematical Sciences, MSU
When: Thursday, October 24, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The immune system is made up of many adaptive and dynamic components that must be delicately regulated to ensure appropriate, precise, and rapid response to a foreign pathogen. A delayed or inadequate immune response can lead to prolonged disease, while an excessive or under-regulated response can lead to autoimmunity. We are interested in the role cytokines (signaling proteins), in particular Interleukin-2 (IL-2), play in maintaining this balance. We will in broad terms review the function of the immune system, and then look more specifically into the function of cytokine signaling in T lymphocytes. We will use several models to understand how IL-2 signaling works. In addition we will explore how IL-2 signaling might play a role in T cell differentiation as well as in maintaining the balance between under-response and autoimmunity. Then we will end by looking at how modeling can help us explore ways to manipulate this balance and possibly even provide insight into intelligent drug design. THIS TALK IS A PART OF PHD ORAL EXAMINATION FOR RYAN

Math Seminars

Easy Complex Dynamics and the Lattes Example
Joe Manlove - Department of Mathematical Sciences, MSU
When: Wednesday, October 23, 2013 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The first dynalite in a (long) time will cover the (very bare bones) basics of Complex Dynamics and the Lattes example. We'll chat about the Julia Set, the Fatou Set, some topology, and the Lattes example. This talk will be introductory and almost prerequisite free (MS students should find the material approachable).

Other

Building a Curriculum Vita
Dr. Lisa Davis - Department of Mathematical Sciences, MSU
When: Tuesday, October 22, 2013 12:30PM to 01:30PM
Where: Wilson Hall 1-144
Details: I will give a brief presentation of materials related to the construction of a Curriculum Vita. Some handouts with samples will be given, and the remainder of the seminar will consist of a working session where small groups work on their individual CVs and give each other feedback on their first attempts. Participants bring your laptop if you prefer to work electronically, or you can simply use a notepad to sketch out the first draft of your CV.
Math Seminars
Transversality and Rigidity in Complex Dynamics I
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Friday, October 18, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This talk will be an introduction to some open questions and results about transversality and rigidity in parameter spaces of rational maps, with the goal to understand Adam Epstein's application of infinitesimal Thurston rigidity to these questions. As an application, we will present Epstein’s improvement on the Fatou-Shishikura inequality, a sharp upper bound of the number of non-repelling cycles of a rational map.

Math Seminars
Deducing Dynamical Coupling from State Space Reconstructions
Dr. Bree Cummins - Department of Mathematical Sciences, MSU
When: Thursday, October 17, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We are investigating how much dynamical structure can be deduced from scalar observations of a deterministic system comprised of weakly or moderately coupled variables. The coupling between the variables can be visualized by an interaction graph: a set of nodes representing the variables that are connected by directed edges wherever one variable directly drives another. In a system of ordinary differential equations, a variable x(t) directly drives y(t) if it appears non-trivially on the right-hand side of the evolution equation for y. Ideally, given time series measurements of the variables in a system we would like to recover the interaction graph in its entirety. I will present work that expands on an idea posed by Sugihara et al. (2012). Their idea is that interactions between variables x and y of a deterministic dynamical system confined to a compact invariant manifold M can be recovered using comparisons of the time-delay reconstructions M_x and M_y made from the time series x and y. The properties of the reconstructions are given by Takens' embedding theorem, which I will discuss. We extend Takens' theorem and show that in the theoretical best case scenario, only the transitive closure of the interaction graph can be recovered using this technique. In practice, there are further limitations that I will illuminate through numerical examples.

Math Seminars
Quorum Sensing - Microbial Speciation
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, October 10, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I will talk a little about two ongoing projects: 1) Quorum Sensing and short-circuiting in Pseudomonas aeruginosa 2) Microbial Speciation in a continuous
environment. 1) Bacterial cell-cell communication, also termed quorum sensing (QS) is a wide-spread process that coordinates multi-cellular behaviors such as virulence, biofilm formation, and nutrient acquisition in response to cell density, population structure and environmental viscosity. There has been an explosion in research directed at understanding the molecular mechanisms of QS, but there is a paucity of information on the ecophysiological implications and on the emergent properties of QS regulatory networks. Short-circuiting, or self-induction, is a major unanswered question in bacterial QS: How is it that diffusible quorum-signals do not immediately bind to their cognate receptors in the same cell in which they are produced and activate gene expression independent of cell density? We will investigate the roles of antiactivation and lasR regulation in modulating the quorum response and in preventing short-circuiting.

2) Biological systematics studies suggest that species are discretized in niche space. That is, rather than finding a continuum of organism types with respect to continuous environmental variations, instead observers find discrete species or clumps of species, with one clump separated from another in niche space by a finite gap. Here, using a simple one dimensional model with a varying environmental condition, we investigate conditions for discrete speciation instability of a continuously varying species structure in the context of asexually reproducing microbes. We find that significant perturbation of heterogeneity is required for instability, but that conditions for such perturbations might reasonably occur, for example through influence of boundary conditions.

Other

**Academic Job Search Timeline**  
**Dr. Lisa Davis - Department of Mathematical Sciences, MSU**  
**When:** Tuesday, October 08, 2013 12:30PM to 01:30PM  
**Where:** Wilson Hall 1-144  
**Details:** I’ll give a presentation outlining the academic job search timeline and possibly include a short discussion of the structure of a Curriculum Vitae and a Cover Letter. The seminar is intended to address questions that apply to both Master’s and PhD level graduate students. Come prepared with questions, and we can have as much discussion as the audience needs in order to get a solid overview of the process.

**Math Seminars**  
**Contact topology and automorphisms of surfaces**  
**William H. Kazez - Department of Mathematics, University of Georgia**  
**When:** Thursday, October 03, 2013 02:10PM to 03:00PM  
**Where:** Wilson Hall 1-133  
**Details:** A contact structure on a 3-manifold is a non-integrable 2-plane distribution, that is a family of planes which are not tangent to any portion of an embedded surface. In other words, it is precisely the opposite of a 2-dimensional foliation. Giroux has shown that there is a surprisingly straightforward and deep connection between contact topology and automorphisms of surfaces. This correspondence allows natural questions in contact topology to be translated into new and interesting questions about
automorphisms of surfaces. I will survey some of the foundational ideas in contact topology and describe some of the corresponding automorphisms of surfaces. This is based on joint work with Honda, Matic, and also Roberts.

Math Seminars
Modeling of critical occlusion via biofilm induced calcite precipitation in porous media
Dr. Tianyu Zhang - Department of Mathematical Sciences, MSU
When: Thursday, September 26, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: A model for biofilm induced calcite precipitation with constant head driven flow is presented in the context of a single pore within a porous medium. The model is based on a mixture model including biomaterial, mineral material, and water with dissolved components. Computational results suggest the possibility of critical clogging in the sense that there is a critical pressure head such that for pressure drops below this critical level, pore clogging occurs relatively quickly while for pressure drops above, clogging occurs after much longer times if at all.

Math Seminars
Evolution and robustness in genetic networks
Prof. Leon Glass - Professor of Physiology and the Isadore Rosenfeld Chair in Cardiology, McGill University
When: Friday, September 20, 2013 02:10PM to 03:00PM
Where: Wilson Hall 1-144
Details: Genetic activity is partially regulated by a complicated network of proteins called transcription factors. I will describe a mathematical framework to relate the structure and dynamics of these genetic networks. SECOND TALK ON FRIDAY. The underlying idea is to capture the topology and logic of the network interactions by a Boolean network, and to then embed the logical network into continuous piecewise linear differential equations. The equations can be analyzed using methods from discrete mathematics and nonlinear dynamics. By changing the logical structure randomly, it is possible to evolve the networks in an effort to identify networks that display rare dynamics - e.g. networks with long stable cycles or with a high level of topological entropy. I also consider the concept of robustness in the context of these equations and argue that robustness should be a key feature of genetic networks underlying important biological functions.

Math Seminars
Dynamical Disease. From Theory to the Clinic
Prof. Leon Glass - Professor of Physiology and the Isadore Rosenfeld Chair in Cardiology, McGill University
When: Thursday, September 19, 2013 04:10PM to 05:00PM
Where: Procrastinator Theatre
Details: Recent discoveries in genomics and proteomics are revolutionizing our understanding of the mechanisms of disease. Yet, in many diseases the body displays complex abnormal rhythms that are amenable to mathematical analysis. The abnormal rhythms often arise as a consequence of changes in key parameters of an underlying physiological control system, and as such the dynamics give important clues about underlying mechanisms and therapy. I will discuss applications of the concept of dynamical disease to basic research, diagnosis, and therapy. I will describe concrete applications for a variety of different diseases including atrial fibrillation, sudden cardiac death Parkinsonian tremor, falling, epilepsy, neutropenia. Even though advances in molecular biology will have major impacts in medicine over the long run, for the foreseeable future, physicians will have to deal with the dynamical diseases experienced by their patients.

Math Seminars

Fast Multipole Method for Differential Equation with Variable Coefficients
Hong Liu - Institute of Geology & Geophysics, CAS
When: Tuesday, September 17, 2013 02:10PM to 03:00PM
Where: Wilson Hall 1-144
Details: NOTE THE SPECIAL TIME AND DAY! The key of direct method for solving the 3D Helmhotz equation in Frequency domain forward modeling is the compression and fast calculation of inverse matrix. Traditional LU decomposition requires O(N*N) for storage and subsequent multiplication, and it poses difficulty for three dimensional FWI if we do not have fast massive storage. Fast Multipole method computes the inverse matrix more efficiently with a reduced storage requirement, where DTA (diffuse, transfer, accumulation) decomposition of the Helmhotz equation inverse matrix is used instead of LU decomposition. However, Fast Multipole method now is only suitable for homogeneous medium due to the lack of Green function in inhomogeneous medium. In this work, we manage to find a Green function in inhomogeneous medium with DTA decomposition form which will be suitable for the Fast Multipole method in forward modeling for frequency domain. Our proposed method is based on Magnus method of exponential solution (1954) or BCH formula that is the solution in Lie algebras for one-way wave equation and Leibnitz formula for pseudo differential equation. Study on the order of iteration in frequency domain inversion suggests that an effective method is conducting the inversion from low frequency to high frequency, and then come back to low frequency. We want to give a theoretical explanation for this method based on phenomena of the mutual coupling of the frequency pointed by an integration expression of multiple according to Magnus method. This explanation is in fact an improvement of Doherty-Anstey formula in which Lie algebras adaptation are introduced. Numerical examples demonstrating some progress will be provided.

Math Seminars

A Short Chat about Dirichlet Integrals on Riemann Surfaces
Joe Manlove - Department of Mathematical Sciences, MSU
When: Friday, September 13, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This is the first of two talks presenting the Riemann-Roch Theorem.

Math Seminars
Rational Numbers and the Common Core: A Descriptive Case Study
Roger Fischer - Department of Mathematical Sciences, MSU
When: Thursday, August 29, 2013 03:30PM to 04:30PM
Where: Wilson Hall 1-134
Details: This is a dissertation proposal.

Other
5 years in Suzhou
Mike Coury - Department of Mathematical Sciences, MSU
When: Thursday, August 29, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I was a mathematics teacher in a school in China for the last 5 years. In this talk, I would like to compare some of the differences in education practices and the learning of mathematics that I have experiences while I was there. This is an open lecture, so all are invited.

Math Seminars
Examining the 5 Practices for Orchestrating Productive Mathematical Discussions
Dr. Elizabeth Hughes - University of Northern Iowa
When: Monday, July 01, 2013 04:10PM to 05:00PM
Where: Wilson Hall 1-133
Details: Dr. Hughes is a candidate for the open faculty position in mathematics education.

Math Seminars
Patterns in the Swift-Hohenberg equation and in social systems
Scott McCalla - Department of Mathematics, UCLA
When: Wednesday, June 26, 2013 02:10PM to 03:00PM
Where: Wilson Hall 1-144
Details: Two topics in localized pattern formation will be addressed in this talk. In the first, I will discuss the existence proof for stationary localized spots in the planar and the three-dimensional Swift-Hohenberg equation using geometric blow-up techniques. The spots have a much larger amplitude than that expected from a formal scaling in the far
field. One advantage of the geometric blow-up methods is that the anticipated amplitude scaling does not enter as an assumption into the analysis but emerges during the construction. In the second half of the talk, the localized structures will no longer be solutions to partial differential equations, but criminal coalitions in an evolutionary, adversarial game. These coalitions will arise from personal relationships and shared ideologies, or ``sacred value networks”. We explore the effects on the dynamics of the system that these networks introduce, through various forms of protection from both victimization and punishment.

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**Math Seminars**

**Discontinuous Galerkin Methods for Modeling and Simulation of Transcription Processes with Short and Frequent Pausing**

Jennifer Thorenson - Department of Mathematical Sciences, MSU

**When:** Wednesday, June 26, 2013 09:00AM to 10:00AM  
**Where:** Hurst Conference Room

**Details:** The classical traffic flow PDE from the 1950s is used to model the biological process of transcription; the process of transferring genetic information from DNA to mRNA, in an E. coli gene. Polymerase elongating along the DNA strand encounter frequent but short pauses which are incorporated into the transcription model as several traffic lights. These pauses result in a delay in the transcription time and a delay function is defined to quantify this effect. Numerical simulations of the PDE model are conducted using a discontinuous Galerkin finite element method (DG) formulation. The DG solution is used to calculate the delay due to the pauses and determine their effect on the overall transcription time. Preliminary parameter studies show a complex relationship between pause location and delay values. To determine the effect of pause clustering on protein production, an ongoing research goal is optimization of the delay function with respect to pause location. For preliminary work on this optimization problem, a DG formulation used to solve a sensitivity equation for a linear hyperbolic PDE with a spatial interface parameter is derived to gain insight for the more complicated nonlinear traffic flow PDE.

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**Math Seminars**

**L-Cuts for Genus Two Translation Surfaces**

Andy Bouwman - Department of Mathematical Sciences, MSU

**When:** Tuesday, June 04, 2013 09:00AM to 10:00AM  
**Where:** Wilson Hall 2-244 (Hurst Conference Room)  
**Details:** This talk is a Ph.D. defense.

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**Math Seminars**

**Entropy and Hausdorff Dimension for Expansive Z^d-actions**

Hannah Bergren - Department of Mathematical Sciences, MSU

**When:** Monday, April 29, 2013 04:10PM to 05:00PM
Where: Wilson Hall 1-133
Details: We will explore expansive $\mathbb{Z}^d$-actions and relate the entropy and dimension.

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**Math Seminars**

**Modeling Biofilm Dynamics Using Multiphase Fluid Models and 3-D Numerical Simulations**

Dr. Qi Wang - Department of Mathematics, University of South Carolina

When: **Friday, April 26, 2013 03:10PM to 04:00PM**

Where: EPS 126

Details: Qi Wang has developed a model for biofilm dynamics and their interaction with the environment using a multiphase complex fluid concept. The model has been recently extended to address issues such as multiple bacterial phenotypes, quorum sensing and bacterial cell motility. He will discuss the various aspects of the model and benchmarking issues with a few existing experiments. He will also present some 3-D simulations of the model for biofilm growth and interaction with the flow. The model can also be used to study pattern formation in bacterial colonies. Some 3-D numerical simulations will also be discussed.

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**Math Seminars**

**Separating the EPS in a Biofilm**

Nathan McClanahan - Department of Mathematical Sciences, MSU

When: **Thursday, April 18, 2013 03:10PM to 04:00PM**

Where: Wilson Hall 1-144

Details: Under conditions such as how across the biofilm there will be a loss of material from the biofilm. We wanted to create a model of the interior of the biofilm that would show how it can lose some material but not all of it. Initially we were thinking of the EPS as a three part system with biomass and two types of EPS. We wanted to look at how these different types of EPS moved around inside the biofilm and how that movement aided in keeping the biofilm intact under different conditions. I will talk about the system of PDEs we started with and how that system has evolved. There will also be some discussion of the results we obtained from early versions of the model and how those led us to change the model to what it is now.

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**Math Seminars**

**Traveling Wave Fronts and Pulses in Pancreatic Islets**

Heather Moreland - Department of Mathematical Sciences, MSU

When: **Thursday, April 11, 2013 03:10PM to 04:00PM**

Where: EPS 126

Details: In response to an increase in blood glucose levels, insulin is released into the bloodstream by the pancreatic islets of Langerhans. As a result of this influx of glucose, the islets start what are called bursting oscillations of the membrane potential and the
intracellular calcium concentration. Time delays of several seconds in the activity of distant cells in the islets have been observed, indicating the presence of traveling waves through the islets. Using the bi-stable equation and a homotopy parameter, we construct a relationship between the wave speed and the model parameters for the existence of a traveling wave front. Additionally, we demonstrate the presence of a traveling wave pulse by establishing the existence of a homoclinic orbit and construct a continuation curve for this orbit in the wave speed and the model parameters.

Submitted by: Tomas Gedeon

Math Seminars

The Role of Science in Creating Best Practices for Oil Industry Activities: Modeling of Unseen Impacts
Dr. Sakke Kuikka - Department of Biological and Environmental Sciences, University of Helsinki
When: Tuesday, April 09, 2013 04:10PM to 05:00PM
Where: Procrastinator Theater, SUB
Details: Risk consists of components that are known or can be estimated scientifically, as well as components that are not known and cannot be estimated precisely. It is essential, however, that both components be taken into account and justified scientifically when managing the various risks. For example, if a society is highly risk averse, uncertainty estimates related to management options serve a crucial role. This talk will review the experience of the FEM group in the development of integrative Bayesian models and belief networks for interdisciplinary risk analysis, while focusing on oil spills in the Gulf of Finland. The future challenges in this demanding modeling task will also be discussed. Dr. Kuikka is also the leader of the multidisciplinary Fisheries and Environmental Management (FEM) Group, which was founded in 2006. He has also served as a member of STECF (Scientific, Technical and Economic Committee for Fisheries), which is an advisory body of the EU Commission. He has numerous publications and continues to act as an advisor to doctoral and masters level students. His areas of expertise include fisheries management of large international systems, decision and risk analysis in fisheries and environmental problems, Bayesian statistics, multidisciplinary probabilistic modeling of human/ecosystem interactions and environmental impact analysis.

Math Seminars

Experiences in Modelling Fisheries and Oil Spill Risks using Bayesian Inference
Dr. Sakke Kuikka - Department of Biological and Environmental Sciences, University of Helsinki
When: Monday, April 08, 2013 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Risk consists of components that are known or can be estimated with scientific tools, as well as components that are not known and cannot be estimated precisely. However, both have to be taken into account when managing the risks. This talk will review statistical techniques in Bayesian inference adopted by the Fisheries and Environmental (FEM) group at the University of Helsinki in the development of integrative Bayesian models and belief networks for interdisciplinary risk analysis, while focusing on oil spills in the Gulf of Finland.

Math Seminars

2D Modeling of Biofilm as a Visco-Elastic Fluid
Daniel Kanewske - Department of Mathematical Sciences, MSU
When: Thursday, April 04, 2013 03:10PM to 04:00PM
Where: EPS 126
Details: We are modeling the visco-elastic flow of biofilms using the Navier-Stokes equation. The so-called High Weissenberg Number Problem (HWNP) has made finding solutions to this type of problem difficult for many years. The loss of the stress tensor's symmetry is a known cause of this instability. We choose to use the algorithm developed by Young-Ju and Xu which preserves the symmetry of the stress tensor. My talk will focus on illustrating the framework of Young and Xu's algorithm. I will also describe the implementation of Young's algorithm that I have employed. My implementation takes advantage of the Trilinos package of solvers.

Math Seminars

God and Science
Dr. Colin Howson - Department of Philosophy, University of Toronto
When: Wednesday, April 03, 2013 04:10PM to 05:00PM
Where: Byker Auditorium, Chemistry & Biochemistry Building

Math Seminars

The Role of Interleukin 2 in Immune Response Regulation
Ryan Waters - Department of Mathematical Sciences, MSU
When: Thursday, March 28, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: During an infection, the immune system needs to respond both rapidly and specifically to fight a foreign pathogen in order to minimize disease. The balance of these two qualities of response are important to ensure that the body responds in a timely manner, but also so that the immune system is not triggered inadvertently in the absence of proper stimulation. To this end our immune systems have developed a series of checks to help ensure that during an immunological response our bodies are responding only when necessary. Today!! One important player in the response and regulation of the immune response is the cytokine Interleukin 2 (IL-2). Since its discovery almost 40 years ago, IL-2 has been one of the most studied signaling
molecules in the adaptive immune response. T cells have a high, intermediate, and low affinity receptor for IL-2. Though both the high affinity and intermediate affinity receptor have the same cytosolic components, signaling through these two receptors have qualitatively different outcomes. In this talk I will discuss some potential mechanisms for translating binding affinity into differential signals with a few modest results. In addition, I will note some potentially interesting questions going forward and how modeling may help to answer them. Also, there will be many cartoons.

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**Math Seminars**

**Geometric Theory of Output Regulation: Solving the Regulator Equations**

Dr. David Gilliam - Department of Mathematics & Statistics, Texas Tech University

**When:** Friday, March 22, 2013 03:10PM to 04:00PM

**Where:** Wilson Hall 1-144

**Details:** In this talk we present a simple and extremely flexible design strategy for solving a large class of regulation problems for nonlinear parabolic boundary control systems. The theoretical underpinnings of our approach is the well-known regulator equations from the geometric theory of regulation applicable in the neighborhood of an equilibrium. The most important point of this work is the wide applicability of the design methodology. In the examples we employ unbounded sensing and actuation but the method works equally well for bounded input and output operators and even finite dimensional nonlinear control systems. The examples given in the talk include: control of a Navier-Stokes Flow in a Two Dimensional Forked Channel and a control problem for a Non-Isothermal Navier-Stokes Flow in a Two Dimensional Box Domain.

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**Math Seminars**

**Ronald Reagan was a Statistician and Other Examples of Learning from Diverse Sources of Information**

Dr. Andrew Gelman - Dept of Statistics and Dept of Political Science, Columbia University, New York

**When:** Thursday, March 21, 2013 03:30PM to 04:30PM

**Where:** Procrastinator Theater

**Details:** Are you better off than you were four years ago? Are beautiful people more likely to have daughters? Why are voters in rich East Coast states so liberal? How many people do you know? Should you check your house for radon gas? These and other questions are best answered by combining information from different sources. We discuss ways to combine information statistically and also how this can go wrong, in the context of several examples in social science and policy.

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**Math Seminars**

**Cycling Without Cyclins: A Transcriptional Network Oscillator**

Dr. Steve Haase - Department of Biology, Duke University

**When:** Thursday, March 21, 2013 02:00PM to 03:00PM
Where: Byker Auditorium, Chemistry Building basement
Details: The cyclin/CDK system is widely viewed as the master oscillator driving cell cycle events. However, we have demonstrated that the majority of the cell-cycle regulated transcriptional program remains periodic in budding yeast cells arrested at the G1/S border by depletion of all S-phase and Mitotic cyclins. These results (and others) led us to propose that the cell-cycle transcriptional program is intrinsically controlled by a cascading network of serially activated transcription factors functioning as an autonomous oscillator, independent of cyclin/CDKs, and cell-cycle progression. The cyclin/CDK system and the transcriptional network oscillator are coupled at multiple points. Cyclins, along with various key cell-cycle regulators, are periodically transcribed by factors in the transcription network; and in turn, cyclin/CDKs regulate several of the transcription factors in the network. These findings establish a new paradigm for cell cycle control in budding yeast. Cell-cycle progression is coordinated by coupling cyclin/CDKs to an autonomous transcriptional network oscillator. (NOTE DIFFERENT TIME AND PLACE) Checkpoints are intracellular signaling pathways that maintain genome stability by inhibiting cyclin/CDK activity, and blocking cell-cycle progression when key events fail to occur according to plan. Our experiments reveal that checkpoint pathways also block the periodic oscillation of the transcriptional network. We hypothesize that checkpoints regulate the dynamics of the cell- cycle-regulated transcriptional program in order to maintain synchrony between the transcriptional program and cell-cycle progression. Taken together, our data suggest that cell-cycle control is achieved by integrating the functions of cyclin/CDKs, checkpoints, and an autonomous transcriptional network oscillator.

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**Math Seminars**

**Causality and Statistical Learning**  
Dr. Andrew Gelman - Department of Statistics and Dept. of Political Science, Columbia University  
When: Thursday, March 21, 2013 11:00AM to 12:00PM  
Where: Byker Auditorium (Chemistry Building)

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**Other**

**WeBWorK: What it is, How it's Used, and Introduction to PGML**  
Dr. David Gilliam - Department of Mathematics & Statistics, Texas Tech University  
When: Wednesday, March 20, 2013 03:10PM to 04:00PM  
Where: Wilson Hall 1-144  
Details: This talk briefly describes the historical development of WeBWorK and its evolution over the past two decades. We also discuss in some detail how it's used at Texas Tech University. This includes an introduction explaining how it is used by instructors to administer a course and the ways students benefit from its proper use. We also provide a short discussion of the new and simplified method for authoring WeBWorK exercises using the PG Markup Language (PGML).
Math Seminars
Modeling and Analysis of Growth, Gene, and Protein Expression in Biofilms
Dr. Tianyu Zhang - Department of Mathematical Sciences, MSU
When: Thursday, March 07, 2013 03:10PM to 04:00PM
Where: EPS 126
Details: (NOTE: A DIFFERENT ROOM!) Reporter gene, transcriptomic, and proteomic technologies have made it possible to measure gene and protein expression in microbial biofilms. How can differences in biofilm gene expression, both in comparison to planktonic cells and in space and time within the biofilm, be understood? Here we provide general theoretical framework for addressing this question. At the core of the model are reaction-diffusion equations that account for microscale concentration gradients within the biofilm. It is these differences in local concentrations that underpin differences in local growth, gene, and protein expression. We will present the study of four specific cases including: Inducible GFP, Denitrification, Acid stress response, and Quorum sensing. Comparison between model simulations and experimental results will be given.

Math Seminars
Collaborative Revision and its Effects on Undergraduate Students Proof Skills
Emily Cilli Turner - Department of Mathematics, University of Illinois Chicago
When: Wednesday, February 27, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-133
Details: Although there is much research showing that proof serves more than just a verification function in mathematics, there is little research documenting which functions of proof undergraduate students understand. Additionally, research suggests that students have difficulties determining the validity of a given argument and constructing valid proofs. This study examines the effects of a teaching intervention using a process called collaborative revision on students’ beliefs regarding proof and on student proof skills. Collaborative revision refers to the process in which students present a proof they have constructed to their classmates and the other students are encouraged to provide feedback to aid in the revision of the proof. Student assessment data in the form of pre and post-assessments were collected, as well as interviews with students in the treatment course and in a comparison course. Preliminary results show that students do understand many functions of proof identified in the literature and, although collaborative revision may not impact the ability to identify valid proofs, it does affect the way that students gain conviction about the proof of a statement.

Math Seminars
Near Optimal Resource Allocation for Enhancing Networks Survivability Under Geographically Correlated Attacks
In this work, we present new algorithms for increasing the survivability of WDM networks after geographically correlated attacks. Causes for such attacks might include Electromagnetic Pulse (EMP) attacks, as well as natural disasters, such as solar flares, earthquakes, hurricanes, and floods. The aim is to pre-allocate resources in the network, so their maintenance creates a small overhead on the network functionality. Our algorithm provides a provably almost-optimal solution, with close to linear running time. To obtain this result, we have proven new bounds on the VC-dimensions of topological structures the network might exhibit after the attack. Bio: Alon Efrat is an associate professor in the Department of Computer Science at the University of Arizona since 2000. He has earned his PhD from Tel-Aviv University under the supervision of Prof. Micha Sharir at 1998. He was also a post doctorate research assistant at Stanford University, and at IBM Almaden Research Center. He won the NSF CAREER award in 2004. He serves on the editorial board of the International Journal of Computational Geometry and its Application (IJCGA). He has published over 110 papers. His focus is on optimization problems from geometric algorithms. In particular, he is intrigued by reliability problems in networks, in algorithms for sensors networks and sensors locations, and by browsing, indexing, and manipulations of videos of educational content.

Math Seminars

Mathematical Modeling in Biology: Successes and Challenges
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, February 21, 2013 04:00PM to 05:00PM
Where: Procrastinator Theater SUB
Details: What role can mathematical models play in description of complex biological systems? In this talk, Dr. Gedeon will share some successes of mathematical models in modeling HIV, microbial consortia and transcriptional elongation. He will also discuss some mathematical challenges that limit applications to high dimensional systems that may arise in biology or climate modeling. This is the College of Letters and Science Distinguished Professor lecture.

Math Seminars

Geometry and Dynamics of Chebyshev-type Maps
Dr. Joshua Bowman - Smith College
When: Thursday, February 21, 2013 02:10PM to 03:00PM
Where: Wilson Hall 1-141
Details: In addition to being useful in numerous applications, Chebyshev polynomials have nice dynamical properties. In the 1980s, they were generalized to self-maps of higher-dimensional complex spaces, using root systems (from this perspective, the original Chebyshev polynomials correspond to the simplest root system \$\mathsf{A}_1\$). We will
explore some of the dynamical properties of these maps in higher dimensions, using geometry, algebra, and analysis.

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**Math Seminars**

**Intersecting Loops on Surfaces, String Topology, and the Moduli Space of Riemann Surfaces**

Dr. Kate Poirier - University of California, Berkeley

When: **Tuesday, February 19, 2013 04:10PM to 05:00PM**

Where: Wilson Hall 1-144

Details: String topology is the study of algebraic structures arising from intersecting loops in manifolds. These structures encode interesting topological and geometric information about the manifold itself. One example of a string topology operation is the Goldman bracket, which is given by intersecting loops on surfaces. In this talk, I will define the Goldman bracket for surfaces, introduce generalizations of it to string topology operations for manifolds of higher dimension, and describe how a compactification of the moduli space of Riemann surfaces parametrizes these operations. This includes joint work with Gabriel C. Drummond-Cole and Nathaniel Rounds.

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**Math Seminars**

**Excisive Invariants of Manifolds and Links**

Dr. David Ayala - University of Southern California

When: **Monday, February 11, 2013 03:10PM to 04:00PM**

Where: Wilson Hall 1-144

Details: This talk will explain a program of constructing sensitive invariants of manifolds and links. A few explicit examples will be discussed which demonstrate the sensitivity of such invariants and the methods used for calculating them -- pictures will be drawn. We will see that numerous previously studied invariants are instances of this program; among these are certain TQFT's, and certain finite-type knot invariants. *Submitted by: Lukas Geyer*

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**Math Seminars**

**The Quasisymmetric Geometry of Domains**

Dr. Kevin Wildrick - University of Bern, Switzerland

When: **Monday, February 04, 2013 03:10PM to 04:00PM**

Where: Wilson Hall 1-144

Details: In 1909, Koebe conjectured that every domain in the two-sphere is conformally equivalent to a domain whose complementary components are either points or round disks. In the case of finitely many complementary components, this was confirmed by Koebe himself in the 1920's. More than 70 years later, He and Schramm confirmed the conjecture in the case of countably many complementary components. The full conjecture remains open. Motivated by this and conjectures in geometric group theory,
we discuss a version of Koebe's conjecture for metric spaces merely homeomorphic to domains in the sphere; in this setting, the role of conformal mappings is played by quasisymmetric mappings.

Math Seminars

An Agent-based Model of Mosquito Host-seeking: Finding and Tracking Odor Plumes
Dr. Bree Cummins - Department of Mathematical Sciences, MSU
When: Thursday, January 31, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Mosquito host-seeking behavior and host distribution heterogeneity are important factors in predicting the transmission dynamics of mosquito-borne infections such as West Nile virus. However, such small scale properties of transmission are often averaged over space and time in models of disease spread. My collaborators and I are interested in quantifying the impact of small scale heterogeneity on the contact rate between mosquitoes and hosts, and more generally in exploring how the results of agent-based models might impact larger scale models. To address these questions, we developed an agent-based model of mosquito host-seeking behavior in which mosquito agents navigate in a two-dimensional space and respond to wind and to carbon dioxide that is steadily emitted from stationary hosts. The scenario inspiring the parameter choices is that of Culex quinquefasciatus mosquitoes preying on roosting birds at night. The exhaled carbon dioxide from the sleeping birds forms an odor plume in the wind, which we simulate using an advection-diffusion equation with stochastic elements. Using simulation results from the model, I discuss the effectiveness of different mosquito navigation strategies with respect to both wind and carbon dioxide, the effect of having more than one host patch, and the effect of changing host density. Overall, our simulations indicate that small-scale heterogeneity in host distribution and mosquito behavior leads to noticeable changes in contact rate. I present our first attempt to use these results to inform parameter choices in compartmental epidemiology models.

Math Seminars

Calculus Students' Understandings of the Concepts of Function Transformation, Function Composition, Function Inverse, and the Relationships among the Three Concepts
Dr. Patrick Kimani - Cal State Fullerton
When: Monday, January 28, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-133
Details: Research has shown that students struggle with the concept of function, which is a fundamental concept in the learning of mathematics (especially calculus). In this talk I will present data from a study that examined 70 calculus students’ understandings of the concepts of function transformation, function composition, and function inverse. The results indicate that while a few of the students exhibited a stable conceptual
understanding of the three concepts, the majority of the students relied on memorization of formulas and patterns that they called upon whenever they encountered the concept names transformation, composition or inverse. This reliance on memorization appeared to limit the students in seeing and utilizing relationships among the three concepts, with some students responses exhibiting no transfer of their knowledge of one concept when working on questions involving one of the other concepts. I will also discuss how these results have influenced my work as a Mathematics Teacher Educator.

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Math Seminars

**Discrete Extremal Lengths for Graph Approximations of the Sierpinski Carpet**

Rob Malo - Department of Mathematical Sciences, MSU  
When: **Friday, January 25, 2013 03:10PM to 04:00PM**  
Where: Wilson Hall 1-144  
Details: I will give a brief introduction to quasisymmetric maps, quasisymmetric equivalence, and properties that are invariant under quasisymmetric maps. In particular, I will be discussing conformal dimension. Some basic examples will be given. An adaptation of an algorithm developed by Schramm to compute discrete extremal lengths for graph approximations of the Sierpinski Carpet will be discussed. Pretty pictures outnumber ugly definitions.

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Math Seminars

**Productivity in 1D Biofilm Models**

Dr. Isaac Klapper - Department of Mathematical Sciences, MSU and Temple University  
When: **Thursday, January 24, 2013 03:10PM to 04:00PM**  
Where: Wilson Hall 1-144  
Details: Some of the most fundamental questions about biofilms concern productivity: given available concentration of a certain nutrient, say, at what rate can this nutrient be turned into product (e.g. new cells)? Models of productivity are best first constructed in one dimension where diffusive transport limitations are more easily understood. This talk will present some simple results and bounds on productivity in 1D biofilm models.

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Math Seminars

**Tectonics and Tessellations: Residuals for Spatial Point Processes**

Andrew Bray - UCLA  
When: **Thursday, January 24, 2013 02:30PM to 03:20PM**  
Where: Wilson Hall 2-244  
Details: Earthquakes are one of many natural phenomena that can be modeled as a point process, but it can be challenging to assess how well a given model describes newly observed quakes. We propose a method of residual analysis for spatial point processes where differences between the modeled conditional intensity and the
observed number of points are assessed over the Voronoi cells generated by the observations. The resulting residuals appear to be substantially less skewed, and hence more stable, particularly for point processes with conditional intensities close to zero, compared to ordinary pixel-based methods.

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**Math Seminars**

**The Effects of an Intensive Mathematics Immersion Program on the Instructional Choices of Secondary Mathematics Teachers**

Mary Elizabeth Matthews - Boston University

**When:** Tuesday, January 22, 2013 11:00AM to 11:50AM  
**Where:** Wilson Hall 1-133  
**Details:** Professional development for teachers is seen as an important component of improving the education of children. One growing form of professional development is an experience-as-learner of mathematics by immersion in inquiry. This presentation discusses my pilot study and dissertation research regarding an intensive mathematical immersion professional development program, PROMYS for Teachers. My research seeks to measure changes in teacher beliefs, task choice, and task implementation using two researcher-created survey instruments and two case studies. I will discuss findings regarding teacher task choice and implementation.

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**Math Seminars**

**Use of Clinical Trials to Decipher the Immunopathophysiology of Multiple Sclerosis**

Bibi Bielekova - Chief, Neuroimmunological Diseases Unit, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, MD

**When:** Thursday, January 17, 2013 04:00PM to 05:00PM  
**Where:** Seminar room, Molecular Biosciences Building Advanced Technology Park, 960 Technology Blvd  
**Details:** I do not have an abstract, but this is not really a math talk. Bibi went to Math focused High school in my hometown and then went to medicine. We met a few years ago, she expressed interest in modeling and Ryan and I are collaborating with her on T-cell receptor modeling. The talk is in the IID department on the other side of 19th. They start promptly at 4:00 and they do have cookies before the talks.

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**Math Seminars**

**Circuit Theory, Random Walks, and Model-Based Inference for Landscape Connectivity**

Ephraim Hanks - Colorado State University

**When:** Thursday, January 17, 2013 02:30PM to 03:20PM  
**Where:** Wilson Hall 2-244
Details: Circuit theory has seen extensive recent use in the field of landscape ecology, where it is often applied to study functional connectivity. The landscape is typically represented by a network of nodes and resistors, with the resistance between nodes a function of landscape characteristics. The effective distance between two locations on a landscape is represented by the resistance distance between the nodes in the network. Circuit theory has been applied to many other scientific fields for exploratory analyses, but parametric models for circuits are not common in the scientific literature. To model circuits explicitly, we demonstrate a link between Gaussian Markov random fields and contemporary circuit theory using a covariance structure that induces the necessary resistance distance. In the landscape ecology setting, the proposed model provides a framework where inference can be obtained for effects that landscape features have on functional connectivity. We illustrate the approach through a landscape genetics study linking gene flow in alpine chamois (Rupicapra) to the underlying landscape.

Math Seminars
Understanding Middle School Mathematics Teachers Enactment of Cognitively Demanding Tasks
Dr. Annie Garrison - Vanderbilt University
When: Monday, January 14, 2013 03:10PM to 04:00PM
Where: Wilson Hall 1-133
Details: The level of challenge, or cognitive demand, of the tasks students solve is the foundation for their learning opportunities in mathematics classrooms. Unfortunately, it is difficult for teachers to effectively use cognitively demanding tasks (CDTs). What can we do to support teachers to enact CDTs? In this talk I describe my investigation of what influences mathematics teachers enactment of CDTs. After providing some background, I outline a set of promising factors to investigate. I then summarize my study of how middle school teachers’ mathematical knowledge for teaching and beliefs about teaching and learning mathematics is related to their enactment of CDTs. Lastly, I explain how this research fits into my larger research agenda of investigating supports for teacher’s development of ambitious mathematics instruction.

Math Seminars
Modeling Heterogeneity within Multiway Array Data
Bailey Fosdick - University of Washington
When: Monday, January 14, 2013 01:10PM to 02:00PM
Where: Wilson Hall 2-244

Math Seminars
Annual Temperature Profiles: Applications to Regional Climate Model Projections and Extremes in the Instrumental Record
Dr. Tamara Greasby - National Center for Atmospheric Research
When: Thursday, January 10, 2013 04:10PM to 05:00PM  
Where: Wilson Hall 1-144  
Details: Using the North American Regional Climate Change Assessment Program ensemble of regional climate models, this talk will define an annual temperature profile to characterize and examine changes in temperature projections and seasonality for two sets of model runs: current and future. These profiles, and the corresponding differences, are a new way to describe climate change and its uncertainty. We propose a Bayesian hierarchical spatial model to simultaneously model the profile for 30 years in each time period. The hierarchical structure is designed to account for many sources of uncertainty, including heteroscedastic seasonal variability and inter-annual variability. Several applications of these temperature profiles are highlighted showing the flexibility of the annual temperature profile, including applications in public health and climate science. The talk will finish by using the annual temperature profile to explore extremes in historical temperature data.

Math Seminars  
Estimating Teaching Effectiveness Using Value-Added Models  
Dr. Jennifer Green - University of Nebraska-Lincoln  
When: Monday, January 07, 2013 03:10PM to 04:00PM  
Where: Wilson Hall 1-144  
Details: National initiatives, such as Race to the Top (2009), aim to improve the quality of education for all students, prompting significant investments in the education of our nation's mathematics teachers. There is considerable interest in assessing and documenting the impact such investments have on teaching quality and, subsequently, student learning over time. While effective teaching is conceptualized broadly, statistical modeling is one approach to identify teaching which induces growth in student achievement that exceeds expectations. In particular, one tool for measuring the impact of professional development programs on teaching effectiveness is student achievement data. Value-added modeling techniques aim to estimate teacher and school effects and the changes to such effects that can be associated with specific interventions, such as professional development programs. Detecting the impact of a program on student achievement requires a coherent picture of student progress before, during and after a program's initiation. However, the data available to programs often do not meet the technical requirements of current statistical methods. This research investigates the use of new methods to analyze less-than-ideal data to help address the broader goal of creating a coherent picture of mathematics teaching and learning. In this presentation, I will provide an introduction to value-added modeling and discuss a selection of the new methods proposed.

Math Seminars  
Modeling the biogeochemistry of sulfate reducing biofilms in pipeline corrosion
Tianyu Zhang - Department of Mathematical Sciences, MSU
When: **Thursday, November 29, 2012 03:10PM to 04:00PM**
Where: EPS 126 or 127
Details: Sulfate-reducing bacteria (SRB) are those bacteria and archaea that can obtain energy by oxidizing organic compounds or molecular hydrogen H\(_2\) while reducing sulfate SO\(^{2-}\)\(_4\) to hydrogen sulfide H\(_2\)S. SRBs have both good impacts such as maintaining the sulfur cycle on earth, cleaning up contaminated soils and bad impacts such as causing corrosion of metal and concrete structures. We develop a mathematical model describing the biogeochemistry of sulfate reducing biofilms in pipeline corrosion. The model incorporates the essential chemical and biological processes involved as well as the growth and detachment of the biofilm. Numerical results and sensitivity analysis of model parameters are also provided.

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**Math Seminars**

**Monitoring milk-powder dryers via Bayesian inference in an FPGA**
Colin Fox - Department of Physics, University of Otago, New Zealand
When: **Thursday, November 15, 2012 03:10PM to 04:00PM**
Where: EPS 126 or 127
Details: The Electronics group at Otago is developing several technologies aimed at sensors that measure flow of milk powder using capacitance tomography (ECT) by sample-based Bayesian inference. Our approach is to use accelerated Gibbs sampling from the posterior distribution, and produce estimates in real time by embedding the calculation in hardware. I will discuss several of the steps: efficient Gibbs sample in ECT, polynomial acceleration of that MCMC, and the compiler to implement this calculation in an FPGA.

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**Math Seminars**

**Linear Algebra in Industry: A Case Study**
Cleve Ashcraft - Livermore Software Technology Corporation
When: **Thursday, November 08, 2012 03:10PM to 04:00PM**
Where: EPS 127
Details: Linear algebra plays an important role behind the scenes of large scale scientific and engineering simulation. Systems of equations, linear and nonlinear, need to be solved many times in a given simulation, and can take a sizeable fraction of the total time. Direct and iterative methods are used to solve the linear systems. Multiphysics is increasingly more common in simulation, so when we speak of the areas of thermal, acoustic, electromagnetic, fluids and mechanics, we will discuss combinations, e.g., coupling thermal-mechanics, fluid-structure-thermal, electro mechanics, etc. Constraints enter the definition of the problem in differing degrees. The manners in which the constraints are handled are diverse and influential. Constraints can be imposed exactly, or approximated, e.g., using a penalty method to impose the constraints. The first part of the talk will be a survey of five application areas: thermal, acoustics, electromagnetics, fluids, and mechanical. The discussions for each will
include stating the problem (from the perspective of the engineer developer), translating into linear algebra and applying one or more solution techniques. The second part of the talk will address the role of linear algebra in the context of a large simulation code. The strongest trend in simulation is towards more and more complex models and analysis, more coupling of modules, and more complicated internal physics, and therefore need for linear algebra will increase as the simulation functionality grows. Our perspective is that of a linear algebraist embedded in a group of physicists and engineers. We will discuss the role of research, publishing and patents while giving a comparison of a career in industry to that of academia and working in the national labs.

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**Math Seminars**

**Modeling Emerging properties of synthetic microbial consortia**

Tomas Gedeon - Department of Mathematical Sciences, MSU

*When:* Thursday, November 01, 2012 04:10PM to 05:00PM

*Where:* Roberts 218

*Details:* (NOTE DIFFERENT TIME AND PLACE. THIS IS BIOFILM SEMINAR) in the last ten years there was a growing appreciation of the role of microbial communities in health, ecology and biotechnology. Microbial consortia are ubiquitous in nature and most microbes participate in such a community. Understanding and control of microbial communities remains an outstanding challenge. Microbial consortia are used in water treatment plants, toxic site remediation, biofuel production and bioprocessing; naturally occurring complex community in human gut has a significant impact on human health. While it has been suggested that diversification of metabolic pathways among members of a community may enhance stability, robustness and increase efficiency, a precise quantitative understanding of advantages that a consortium provides for its members has been lacking. I will present some preliminary model of two species microbial consortia.

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**Math Seminars**

**A Discontinuous Galerkin FEM Approach for Simulation of a Model Describing Transcription in Ribosomal RNA**

Lisa Davis - Department of Mathematical Sciences, MSU

*When:* Thursday, October 25, 2012 03:10PM to 04:00PM

*Where:* EPS 127

*Details:* (NOTE THE SPECIAL PLACE OF THE TALK!!) Bio-polymerization processes such as transcription of DNA to mRNA and translation of mRNA to protein are two key cellular processes. On a very basic level these processes consist of the motion of a complex machine along a one-dimensional strand. Recent experimental data (using bacterial DNA) indicates that the motion of RNAP along a strand of DNA is not uniform. Single molecule observation using optical traps indicates that the elongating polymerase frequently pauses, and the duration of the pauses is roughly bi-modal with means of 1.2 seconds (about sixty percent of the time) and 6 seconds (about forty
percent of the time). In fast transcribing ribosome genes, the density of elongating complexes may be sufficiently high to create so-called bottlenecks or traffic jams along the DNA strand. The current research attempts to mathematically model this behavior and quantify the effects of these traffic jams on protein synthesis. During this presentation, I will briefly mention three broad categories of mathematical models for transcription and translation. Stochastic models such as the popular TASEP (Totally Asymmetric Simple Exclusion Process) model have been studied in the Physics community for many years. There are also classical deterministic models consisting of systems of ODEs that were proposed and studied within the last thirty years. The third class of models consists of various continuum models that represent the behavior of the relevant quantities in a continuous, average sense. The main focus of the presentation will be the consideration of a continuum model which uses the classical nonlinear LWR traffic flow model introduced in the 1950s. A first step in the modelling process has been to rigorously show that the classical model is a limit of a mean occupancy ODE model also popular within the literature. We make certain assumptions on the model's density velocity relationship that incorporates the presence of non-uniform distributions of pauses. The resulting equation is a nonlinear conservation law model with a discontinuous coefficient representing the mean elongation velocity of the RNAP. Numerical simulation of such a model is challenging for a standard Galerkin approach. Discontinuous Galerkin methods are currently being used for the model simulations, and some error results will be presented for a simple model which uses one pause (red light). Questions of particular interest center around the affect that the location and mean duration time of these pauses can have on the overall production of mRNA by a particular strand of DNA. We will explore some of these questions and give some numerical results for three versions of our current model.

Submitted by: Tomas Gedeon

Math Seminars
Spread of Viral Infection of Immobilized Bacteria
Hal Smith - Department of Mathematics, Arizona State University
When: Thursday, October 18, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: A reaction diffusion system with a distributed time delay is proposed for virus spread on bacteria immobilized on an agar-coated plate. A distributed delay explicitly accounts for a virus latent period of variable duration. The model allows the number of virus progeny released when an infected cell lyses to depend on the duration of the latent period. A unique spreading speed for virus infection is established and traveling wave solutions are shown to exist.

Math Seminars
Nanoparticles with a range of aerodynamic diameters were studied with respect to their transport and deposition properties in the human airways. A finite element code was developed that solved both the Navier-Stokes and advection diffusion equations monolithically. When modeling nanoparticle transport in the airways, the finite element method becomes unstable, and, in order resolve this issue, various stabilization methods were considered in terms of accuracy and computational cost. The stabilization methods considered here include the Streamline Upwind, Streamline Upwind Petrov-Galerkin and Galerkin Least Squares approaches. In order to compare the various stabilization approaches, the approximate solution from each stabilization approach was compared to the analytical Graetz solution, which is a model for monodispersed, dilute particle transport in a straight cylinder. The optimal stabilization method, especially with regards to accuracy, was found to be the Galerkin Least Squares approach for the Graetz problem. In the human airways geometry, the Galerkin Least Squares stabilization approach once more provided the most accurate approximate solution. The choice of stabilization method had a significant impact for particles with an aerodynamic diameter or smaller.

Math Seminars
Global Linearization of Solenoidal Maps via Conditional Measures II
Jaroslaw Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, October 05, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This will be a continuation of the talk from two weeks ago.

Math Seminars
Igniting the Core: A Once in a Generation Chance for Mathematics Education
Dr. William McCallum - University of Arizona
When: Thursday, October 04, 2012 04:10PM to 05:00PM
Where: Procrastinator Theater
Details: The Common Core State Standards for Mathematics, released in June 2010, have been adopted by 45 states (including Montana). This constitutes a revolution for mathematics education in this country, a chance to change the way we do business which will not come again. William McCallum, head of the Department of Mathematics at the University of Arizona, who led the writing team for the standards, will talk about the coherence and focus of the standards, and the opportunities and challenges in implementing them.
Math Seminars
Data Analysis: Identifying the Structure of a Cloud of Biological Data Points using Mathematical Techniques
Jacob W. Brown - Department of Mathematical Sciences, MSU
When: Thursday, October 04, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In many areas of biological research, there is an abundance of noisy, imprecise data coupled with a lack of high precision quantitative data. This results in many biological researchers searching out mathematicians and/or statisticians to help design, and use, data analysis methods that are not only insensitive to small errors in measurements, but are also robust enough to discover the underlying structure of the data set. I will present one of these insensitive, yet robust methods that investigates the three dimensional spatial structure of a point cloud data set. This data set has been acquired from the locus of afferent neuron terminals in a house cricket. The method incorporates knowledge gained from computer science, biology (neuroscience) and mathematics, and is easily adaptable in the analysis of a wide range of other point cloud data sets.

Math Seminars
The Math of Biofilm Tolerance to Antimicrobial Agents
Philip S. Stewart - Center for Biofilm Engineering, MSU
When: Thursday, September 27, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: When bacteria or fungi form multicellular biofilms they become protected from killing by diverse antimicrobial agents. The phenomena important to the development of biofilm tolerance may include antimicrobial penetration, nutrient and electron acceptor gradients and resulting growth and dormancy, differential gene and protein expression, and the dependence of antimicrobial susceptibility on the resultant physiological and phenotypic states. Each of these phenomena is amenable to description by relatively simple (though interconnected) differential equations. A framework for such an integrated analysis will be presented.

Math Seminars
Global Linearization of Solenoidal Maps via Conditional Measures
Jaroslaw Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, September 21, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I will explain how conditional measures can be used to globally linearize certain non-linear maps. This procedure trades a non-linear dynamical system with discrete time for a linear one with "two-dimensional time". It generates more questions than answers. I will advertise some of them.
Math Seminars
A simple flow channel model: estimating kinetic parameters in a biofilm
Benjamin Jackson - Department of Mathematical Sciences, MSU
When: Thursday, September 20, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Biofilm growth is present in many natural and industrial settings, and models to describe it grow ever more complex. Much of this growth occurs in flow channels where this complexity may not be necessary. We present a simple model describing the transport and kinetics of urea in a flow channel containing biofilm.

Math Seminars
Some Routing and Flow Allocation problems in Networks
Brendan Mumey - Department of Computer Science, MSU
When: Thursday, September 13, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I will survey some recent results on determining energy/cost efficient solutions to some network routing, flow allocation and data center provisioning problems.

Math Seminars
Using Technology to Enhance Teaching and Learning in the Mathematics Classroom
LeAnne Yenny - Department of Mathematical Sciences, MSU
When: Wednesday, September 12, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-133
Details: This talk will present uses for video, SmartPen pencasts, and cell phone technology in classroom settings. Please bring a cell phone with text capability!

Math Seminars
A Study of the Development of TPACK in Pre-service Secondary Teachers
Rejoice Mudzimiri - Department of Mathematical Sciences, MSU
When: Thursday, June 07, 2012 10:00AM to 10:50AM
Where: Hurst Conference Room
Details: This is a dissertation defense.

Math Seminars
Applying Nonlinear Alternate Direction Implicit Methods to a 2D Model of a Pancreatic Islet
Heather Moreland - Department of Mathematical Sciences, MSU
When: Thursday, April 26, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
In response to an increase in blood glucose levels, insulin is released into the bloodstream by the pancreatic islets of Langerhans. As a result of this influx of glucose, the islets start bursting oscillations of the membrane potential and the intracellular calcium concentration. However, time delays of several seconds in the activity of distant cells in the islets have been observed, indicating that electrical and calcium wave propagation through the islets can occur. A robust biophysical model of a 2D pancreatic islet is considered. As the islets are roughly circular, polar coordinates will be employed. The resulting model equations contain two nonlinear reaction-diffusion equations. A modification of the standard Alternate Direction Implicit (ADI) Method proposed by Amiri & Hosseini for nonlinear parabolic partial differential equations is employed. The method is applied to a test problem in polar coordinates with a mixed boundary condition. The numerical method is then applied to the biophysical model of an islet. Two simulations are carried out; the islet being immersed in a glucose bath and having glucose applied to a portion of the boundary of the islet.

**Math Seminars**

**Stochastic Perturbations of Fast-Slow Dynamical Systems**

**Jacob W. Brown - Department of Mathematical Sciences, MSU**

**When:** Thursday, April 19, 2012 03:05PM to 04:00PM  
**Where:** EPS 126  
**Details:** Excitable systems are a class of nonlinear dynamical systems that are prevalent in modeling problems throughout the many disciplines of science. These deterministic models do not, however, incorporate the random perturbations that can affect the natural systems that are being modeled. We try to understand the effect of these stochastic perturbations on a simple FitzHugh-Nagumo model through the analysis of the associated stochastic differential equations. This analysis is conducted by adapting/implementing a technique from geometric singular perturbation theory known as the blow-up method. We will present the blow-up method for both the deterministic and stochastic FitzHugh-Nagumo models. Also, we will illustrate numerically the effect of stochastic perturbations on a regular phase oscillator versus that of a Van der Pol oscillator.

**Math Seminars**

**Aperiodic Cantor Dynamics: A Survey and New Results**

**Dr. Sergey Bezuglyi - Department of Mathematics, Institute for Low Temperature Physics, Kharkov, Ukraine**

**When:** Monday, April 16, 2012 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-144  
**Details:** Traditionally, the most studied homeomorphisms in topological dynamics are minimal ones (meaning that every orbit is dense in the space). The property that every orbit is just infinite characterizes the so called aperiodic dynamics. I will consider in my talk different aspects of aperiodic dynamics on a Cantor set X. I will first discuss the topological properties of the set of all aperiodic homeomorphisms considered as a
subset of Homeo(X). Every aperiodic homeomorphism admits a realization as a Vershik map acting on a path space of a (non-simple, in general) Bratteli diagram. The second part of my talk will be focused on aperiodic homeomorphisms whose Bratteli-Vershik models are represented by the diagrams of simplest form: stationary and finite rank diagrams. For such diagrams one can explicitly describe the set of ergodic invariant measures and study properties of these measures.

Math Seminars
When less is more: estimating zero-order ureolysis rates in E.coli biofilms using a simple PFR model.
Benjamin Jackson - Department of Mathematical Sciences, MSU
When: Thursday, April 12, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Biologically mediated calcite precipitation via urea hydrolyzing bacteria has many attractive applications. Unfortunately, ureolysis rates in biofilms for various organisms are not well known. This talk will discuss a very simple ureolysis model in the context of experiments being conducted at Montana State University's Center for Biofilm Engineering. Ureolysis rates are computed and compared to lab-measured values for a simple plug flow reactor (PFR) growing a species of E. coli.

Math Seminars
Light, Temperature, and Their Role in Determining the Niche Structure of Synechococcus spp. Inhabiting Yellowstone Hot Spring Microbial Mats.
Shane Nowack - Department of Mathematical Sciences, MSU
When: Thursday, April 05, 2012 03:10PM to 04:00PM
Where: EPS 126
Details: NOTE THE EPS ROOM! Previous research (Ward 2006) suggests Synechococcus spp., oxygenic phototrophs inhabiting the upper photic zone of microbial mats found in the effluent channels of Mushroom and Octopus Springs in Yellowstone National Park, can be grouped into fundamental, ecologically distinct units (ecotypes). Two ongoing projects will be discussed in this presentation. For the first project, genetically distinct (at the psAa locus), mat-relevant laboratory isolates were cultivated, from several different putative ecotypes, and currently a phenotypic analysis of these isolates is underway. The goal of this analysis is to confirm the existence of \textit{Synechococcus} ecotypes that have different adaptations to temperature and light. For the second project, light and channel temperature data were collected from the field (every 20 minutes for an entire year) and these data will be used to supply a temperature and/or light history to a one-species chemostat model. Through a constrained optimization procedure, the model is designed to provide insight on how naturally occurring temporal fluctuations may influence ecotype niche structure. After briefly addressing the details of the experimental setup and the data collection, the
remaining time will be spent discussing preliminary results from the phenotype experiment and from the model.

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**Math Seminars**

**Discontinuous Galerkin Finite Element Methods for Simulation of a DNA Transcription Process Model**
Jennifer Thorenson - Department of Mathematical Sciences, MSU
When: Thursday, March 29, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: A nonlinear PDE is used to model the transcription process of ribosomal RNA. Experimentally, the motion of a transcription complex experiences multiple pauses, and the density of elongating complexes may be sufficiently high to experience traffic jams. In the 1950’s the nonlinear PDE was used as a very simplified model for traffic flow, and we make use of those similarities that the transcription process shares with simple traffic flow. A Discontinuous Galerkin FEM is used for simulation of the nonlinear conservation law model. The model includes the presence of physically relevant, nonuniform distributions of pauses along the rrn operon, and these pauses result in delays during the transcription process, possibly affecting protein production of the cell. The DG simulations allow us begin to gain insight into the instantaneous elongation rate. This elongation rate has been estimated experimentally using a basic arithmetic calculation that takes into account neither the density of polymerases on the operon nor the existence of pauses on the operon. The PDE model accounts for both of these phenomena, and the DG simulations allow us to numerically estimate both the instantaneous elongation rate and the average delay experienced by a polymerase under such conditions. A short description of the model is followed by a discussion of the DG methods, the incorporation of pauses into the nonlinear PDE model, the delay calculations, and subsequent simulations for various choices for the elongation rate.

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**Math Seminars**

**Numerical Methods for Two-fluid Mixtures and Extension of the Immersed Boundary Method to Such Mixtures**
Dr. Aaron Fogelson - Departments of Mathematics and Bioengineering, University of Utah
When: Monday, March 26, 2012 01:00PM to 02:00PM
Where: Wilson Hall 1-144
Details: THIS IS A SPECIAL APPLIED MATH SEMINAR. PLEASE NOTE DIFFERENT DAY AND TIME. Gels made up of a polymer network and a solvent play important roles in many physiological situations including, for example, the cytoplasm of cells. One approach to modeling such a gel is as a mixture in which both network and solvent can co-exist at each spatial point and the volume fraction of each material is tracked. Each material has its own velocity field, and this two-fluid model allows relative motion between the two materials. Two sets of momentum equations are solved along with an
incompressibility constraint on the volume-average velocity field. The solvent is typically regarded as a Newtonian fluid with the usual viscous and pressure stresses. The network may have properties ranging from those of a viscous fluid to a viscoelastic fluid to a viscoelastic solid, and these properties may change both in time and space. A differential constitutive law for tracking the stresses within the network is specified. I will present robust and efficient methods for solving the equations of such a two-fluid model. I will also present our work to date on embedding membranes or other structures in the two fluids using an extension of the Immersed Boundary method.

Math Seminars
Two Different Flavors of Introductory Statistics
Dr. Robert delMas - Department of Educational Psychology, University of Minnesota
When: Friday, March 23, 2012 03:10PM to 04:00PM
Where: Linfield 125
Details: Dr. delMas and his colleagues have developed two different introductory statistics curricula through NSF-funded projects. Both curricula are based on implications from educational research and implement the Guidelines for Assessment and Instruction in Statistics Education (GAISE). The Adapting and Implementing innovative Materials in Statistics (AIMS) curriculum, based on a traditional sequence of topics, consists of innovative lessons designed to involve students in lots of discussion, computer explorations, and small group activities. The CATALST curriculum is a radically different undergraduate introductory statistics course consisting of a carefully designed sequence of activities that helps students develop their understanding of statistical inference using randomization and bootstrap methods. The talk will present activities from different parts of each course to illustrate the two different approaches to active learning in introductory statistics.

Math Seminars
Gaussian Markov Random Field Priors and MCMC for Inverse Problems
John Bardsley - Department of Mathematics, University of Montana
When: Thursday, March 22, 2012 03:00PM to 04:00PM
Where: EPS - 126
Details: IMPORTANT: This talk will be at a different place, because it will be broadcasted on IVN to Dickinson State University. We need to finish right at 4 so it would be great if we can start closer to 3 than to 3:10. Abstract: In this talk I will explore the connections between Bayesian statistics and inverse problems. In particular, I will show how familiar quadratic regularization functions can be viewed as prior probability densities arising from Gaussian Markov Random Fields (GMRFs). GMRFs, in turn, correspond to concrete probabilistic assumptions regarding the value of the unknown image at a specific pixel based on the value of its neighbors. With a GMRF prior in hand, I will then show how to perform MCMC sampling of the unknown image and of the noise and prior precision values. The image sampling step is a large-scale structured
linear algebra problem that has seen little attention by the numerical linear algebra community. The samples outputted by the MCMC method can be used to compute a reconstructed image, e.g. the sample mean, as well as estimates of the precision parameters, which can in turn be used to estimate the regularization parameter.

Math Seminars
To be announced
Dr. Andrew Gelman - Professor of Statistics and Political Science, Columbia University
When: Monday, March 19, 2012 04:10PM to 05:00PM
Where: Procrastinator Theater
Details: CANCELED - due to health reasons. We hope Dr. Gelman will visit during the 2012-2013 academic year.

Math Seminars
Comparison of Continuous and Discontinuous Galerkin Finite Element Methods for Parabolic Differential Equations Employing Implicit Time Integration
Dr. Jeff Heys - Department of Biological and Chemical Engineering, MSU
When: Thursday, March 08, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: A number of different discretization techniques and algorithms have been developed for approximating the solution of parabolic partial differential equations. A standard approach, especially for applications that involve complex geometries, is the classic continuous Galerkin Finite Element Method (GFEM). This approach has a strong theoretical foundation and has been widely and successfully applied to parabolic partial differential equations. One challenging category of problems, however, are equations that include an advective term that is large relative to the second-order diffusive term. For these advection dominated problems, the un-stabilized continuous GFEM can show stability issues or yield poor results. An alternative to the continuous GFEM is the discontinuous GFEM; through the use of a numerical flux term used in deriving the weak form the discontinuous approach has the potential to be more stable in strongly advective problems. However, the discontinuous GFEM also has significantly more degrees-of-freedom due to the replication of nodes along element edges and vertices. This paper compares the computational cost, stability, and accuracy (when possible) of continuous and discontinuous GFEM for four different test problems including the advection-diffusion equation, viscous Burgers' equation, and the Turing pattern formation equation system. The comparison is performed using as much shared code as possible between the two algorithms and considers the use of direct, iterative, and multilevel linear solvers. The results show that, for implicit time integration, the continuous GFEM is typically 5-20 times less computationally expensive than the discontinuous GFEM using the same finite element mesh and element order. However,
the discontinuous GFEM is significantly more stable than the continuous GFEM for advection dominated problems and is able to obtain accurate approximate solutions for cases where the classic, un-stabilized continuous GFEM fails.

Math Seminars

Classification of Musical Instruments Using Bayesian Networks
Patrick Donnelly - Department of Computer Science, MSU
When: Thursday, March 01, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This talk explores the use of Bayesian networks for the identification of monophonic musical instruments. Peak spectral amplitude in ten frequency windows are extracted for each of twenty time windows to be used as features. Over a dataset of 24,000 examples covering the full musical range of 24 different common orchestral instruments, four different Bayesian Network structures, including Naive Bayes, are examined and compared to Support Vector Machines and k-Nearest Neighbor classifier. Classification accuracy is examined by instrument, instrument family, dynamic level, and dataset size. Bayesian networks with conditional dependencies of both time and frequency features achieved 98% accuracy in the instrument classification task and 97% accuracy in the instrument family identification task. These results demonstrated a significant improvement over the previous approaches in the literature on this dataset.

Math Seminars

Observation and Quantitative Analysis of Microbial Consortia; Natural and Engineered Synthetic Community Systems
Hans C. Bernstein - Dept. Chemical and Biological Engineering, Center for Biofilm Engineering and Thermal Biology Institute
When: Thursday, February 23, 2012 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: A novel synthetic microbial community was designed based on biomimicry of key ecological roles found in stable, naturally occurring microbial consortia. The engineered community paradigm exploits the syntrophic relationship community found in fermenter-oxidizer ecological motifs. Specific examples of natural microbial systems were observed in Yellowstone National Park hot spring systems and used as comparative templates for the engineered systems. The synthetic consortia were composed of metabolically engineered Escherichia coli (E.coli) binary cultures enabling enhanced culture performance as compared to traditional mono-culture techniques. Individual community members were responsible for primary-productivity and ability to assimilate glucose or secondary-heterotrophy, constrained to scavenge byproducts from the system. The study demonstrated that synthetic-biology enabled division of labor permits simultaneous optimization of multiple tasks which give rise to new emergent properties of the system. The benefits of this engineered community system were demonstrated using three relevant culturing systems: batch, chemostat and biofilm and glucose-based binary culture productions increased by ~10, 30 and 50%
respectively compared to appropriate monocultures grown under identical conditions. The increased culture production observed in the engineered consortia was an emergent property of the community system and could not be obtained with monocultures. Additionally, biofilm community cultures showed an example of another emergent property by self-assembling into strain specific spatial laminations. Spontaneous assembly of position specific community member portioning was also consistent with observations from natural hot springs systems which are subject to mass transfer limitations. The study identified a metabolic engineering archetype which can serve as a biocatalyst platform and be easily adapted for many E.coli based bioprocesses.

Math Seminars

Using Survival Analysis to Inform Decisions about Dynamic Models: A Case-Study on Pneumonia in Bighorn Sheep
Kezia Manlove - Center for Infectious Disease Dynamics, Penn State University
When: Wednesday, February 22, 2012 04:10PM to 04:45PM
Where: Wilson Hall 1-134
Details: Pneumonia in bighorn sheep is an on-going conundrum for wildlife managers. The consequences of culling sheep populations in the face of pneumonia outbreaks depend on whether individuals are able to recover and develop protective immunity for future outbreaks. While it is widely accepted that reducing contact between domestic and wild sheep limits pneumonia introduction, in some regions pneumonia persists for many years, even as local domestic inholdings decline. This analysis focused on one such system, the Hells Canyon region. We assessed the evidence that pneumonia causing pathogens induce an acquired immune response in bighorn sheep by reconstructing pneumonia exposure histories, and evaluating the impact an individual's exposure history has on its survival. We found evidence of protective immunity lasting approximately two years, and saw that translocated individuals suffered much higher pneumonia risk than residents. Surviving many past pneumonia events decreased an adult’s risk in future events, although lambs born to ewes with many past exposures were at higher risk than their peers. These results are consistent with a disease that produces some chronic carriers that shed to their lambs for many years. Interestingly, while we might expect that the impact of chronic carriage on a population should decline over time and allow for population recovery (through senescence of carriers), we instead saw a trend of increasing lamb pneumonia mortality. Our findings corroborate long-held hypotheses about the presence of a chronic carrier state, and suggest that better understanding the specific mechanisms leading to chronic carriage will help clarify the costs and benefits surrounding various management strategies.

Math Seminars

Culturally-Mathematically Relevant Pedagogy (CMRP): Fostering Urban English Language Learners’ Cognitive Transition from Additive to
Multiplicative Reasoning
Dr. Ron Tzur - School of Education and Human Development, University of Colorado - Denver
When: Friday, February 17, 2012 04:10PM to 05:00PM
Where: Procrastinator Theater
Details: Dr. Tzur will articulate an approach, termed Culturally-mathematically relevant pedagogy (CMRP), for fostering urban English language learners' (ELLs') mathematical progression. To situate CMRP, he will use preliminary findings from a pilot study in which he co-taught with the homeroom teacher of a Grade-4 classroom (85% ELLs) to promote the students' transition from additive to multiplicative reasoning. The teaching is rooted in a conceptual framework about cognitive change - Reflection on Activity Effect Relationship, which guides design and selection of tasks to fit with and proceed from students' prior conceptions.

Math Seminars
Research Opportunities in Mathematics Instructional Coaching
Dr. Beth Burroughs - Department of Mathematical Sciences, MSU
When: Tuesday, February 07, 2012 10:00AM to 10:50AM
Where: Hurst Conference Room
Details: I will present an overview of the "Examining Mathematics Coaching" (EMC) project. I will highlight some of the ongoing research and illustrate some of the opportunities that are available for graduate students looking for research topics.

Math Seminars
Mathematics and Systems Biology: Can Mathematical Models Help Discover New Biology?
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, February 02, 2012 04:00PM to 05:00PM
Where: Procrastinator Theater, SUB
Details: What is the role of mathematical models in biology? Modern physics and calculus have common roots, but can mathematics be used in a meaningful way in biology, specifically cell biology? I will illustrate these issues on a current research project modeling transcription of ribosomal genes in E.coli. This talk is part of the Kopriva Science Seminar Series.

Math Seminars
Expansive Homeomorphisms on Minimal Sets
Hannah Bergren - Department of Mathematical Sciences, MSU
When: Friday, December 02, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I will be presenting a research paper I have been reading: "Expansive Homeomorphisms and Topological Dimension" by Ricardo Mane, 1979. Specifically I will show that a minimal set of an expansive homeomorphism is totally disconnected.

Math Seminars

Physics, Symmetry and Topology of Superfluid 3He
Anton Vorontsov - Department of Physics, MSU
When: Thursday, December 01, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk, aimed at the general audience, I will give an introduction to the field of condensed-matter physics, in the context of the low-temperature properties of an isotope of Helium, which becomes a very special liquid at $10^{-3}$ Kelvin. I will introduce phenomena of Superconductivity and Superfluidity, and talk about symmetry classification of different phases of superfluid He-3. We then look at the effects of samples boundaries on the superfluid state, and describe the quasiparticle states that are generated at interfaces. These states can be of a topological nature due to the symmetry properties of the bulk superfluid condensate. Quasiparticle states at the boundaries can play a crucial role in determining the fate of the superfluidity in a constrained geometry, such as film with thickness of several coherence lengths. By varying geometry, temperature or pressure one can tune the interactions between these states, and induce appearance of superfluid phases with broken non-trivial symmetries, including time-reversal symmetry or spatial translations.

Math Seminars

Neuroinflammation and electroanatomy: Integrative roles in pain and movement disorders
Mark Cooper - Department of Biology, University of Washington
When: Tuesday, November 15, 2011 04:00PM to 05:00PM
Where: Procrastinator Theater, SUB
Details: Dr. Cooper will discuss new evidence about the origins of some pain disorders, as well as some classes of movement disorders (including Tourette syndrome, Dystonia and gait disorders), which may be linked to the same underlying causes. This lecture is presented by the Kopriva Science Seminar Series. (Note this will lecture is on TUESDAY)

Math Seminars

Discrete Ecology in a Continuous Environment
Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, November 10, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: On the one hand, microbes reproduce asexually in most cases (and so lack the homogenization of sexual reproduction); on the other hand, in many instances microbes are able to exchange genetic material even with other microbes that are not closely related. Specialization together with wide access to genetic potential could lead to efficient adaptation to local environmental circumstances - a continuously varying environment might then exhibit continuously varying ecology. In at least one case (Yellowstone cyanobacterial communities), though, the ecology seems to be discretized in a finite way. A mathematical model addressing this issue will be presented.

Math Seminars
Math Placement Exams and Calculus: Researching an Approach
Dr. Jessica Deshler - Department of Mathematics, West Virginia University
When: Monday, November 07, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-133
Details: At West Virginia University we have been using the MAA placement exams and student majors to place students into one of three calculus courses. Students majoring in fields which require calculus but no knowledge of trigonometry may take Applied Calculus for 4 hours per week for 3 credits. Majors requiring knowledge of trigonometry and calculus may place into a 4-credit, 5- or 6-hour-per-week course or take the course at a slower pace as an 8-credit, 4-hour-per-week, 2 semester course which provides time for pre-calculus instruction as needed throughout the course. In this talk I will explain this strategy, some research questions our department is asking, and preview some preliminary results. There will be time for Q&A about this approach.

Math Seminars
Models of Cartilage Stress-Relaxation: fitting and relevance
Ron June - Department of Mechanical and Industrial Engineering, MSU
When: Thursday, November 03, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Cartilage is the soft tissue that lines human joints such as knees and hips. More than 50% of the population above age 65 will exhibit cartilage degradation associated with osteoarthritis. During normal usage, cartilage functions as a mechanical tissue with deformation in response to loading. However, the molecular mechanisms by which cartilage resists deformation are poorly understood. Toward understanding the molecular basis of cartilage mechanics, we performed multiple experimental stress relaxation tests. Mathematical models were fit to the experimental data toward interpreting the experiments based on the values of the fitted parameters. One particular model, the stretched exponential, appears promising both because of its underlying physical principals and because of its ability to fit the data. In fitting this model, we discovered some atypical fitting challenges, and we present a novel fitting algorithm which has been used successfully on a wide range of data.
Math Seminars

A combinatorial approach to multiparameter nonlinear dynamics II.
Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, October 20, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This is a second talk in a series of two, where I introduce a combinatorial approach to multiparameter nonlinear dynamics. I will first briefly review how to construct a combinatorial approximation of dynamics at a single parameter value. I will introduce ideas that allow computation of Conley-Morse graphs over multiple parameters, which leads to the concept of Database of a dynamical system. At the end I will mention current work on using data mining ideas on detection of bifurcations in the parameter space.

Math Seminars

A combinatorial approach to multiparameter nonlinear dynamics I.
Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, October 13, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This will be a first out of two talks where I want to introduce a relatively new approach to computations of dynamics in multiparameter systems. Since in many applications there is a great uncertainty in values of the parameters, and even the selection of the appropriate model is part of the problem, there is a need to characterize dynamics of different competing models over a multidimensional parameter space. The comparison of the dynamics of the alternative models with the experimental data can help in model selection. I this first talk my aim is to provide a gentle, accessible introduction to the main ideas of the theory. In the second talk a week later I will talk about our current work in this area. All graduate students are encouraged to attend.

Math Seminars

Modeling of Biocide Action against Biofilm
Tianyu Zhang - Department of Mathematical Sciences, MSU
When: Thursday, October 06, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We consider the mathematical model of dynamic antimicrobial action against bacterial biofilm. A one-fluid two-component model is used in which the biofilm consisting of live and dead bacteria is modeled as one fluid component, while the solvent containing biocide is modeled as the other, and each component is represented by its volume fraction. The whole system is assumed to be an incompressible fluid and the velocity is governed by Navier-Stokes equation. Biocide kills the live bacteria and its transport is governed by an advection-reaction-diffusion equation. Certain biocide also weakens the mechanical cohesiveness of the biofilm and results biofilm removal under the shear stress of external flow. Spatial and temporal patterns of antimicrobial action of
three different biocides are considered and numerical simulation results by finite difference method are presented.

**Math Seminars**

**The Origin of Behavior**
Andrew Lo - Harris & Harris Group Professor at the MIT Sloan School of Management and Director of the MIT Laboratory for Financial Engineering

When: **Friday, September 30, 2011 03:10PM to 04:00PM**
Where: Wilson Hall 1-144

Details: We propose a single evolutionary explanation for the origin of several behaviors that have been observed in organisms ranging from ants to human subjects, including risk-sensitive foraging, risk aversion, loss aversion, probability matching, randomization, and diversification. Given an initial population of individuals, each assigned a purely arbitrary behavior with respect to a binary choice problem, and assuming that offspring behave identically to their parents, only those behaviors linked to reproductive success will survive, and less reproductively successful behaviors will disappear at exponential rates. When the uncertainty in reproductive success is systematic, natural selection yields behaviors that may be individually sub-optimal but are optimal from the population perspective; when reproductive uncertainty is idiosyncratic, the individual and population perspectives coincide. This framework generates a surprisingly rich set of behaviors, and the simplicity and generality of our model suggest that these derived behaviors are primitive and nearly universal within and across species. Our approach also yields an evolutionary foundation for bounded rationality and a simple version of Hawkins' "memory-prediction" model of intelligence.

**Math Seminars**

**Can Financial Engineering Cure Cancer, Solve the Energy Crisis and Stop Global Warming?**
Dr. Andrew Lo - Harris & Harris Group Professor, MIT Sloan School of Management

When: **Thursday, September 29, 2011 03:00PM to 04:00PM**
Where: Procrastinator Theater, SUB

Details:

**Math Seminars**

**Mechanics of cell motility**
Dr. Alex Mogilner - Department of Neurobiology, Physiology and Behavior and Department of Mathematics, University of California at Davis

When: **Friday, September 23, 2011 03:10PM to 04:00PM**
Where: Wilson Hall 1-144

Details: Animal cells migrate on surfaces using lamellipodium, flat dynamic network of actin polymers enveloped by the cell membrane. Recent experiments showed that the
lamellipodial geometry is tightly correlated with cell speed and with actin dynamics. These quantitative data combined with computational modeling suggest that motile cells crawling is based on "actin treadmill inside unstretchable membrane bag". According to this model, a force balance between membrane tension and growing and pushing actin network distributed unevenly along the cell periphery can explain the cell shape and motility. However, when adhesion of the cell to the surface weakens, the actin dynamics become less regular, and muscle-like myosin-powered contraction starts playing crucial role in stabilizing the cell shape. The lesson is that multiple and redundant processes govern cell motility, and modeling challenge is a synthesis of these processes operating on multiple scales within a computational framework that treats the cell as an object with a free boundary. I will illustrate how the combination of theoretical and experimental approaches helped to unravel the cell motile behavior and how modeling is starting to explain not only steady migration, but also cell turning.

Math Seminars

On the Homology of Lifts of Maps on Graphs
Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, September 23, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: NOTE: The room has changed from 1-144 to 1-139 this talk will be grad student friendly. All 511, 595, 547 students are encouraged (!!) to attend. First third to half of talk, background describing covering spaces, the fundamental theorem of covering spaces, induced homomorphisms on homotopy groups. Broad Question: Given a map f:X -> X with nonsingular homology and a finite cover E ->X, with a lift F:E \to E, what can be said about the homology of the lift F? Sample result: Suppose that C_n is a wedge of n circles with a double cover E_n. If the homology map H_1(f) is invertible over Z_2, then the same holds for the homology map H_1(F). Over the integers Z, we give a counterexample for n=2.

Math Seminars

Mathematics and Biology of Cell Molecular Machines: From Mitosis to the Golgi apparatus
Dr. Alex Mogilner - Department of Neurobiology, Physiology and Behavior and Department of Mathematics, University of California at Davis
When: Thursday, September 22, 2011 03:00PM to 04:00PM
Where: Procrastinator Theater, SUB
Details: Prior to cell division, chromosomes are segregated by mitotic spindles. This molecular machine self-assembles remarkably fast and accurately in an elegant process of search and capture, during which dynamic polymers from two centers grow and shrink rapidly and repeatedly until a contact with chromosomes is established. At the same time, the chromosomes interact with each other. Dr. Mogilner will show computer simulation and experimental microscopy results illustrating how cells deploy a number of redundant mechanisms optimizing the assembly by keeping it accurate yet
rapid. Very similar strategies are used to assemble Golgi apparatus. The talk will illustrate how computer modeling assists experiment in unraveling mysteries of cell dynamics. Alex Mogilner grew up in the Urals in Russia where he received a M.Sc. in Engineering in 1985. He did research in mathematical physics until 1992, when he started studying mathematical biology at the University of British Columbia. After receiving a Ph.D. in applied mathematics in 1995, he worked at UC Berkeley as a postdoctoral researcher, and then in 1996 at the Math Department at UC Davis as an assistant professor. He is now a Professor there in the Department of Mathematics, as well as the Department of Neurobiology, Physiology and Behavior. Professor Mogilners areas of expertise include mathematical biology, cell biology and biophysics; he researches mathematical and computational modeling of cell motility and cell division. Alex has written almost 100 papers including influential and pioneering models of polymerization ratchets, search-and-capture mechanism of spindle assembly and keratocyte motility.

Math Seminars
A Sloppy Introduction to Large Deviations, Thermodynamical Formalism, and Multifractal Analysis
Dr. Jaroslaw Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, September 16, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The talk will be aimed at students.

Math Seminars
What Math Should We Teach, Now that Cell Phones Can Do It All?
Dr. Warren Esty - Department of Mathematical Sciences, MSU
When: Thursday, September 15, 2011 04:10PM to 05:00PM
Where: Wilson Hall 1-133
Details: The electronic world is changing rapidly. What should we be teaching students, especially future elementary education teachers, about math now that apps for iPads and iPods and cell phones can do the math we traditionally teach?

Math Seminars
Analyzing Mathematical Models of Intracellular Calcium Dynamics using Geometric Singular Perturbation Techniques
Dr. Emily Harvey - Department of Chemical Engineering and Department of Mathematical Sciences, MSU
When: Thursday, September 15, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Oscillations in free intracellular calcium (Ca$^{2+}$) concentration are known to act as signals in almost all cell types, transmitting messages which control cellular
processes including muscle contraction, cellular secretion and neuronal firing. Due to the universal nature of calcium oscillations, understanding the physiological mechanisms that underlie them is of great importance. It has been proposed that a simple experiment, whereby a pulse of inositol (1,4,5)-trisphosphate (IP$_3$) is applied to a cell, can be used to distinguish between two competing mechanisms which lead to calcium oscillations. However, detailed mathematical investigation of models has identified an anomalous delay in the pulse responses of some models, making interpretation of the experimental data difficult. A key feature of intracellular calcium dynamics that has been found experimentally is that some physiological processes occur much faster than others. This leads to models with variables evolving on very different time scales. We find that the response of models to a pulse of IP$_3$ can be understood in part by using geometric singular perturbation techniques, which take advantage of the separation in time scales. Using recently developed theory for systems with three or more slow variables, we find that the anomalous delay is due to the presence of a curve of folded singularities and corresponding canard solutions. Importantly, we find that in some models the response to a pulse of IP$_3$ is contrary to predictions and invalidates the proposed protocol, thus indicating the need for development of a different experimental protocol.

Math Seminars

Computing multifractal spectra via simplicial measures
Jesse Berwald - Department of Mathematical Sciences, MSU
When: Monday, June 13, 2011 10:00PM to 11:00PM
Where: Wilson Hall 1-144
Details: Complex dynamical systems occur on many scales in the natural world, and serve as rich subjects of study. Examples include ecosystems, physiological systems, and financial markets. Simplified versions of these system can be described by dynamical systems. As such, understanding the qualitative behavior of dynamical systems provides an important window into real-world phenomena. In this talk we focus on the qualitative behavior described by the measure concentrated on the attractor of a dynamical system. A common way to study such complicated measures is through their multifractal spectra. We will describe a new method, developed to approximate the Sinai-Bowen-Ruelle measure on an attractor that is based on the Vietoris-Rips complex. We use it to approximate various measures concentrated on a number of example sets, and demonstrate its efficacy by computing the corresponding multifractal spectra. This presentation will serve as the public portion of the dissertation defense.

Math Seminars

Quasiperiodic Structures and the Semiconjugacy Problem
Dr. José Aliste-Prieto - Centro de Modelamiento Matemático, Universidad de Chile
When: Tuesday, May 10, 2011 02:10PM to 03:00PM
Where: Wilson Hall 1-139
Details: The description of quasiperiodic structures has a long tradition in mathematical physics, in particular since the discovery of quasicrystals in the early 80s. Frequently, the modelling of such structures leads to different types of dynamical systems which include, depending on the concept of quasiperiodicity that is used, skew products over quasiperiodic or almost-periodic base flows, mathematical quasicrystals or maps of the real line with almost-periodic displacement. A first problem that arises is to know whether there is a uniqueness of rotation/translation number. Next, an important problem in this context is to know whether the considered system is semi conjugate to a rigid translation. In this talk, we focus on the one dimensional case, and review previous results and then show a solution to the semiconjugacy problem in a general setting, which includes all the above-mentioned examples.

Math Seminars
Stochastic Perturbations of Fast-Slow Dynamical Systems
Jacob Brown - Department of Mathematical Sciences, MSU
When: Thursday, April 28, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Fast-slow systems are a class of nonlinear dynamical systems that are prevalent in modeling problems throughout the many disciplines of science. These deterministic models do not, however, incorporate the random perturbations that can affect the natural systems that are being modeled. We try to understand the effect of these stochastic perturbations on a simple FitzHugh-Nagumo model through the analysis of the associated stochastic differential equations. This analysis is conducted by implementing a technique from geometric singular perturbation theory known as the Blow-up method. We will present the Blow-up method for both the deterministic and stochastic FitzHugh-Nagumo models. We will, also, compare the effect of stochastic perturbations on a phase oscillator and that of a van der Pol oscillator.

Math Seminars
Tentative title: Teaching Introductory Statistics
Dr. Dan Schafer - Department of Statistics, Oregon State University
When: Friday, April 15, 2011 03:10PM to 04:00PM Where:
Wilson Hall 1-144

Math Seminars
The Pressures, Pitfalls, and Possibilities of the Introductory Statistics Course
Dr. Dan Schafer - Department of Statistics, Oregon State University
When: Thursday, April 14, 2011 03:10PM to 04:00PM
Where: Procrastinator Theater
Details: I will discuss the modern history of the field of statistics and the introductory class, statisticians' never-ending identity crisis, the increasing need for college-educated
citizens to be statistically literate even if they don’t use statistics in their jobs, what we can reasonably expect students to know after passing the class, and how we might do the best we can with limited resources. I will also assert my opinion that all college students should learn skills for critical evaluation of conclusions from numerical evidence and that a few should also specialize in the craft of drawing such conclusions.

Math Seminars
Adventures in One-Dimensional Biofilm Modeling: R. Freter's model for biofilm formation in a plug flow reactor
Benjamin Jackson - Department of Mathematical Sciences, MSU
When: Thursday, April 07, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In 1983 Rolf Freter formulated a one dimensional biofilm model with some unique features. This model was expanded by Kung and Baltzis and then Ballyk and Smith in the late 90s. My talk will focus on the details of Freter's model along with my attempts to implement it. I will end with a description of my current effort to tweak Freter's model into something a bit new. With any luck we will have a few photos as well as a movie or two to punctuate the equations.

Math Seminars
Changepoints in Climatology
Dr. Robert Lund (with Dr. QiQi Lu) - Department of Mathematical Sciences, Clemson University
When: Friday, March 25, 2011 03:15PM to 04:15PM
Where: Wilson Hall 1-144
Details: This talk overviews changepoint issues in climate studies. Changepoints are ubiquitous features in climatic time series, occurring whenever stations relocate or gauges are changed. Ignoring changepoints can produce spurious conclusions. Changepoint tests involving cumulative sums, likelihood ratio, and maximums of F statistics are introduced; the asymptotic distributions of these statistics are quantified under the changepoint-free null hypothesis. We find that cumulative sum procedures work best when the changepoint is near the center of the data record; otherwise, maximums of F statistics perform better. Next, time series aspects of the problem are addressed. Series with positive autocorrelation can have long sojourns above and below mean levels, hence mimicking a mean shift. We show how to modify the above methods to account for autocorrelation. The methods are illustrated in several applications, including temperature trends and Atlantic Basin tropical storm counts. Changes in tropical storm and hurricane counts has been controversially addressed in the media recently, with the debate even reaching US Senate floors.
Numerical Solution of Nonlinear Conservation Laws and Sensitivity Equations using the Discontinuous Galerkin Finite Element Method
Jennifer Thorenson - Department of Mathematical Sciences, MSU

When: Thursday, March 24, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: (THIS IS A PART OF A PH.D. ORAL EXAMINATION) The Discontinuous Galerkin finite element method is a localized element-based numerical method developed for solving the neutron transport equation and has since been extended to nonlinear hyperbolic conservation laws. The current goal of the research is to combine DGFEM and Sensitivity Analysis to study a basic nonlinear traffic flow model. We focus on how density varies with respect to interface parameters. Sensitivity Analysis with respect to interface parameters can be tricky using traditional finite element methods because sensitivity variables tend to lack the same smoothness properties as the corresponding density variable. Since the DG numerical flux function imposes interface connectivity of the local solutions, DGFEM is a more natural technique for computation of these sensitivities.

Math Seminars
Evolution of Metabolic Networks Organization
Dr. Aurelien Mazurie - Senior Bioinformatics Scientist, Bioinformatics Core Facility, MSU

When: Thursday, March 03, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Macromolecular mechanisms of the cell are shaped by evolutionary processes, and so are biological networks. These networks, sum of all the interactions between cellular components, are used as a convenient representation of the cell's internal organization. From the structure of these networks one can derive general principles of this organization. What is missing, however, is the precise knowledge of how this organization is linked to the phylogeny of species, and how this organization is affected by environmental constraints. I will present here results of an ongoing project to characterize this relationship. First will be introduced an intuitive, robust and high-level description of the metabolic capabilities of species, termed network of interacting pathways or NIP. I will show that NIPs capture sufficient information about the underlying evolutionary events leading to the formation of metabolic networks to permit accurate prediction of the phylogenetic position of species. Finally, I will demonstrate that the metabolism of species subject to distinct evolutionary paths or environmental constraints show subtle but significant differences in their high-level organization. These changes are unevenly distributed among metabolic pathways, with specific categories of pathways being promoted to more central locations as an answer to environmental constraints

Math Seminars
Magnetic Resonance Studies of Transport in Multiphase Pharmaceutical

Delivery and Mixing Systems
Amber L. Broadbent - Department of Chemical and Biological Engineering, MSU
When: Thursday, February 24, 2011 11:00AM to 12:00AM
Where: EPS 127
Details: (DIFFERENT TIME AND PLACE!) The noninvasive characterization and measurement of transport properties by magnetic resonance techniques in an osmotic controlled release pharmaceutical tablet as well as in Taylor-Couette and jet-in-tube two-fluid mixing devices will be presented. Magnetic resonance imaging of a commercially available controlled-release osmotic pharmaceutical tablet is used to measure water concentration as a function of tablet hydration. A 1D mass transport model of tablet water hydration directly quantifies whether osmotic or diffusive processes dominate water transport and is used to estimate transport coefficients for these processes. Magnetic resonance velocity mapping of Couette and Taylor vortex flow regimes for single and two-fluid systems in a vertically oriented Taylor-Couette device are compared to simulations. For the single fluids, the magnetic resonance experiments and computational fluid dynamics simulations in Fluent show excellent agreement in determining the rotation rate at which the flow transitions from stable Couette to unstable Taylor vortex flow and the corresponding critical wavelength of the unstable flow. In the two-fluid studies, immiscible fluids are axially stratified in the stable density, heavy fluid on bottom, configuration. In both simulation and experiment, the two-fluid interface is observed to remain in the Couette flow regime after the pure fluids away from the interface have transitioned to the Taylor vortex flow regime, thus indicating a stabilizing force, surface tension, at the interface. A vertically oriented cocurrent jet-in-tube device with acetone as the jet fluid and water as the tube fluid, operated at low jet Reynolds numbers (Rejet ~ 17), is used to produce a laminar positively buoyant jet, which transitions to an unstable mixing regime, characterized by vortex formation and breakdown in crystal violet dye flow visualization experiments. Magnetic resonance velocity mapping and Stejskal-Tanner diffusion measurements at varying positions downstream of the jet exit are used to quantitatively characterize the mixing due to vortex formation and breakup seen in tracer dye flow visualization. The buoyancy driven instability which results from introducing the less dense acetone (SG=0.79) into the more dense water (SG=1) in opposition to gravity gives rise to significantly enhanced hydrodynamic dispersion of the two fluids as compared to non buoyant jets. For the first time, enhanced dispersion due to buoyancy driven instability is quantified as a function of fluid displacement observation time and position relative to the jet exit. The coherent and incoherent aspects of the mixing flow are captured by the NMR measurements. The data suggest the introduction of non-equilibrium statistical mechanics concepts as a model for mixing by the formation and decay of coherent vortex structures generated by the buoyancy-driven instability.

Math Seminars
An Algorithm for Determining Pure Discrete Spectrum
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, February 18, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144  
Details: I'll present a method, based on topological dynamics, for quickly determining that certain atomic arrangements are pure point diffractive. This is joint work with Bob Williams. Accessibility rating: Very.

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**Weak Kernels and Their Applications**  
Dr. Binhai Zhu - Department of Computer Science, MSU  
When: Thursday, February 17, 2011 03:10PM to 04:00PM  
Where: Wilson Hall 1-144  
Details: In this talk, I will introduce weak kernels (parameterized search spaces) for intractable NP-hard problems. I will show three biological applications of this new technique.

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**Dimensionality Reduction for Probability Distributions**  
Dr. Suresh Venkatasubramanian - School of Computing, University of Utah  
When: Friday, February 11, 2011 03:00PM to 04:00PM  
Where: 101 Roberts Hall  
Details: (DIFFERENT TIME AND PLACE!) In many application areas, the natural representation of data is in the form of an empirical probability distribution. Documents are represented as normalized frequency counts of words, images are represented by color (or other feature) histograms, and speech signals can be represented by spectral histograms. There are many natural and meaningful ways of measuring similarity (or distance) between such distributions, and these define different geometries in which we might wish to analyze collections of distributions for interesting patterns. However, a key practical bottleneck is the high dimensionality of these representations: for example, a 256 x 256 image might be represented by a vector of over 1000 features, and a document might be represented as a sparse vector with hundreds of attributes. Thus, a key problem is: can we reduce the dimensionality of collections of distributions to make data analysis tractable while preserving the distances in the collection? In this talk, I'll discuss a collection of recent results centered on this theme that provide both good news (and bad) for dimensionality reduction on distributions in theory and in practice.

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**Turning off a Non-linear Oscillator in a Quasi-periodic Medium**  
Dr. Jaroslaw Kwapisz - Department of Mathematical Sciences, MSU  
When: Friday, February 04, 2011 03:10PM to 04:00PM  
Where: Wilson Hall 1-144  
Details: I will give an introduction to some dynamical phenomena and open questions that distinguish the process of turning off non-linear oscillations in a quasi-periodic
medium as compared to the classical periodic case. This is a joint work with Mark Mathison.

**Math Seminars**

**Electrodiffusion in Microbial Biofilms**  
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU  
**When:** Thursday, February 03, 2011 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** The familiar view of microbes in their free (planktonic) state is not the norm; rather it is believed that much of the microbial biomass, perhaps 95-99%, is located in close-knit communities, designated biofilms and microbial mats, consisting of large numbers of organisms living within self-secreted matrices constructed of polymers and other molecules. (Microbes in collective behave very differently from their planktonic state; even genetic expression patterns change.) These matrices serve the purposes of anchoring and protecting their communities in favorable locations while providing a framework in which structured populations can differentiate and self-organize. One of the salient features of biofilms is their spatial heterogeneity; they are not uniform, well mixed systems like many laboratory microbial communities are. Because of spatial variation, advective and diffusive processes become influential. Further, when ionic quantities are important, these processes in turn can lead to electric field effects becoming significant, including particularly in connection to diffusive transport. These issues are discussed in the context of a particular phenomenon, namely mineralization resulting from biological activity in biofilms.

**Math Seminars**

**Imitating the Cricket Cercal System: The Beauty of the Beast with a Twist of the Engineer**  
Dr. Gijs Krijnen - Electrical Engineering, Mathematics and Computer Science, University of Twente, the Netherlands  
**When:** Friday, January 21, 2011 03:00PM to 04:00PM  
**Where:** 101 Roberts Hall  
**Details:** MEMS offers exciting possibilities for the fabrication of bio-mimetic mechanosensors. Over the last years we have been working on cricket inspired hairsensor arrays for flow-field observations and source localization. Whereas making flowsensors as energy efficient as cricket hair-sensors appears to be a real challenge, we have managed to fabricate capacitively-interrogated sensors with sub millimeter per second flow sensing thresholds, address them individually while in arrays, and use nonlinear effects to achieve parametric filtering and amplification. During these developments we have been working in close collaboration with insect biologists, generating a bidirectional flow of information and insights, beneficial to both parties. In the presentation the important insights, developments and results will be highlighted.
Math Seminars
Discontinuous Galerkin FEM for Nonlinear Scalar Conservation Laws
Jennifer Thorenson - Department of Mathematical Sciences, MSU
When: Thursday, January 20, 2011 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The Discontinuous Galerkin finite element method is a localized element-based numerical method developed for solving the neutron transport equation and has since been extended to nonlinear hyperbolic conservation laws. For a 1D nonlinear conservation law, we will discuss the DG formulation and a technique used to guarantee stability of the nonlinear method. Numerical results for Burgers equation and a basic traffic flow model will be presented.

Math Seminars
Hausdorff Dimension in Complex Dynamics
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Thursday, December 09, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Dynamical systems in the complex plane give rise to many beautiful self-similar fractals as invariant sets. In order to study geometric properties of these fractals, one has to use Hausdorff measures and Hausdorff dimension instead of traditional area and length measures. I will present an overview of the basic concepts and results about fractal geometry of Julia sets and the Mandelbrot set, as well as some of my own research about dimension of boundaries of rotation domains.

Math Seminars
A Novel Approach to Analyzing Multifractal Spectra
Jesse Berwald - Department of Mathematical Sciences, MSU
When: Thursday, December 02, 2010 02:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk I will introduce a novel method for determining the multifractal spectrum of the attractor of a dynamical system. The work is motivated by prior research into developing models of complex physiological systems. This will serve as the oral portion of Jesse Berwald's Ph.D. comprehensive exam.

Math Seminars
L-cuts on Translation Surfaces
Andy Bouwman - Department of Mathematical Sciences, MSU
When: Friday, November 19, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk I will define "L cuts", a generalization of saddle connections, which have horizontal and vertical segments. I will then use them to address Hirsch's question
of whether a hyperbolic toral automorphism can have an invariant subsurface apart from a finite union of subtori. This will serve as the oral portion of Andy Bouwman's Ph.D. Comprehensive exam.

Math Seminars
Getting Together: Flocks and the Single Bird
Dr. Leah Edelstein-Keshet - Department of Mathematics, University of British Columbia
When: Friday, November 19, 2010 02:10PM to 03:00PM
Where: Procrastinator Theater, SUB
Details: Dr. Leah Edelstein-Keshet will present a few examples of the marvelous phenomena that accompany the formation and dynamics of bird flocks and other collective social groups, and describe some of the common questions that scientist are interested in addressing. How do such flocks stay together? How do individuals keep from colliding or getting too crowded? What exactly are the individuals doing inside that flock? Shell describe some recent work on ducks where she has been able to answer at least some of these questions.

Math Seminars
Models for Cell Polarization and Crawling
Dr. Leah Edelstein-Keshet - Department of Mathematics, University of British Columbia
When: Thursday, November 18, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk I will survey work in my group over the past years on the topic of eukaryotic cell motility. I will describe how investigating the regulatory biochemistry controlling such motility has led to some interesting mathematical problems, and how we have addressed cell shape change and motion using computational approaches.

Math Seminars
Tiling Spaces for Beginners and Structure Groups of Covering Spaces
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, November 12, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Professor Swanson will give a leisurely overview of tiling spaces in different dimensions and present some observations about symmetry groups of tiling spaces.

Math Seminars
Coupling of Fluid Flow and Biological Materials
Dr. Jeff Heys - Department of Chemical Engineering, MSU
When: Thursday, November 04, 2010 03:10PM to 04:00PM
Details: This talk will examine two different problems involving a fluid that is mechanical coupled to a biological material. The first example will examine our efforts to solve the Navier-Stokes equations in moving domains (e.g., the left ventricle of the heart). This problem has been studied fairly extensively, but, in our case, we have additional data from particle imaging velocimetry that we are trying to assimilate into the approximate solution in a "meaningful" way. The second example will explore recent studies on the interaction between a biofilm and a moving fluid. This study was motivated by magnetic resonance imaging measurements showing unexpectedly high secondary velocities around a biofilm. Secondary velocities are defined as velocity components perpendicular to the surface that the biofilm is attached, and primary velocity components are tangential to the attachment surface. A hypothesis for the mechanism behind the elevated secondary velocity will be given, and support from numerical simulations will be shown.

Math Seminars
Connecting Diagrams for Cocyclic Sub shifts
David Buhanan - Department of Mathematical Sciences, MSU
When: Friday, October 29, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I will be talking about cocyclic sub shifts. In particular, I will discuss an algebraic method to decompose a sub shift into irreducible components as well as find topological connections between the components. This will serve as the oral portion of David Buhanan's Ph.D. Comprehensive exam.

Math Seminars
State Dependent Delays in Gene Regulation
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, October 28, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I will review some sources of delay in gene regulation. I will discuss models of mRNA production in two cases: when transcription initiation is limiting and when the elongation is limiting. This talk will present an incomplete work and will therefore pose more questions than answers.

Math Seminars
Issues Arising in the Medical Drug Approval Process: Some Problems and Solutions
Dr. Peter (Tony) Lachenbruch - Department of Public Health, Oregon State University
When: Tuesday, October 19, 2010 04:10PM to 05:00PM
Where: Procrastinator Theater, SUB
Details: This talk discusses some problems that have arisen in the medical literature and in the drug approval process. In particular, the talk will discuss inclusion of authors who did not participate in the research and the use of authors who are not cited (e.g., a technical writing firm), the solutions to which have not always been rational. Other issues addressed will be improper statistical analyses of data, politically based analyses, and availability of data in usable form.

Math Seminars

Observed Statistical Problems in Drug Development
Dr. Peter (Tony) Lachenbruch - Department of Public Health, Oregon State University
When: Monday, October 18, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This talk was prepared in collaboration with former FDA colleagues and discusses some issues we faced. I give some examples and proposed solutions. It is very important to have a clear protocol and statistical analysis plan in place prior to observing the data. To demonstrate safety of a drug one must consider studies various subgroups, organ systems and specific types of toxicity. All phases of a drug development plan may need to consider dose determination. After a drug has been licenses, post-marketing studies may be required, but not all sponsors conduct them and FDA is relatively powerless to enforce this. This includes adverse event reporting. Other issues include design of the studies, analysis of them, selective reporting, and analyses defined after observing the data (it's easy to hit a bulls eye if you paint the target around the bullet hole). RECEPTION in Hurst Conference Room immediately following talk.

Math Seminars

A Multicomponent Model for Biofilm-Drug Interaction
Dr. Tianyu Zhang - Department of Mathematical Sciences, MSU
When: Thursday, October 14, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We develop a tri-component model for the biofilm and solvent mixture, in which the extracellular polymeric substance (EPS) network, bacteria and effective solvent consisting of the solvent, nutrient, drugs etc. are modeled explicitly. The tri-component mixture is assumed incompressible as a whole while inter-component mixing, dissipation, and conversion are allowed. A linear stability analysis is conducted on constant equilibria revealing up to two unstable modes corresponding to possible the bacterial growth induced by the bacterial and EPS production and dependent upon the regime of the model parameters. A 1-D transient simulation is carried out to investigate the nonlinear dynamics of the EPS network, bacteria distribution, drug and nutrient distribution in a channel with and without shear. Finally, the transient biofilm dynamics is studied with respect to a host of diffusive properties of the drug and nutrient present in the biofilm.
Math Seminars

Measuring Effective Mathematics Teaching
Dr. Heather C. Hill - Harvard Graduate School of Education
When: Friday, October 08, 2010 03:10PM to 04:15PM
Where: Procrastinator Theatre
Details: U.S. policymakers have sought to measure effective math teaching in various ways. Dr. Hill will provide an overview of these means. In addition, she will discuss the implications these measures have for teachers and education. Recent media attention has focused on the use of value-added scoring as a means of determining teacher salaries. The relationship between assessment and value-added scoring will be discussed. Dr. Heather Hill received her doctorate from the University of Michigan in 2000 and is currently an associate professor at the Harvard Graduate School of Education. Her primary work focuses on developing measures of mathematical knowledge for teaching and the mathematical quality of teaching, and using these measures to evaluate public policies and programs intended to improve teachers understanding of this mathematics. She is co-director of the National Center for Teacher Effectiveness, and has served on the editorial board of the Journal of Research in Mathematics Education.

Other

The Theory of Symbiogenesis and Seminal Contributions to Understanding Evolution and Biology
Dr. Lynn Margulis - Department of Geosciences, University of Massachusetts
When: Thursday, October 07, 2010 03:10PM to 04:00PM
Where: Procrastinator Theatre
Details: Distinguished University Professor in the Department of Geosciences at the University of Massachusetts, Amherst, for the theory of symbiogenesis and seminal contributions to understanding evolution and biology. Margulis, a member of the National Academy of Sciences, received the Presidential Medal of Science in 1999 from President Clinton. In 1998, the Library of Congress announced it would permanently archive her papers.

Math Seminars

The Work of Stanislav Smirnov: Conformally Invariant Scaling Limits
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Tuesday, October 05, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Stanislav Smirnov received a Fields medal in 2010 for his work on conformal invariance in two-dimensional statistical physics problems. I will try to give an overview of his work, in particular his proof of conformal invariance of critical percolation.
Math Seminars
Ergodic Theory for Tiling Spaces
Dr. Jean-Marc Gambaudo - Laboratoire J.A. Dieudone, Universite de Nice, Nice, France
When: Friday, September 17, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-148

Math Seminars
Hierarchical Structures: Aperiodic Tilings, Quasicrystals and Quasipatterns
Dr. Jean-Marc Gambaudo - Laboratoire J.A. Dieudoné, Université de Nice, Nice, France
When: Thursday, September 16, 2010 04:10PM to 05:00PM
Where: Procrastinator Theater, SUB
Details: The sequence of lunar cycles, the distribution of atoms in a quasicrystal and, at a larger scale, the quasi-patterns observed in the Faraday experiment, are examples of the ubiquity of hierarchical structures in nature. In this talk, Dr. Jean-Marc Gambaudo will discuss these structures by focusing on the mathematical models associated with aperiodic tilings (such as Penrose tiling). This will be done from three different points of view: dynamical systems, geometry and statistical mechanics.

Math Seminars
Modern Mathematics Initiatives
Dr. Christina Mariani - Department of Mathematical Sciences, University of Texas at El Paso
When: Thursday, September 09, 2010 10:30PM to 11:30PM
Where: Procrastinator Theater, SUB

Other
Discrete and Complex Analysis (Workshop)
Several - International workshop
When: Monday, July 19, 2010 09:00AM to 06:00PM
Where: Leon Johnson Hall 213

Math Seminars
Dynamics of Soap Films: Energy Minimization and Topological Jumps
Dr. H. K. Moffatt - Department of Applied Mathematics and Theoretical Physics, University of Cambridge
When: Monday, June 07, 2010 04:10PM to 05:00PM
Equilibrium states of complex physical systems are frequently characterized by minimization of an energy functional subject to constraints that are often topological in character. A familiar example is provided by the problem of a soap film which forms a surface of minimum area spanning the wire boundary (a closed curve in 3D) on which it is suspended. Much is known about the static configurations of such films, but very little about the dynamic (and topological) transitions that can occur under slow deformation of the boundary wire. An introduction to this field will be presented, and some new experimental and theoretical results will be described (joint work with Ray Goldstein, Adriana Pesci and Renzo Ricca).

Fluid Dynamics: From Theory to Experiment (Conference)
Several - International conference
When: Monday, June 07, 2010 08:30AM to 05:00PM
Where: Procrastinator Theater, SUB

Math Seminars
Modeling Niche Partitioning of Synechococcus Species in Yellowstone Hot Spring Microbial Mats
Shane Nowack - Department of Mathematical Sciences, MSU
When: Thursday, April 29, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We developing a theory of niche structure for Synechococcus species inhabiting microbial mats in the effluent channels of Yellowstone alkaline siliceous hot springs. We are applying both modeling and biological realities of this community. In this talk I will discuss the analytic and numerical studies we have conducted on a simplified chemostat model, and what we hypothesize our mathematical results are inferring about the biological system.

Math Seminars
Developing a Graduate Credit Algebra Course for Teachers: Building a Conceptual Understanding of Polynomial Algebra in the Secondary Curriculum
Dr. Ira Papick - Department of Mathematics, University of Nebraska
When: Wednesday, April 28, 2010 04:10PM to 05:00PM
Where: Procrastinator Theater, SUB
Details: In this talk we will discuss the need for and nature of specialized graduate credit mathematics courses for practicing teachers. Our primary focus will involve the description of an algebra course for algebra teachers. The main goal of this course is to help teachers better understand the conceptual underpinnings of school algebra, and
how to leverage that understanding into improved classroom practice. Specific course content and pedagogy will be highlighted.

Math Seminars

Red Tide as a Biological Oscillator
Aaron Sheppard - Department of Mathematical Sciences, MSU
When: **Monday, April 26, 2010 04:10PM to 05:00PM**
Where: Hurst Conference Room, Wilson Hall 2-244 Details: Submitted by: Ken Bowers

Math Seminars

Young Person’s Guide to Translation Surfaces of Genus Two: McMullen’s Connected Sum Theorem
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: **Friday, April 23, 2010 04:10PM to 05:00PM**
Where: Wilson Hall 1 Details: I will give an introduction to translation surfaces of genus two including an elementary construction of the Weierstrass involution and a simplified proof of a result asserting that any such surface can be obtained as a connected sum of two flat tori. (This is the key to McMullen’s establishing of Ratner’s Conjectures for the $SL_2(R)$ action on the bundle of holomorphic 1-forms of genus two.) This work is a part of a joint project with Andy Bouwman.

Math Seminars

Persistent Homology Analysis of Cricket Cercal Afferents
Jacob Brown - Department of Mathematical Sciences, MSU
When: **Thursday, April 22, 2010 03:10PM to 04:00PM**
Where: Wilson Hall 1-144 Details: Mehanosensory afferents in the cricket cercal sensory system project into the terminal ganglion. The terminal arborizations of these cells form a point-cloud data set with certain underlying topological attributes. Persistent Homology Analysis is a method that can be used to recover some of these attributes. We will introduce and define persistent homology, along with algorithms that are used in its computations.

Math Seminars

Discontinuous Galerkin Finite Element Method
Jennifer Thorenson - Department of Mathematical Sciences, MSU
When: **Thursday, April 15, 2010 03:10PM to 04:00PM**
Where: Wilson Hall 1-144 Details: The discontinuous Galerkin finite element method is a localized element-based numerical method typically used to solve hyperbolic pdes. It was introduced in 1973 to
solve the steady-state neutron transport equation and recently the method has been applied to elliptic and parabolic equations. We will discuss the basic underlying properties of the DG methods and for the 1D advection equation, provide details of the numerical formulation and present examples.

**Undergrad Workshop**

**Undergraduate Research Presented by Math Sciences Majors**

Autumn Laughbaum & Garrett Vo - Department of Mathematical Sciences, MSU  
**When:** Tuesday, April 13, 2010 04:30PM to 05:30PM  
**Where:** Hurst Conference Room, Wilson Hall 2-244  
**Details:** Join us today at 4:30 for the Math Undergraduate Seminar during which Autumn Laughbaum and Garrett Vo will present short talks about their undergraduate research.

**Math Seminars**

**Cantor Sets and the Rauzy Fractal, Part II**

Adrian Soto - Department of Mathematical Sciences, MSU  
**When:** Monday, April 12, 2010 04:10PM to 05:00PM  
**Where:** Hurst Conference Room, Wilson Hall 2-244

**Math Seminars**

**Depth-averaged Models and Software for Tsunamis, Landslides and Other Geophysical Flows**

Dr. Randy LeVeque - Applied Mathematics Department, University of Washington  
**When:** Friday, April 09, 2010 04:10PM to 05:00PM  
**Where:** Procrastinator Theater, SUB  
**Details:** Many geophysical flows over topography can be mathematically modeled by two-dimensional depth-averaged fluid dynamics equations. The shallow water equations are the simplest example of this type, but it is often necessary to incorporate nonhydrostatic pressures, more complicated rheologies (e.g. for avalanches, landslides or debris flows) or to use multi-layer models for capturing internal waves or to model a landslide-induced tsunami. These models are generally hyperbolic and can be modeled using high-resolution finite volume methods. However, several features of these flows lead to new algorithmic challenges making adaptive mesh refinement essential. Dr. LeVeque will discuss these applications and the GeoClaw software, a specialized version of Clawpack aimed at solving real-world geophysical flow problems over topography.

**Math Seminars**

**Well Balanced Methods for Conservation Laws with Source Terms**

Dr. Randy LeVeque - Applied Mathematics Department, University of Washington
Details: Hyperbolic conservation laws with a source term (balance laws) often require well-balanced methods that numerically preserve important steady state solutions in which the divergence of the flux exactly balances the source term. The goal is often to accurately compute solutions that are quasi-steady, modeling small amplitude waves propagating on top of such an equilibrium, for example when modeling tsunami propagation across the ocean. Examples also arise in a quasi-steady atmosphere in which the gravitational force is balanced by the pressure gradient. I will discuss a general approach to this problem in the context of high-resolution finite volume methods (Godunov-type methods) that are designed to also accurately capture discontinuous shock wave solutions.

Math Seminars
Cantor Sets and the Rauzy Fractal, Part I
Adrian Soto - Department of Mathematical Sciences, MSU
When: Monday, April 05, 2010 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars
A Novel Approach to Multifractal Analysis of Time Series
Jesse Berwald - Department of Mathematical Sciences, MSU
When: Thursday, April 01, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The fractal characteristics of an invariant measure on an attractor of a dynamical system have been used as a proxy for complexity of the system. Using delay embedding we embed a time series into R^d, visualize the resulting points as a graph, and then use the graph diffusion operator approach advanced by Coifman. The powers of the diffusion operator lead to a natural wavelet decomposition of the density function, which we use to approximate the multifractal spectrum of the embedded attractor. We discuss the motivation as well as intended application of our analysis.

Undergrad Workshop
Writing Resumes: A Workshop for Mathematical Sciences Majors
Dr. Christina Hayes - Department of Mathematical Sciences, MSU
When: Monday, March 29, 2010 05:00PM to 06:00PM
Where: Hurst Conference Room, Wilson Hall 2-244
Details: Do you know what the purpose of a resume is? Do you know what it takes to make a great impression with your resume? Spend time with Career, Internship & Student Employment Services and you will! Learn what it takes to make it into the "yes" pile to get an interview for the position of your choice. Bring your resume and a notebook to this interactive session and learn what it takes to make your resume stand
out above your competition. This talk is specifically geared toward Mathematical Sciences majors.

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**Undergrad Workshop**  
**Math Sciences Undergraduate Course Offering Open House**  
Dr. Christina Hayes - Department of Mathematical Sciences, MSU  
*When:* Thursday, March 25, 2010 09:15PM to 10:15PM  
*Where:* Hurst Conference Room, Wilson Hall 2-244  
*Details:* What classes will you take next year? Do you wonder what Dynamical Systems or History of Math or Sampling or is really all about? Join us tomorrow for an informal question and answer session about the courses being offered for Mathematical Sciences majors for the 2010-2011 academic year.

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**Math Seminars**  
**The Ingram Conjecture**  
Dr. Sonja Stimac - University of Zagreb  
*When:* Tuesday, March 23, 2010 03:10PM to 04:00PM  
*Where:* Wilson Hall 1-144  
*Details:*

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**Math Seminars**  
**The Branch Locus for Two-Dimensional Tiling Spaces**  
Carl Olimb - Department of Mathematical Sciences, MSU  
*When:* Friday, March 12, 2010 04:10PM to 05:00PM  
*Where:* Wilson Hall 1-144  
*Details:* In a recent paper, Barge, Diamond and Swanson showed the cohomology formed from the asymptotic structure in one-dimensional Pisot substitution tiling spaces is a topological invariant. The techniques used rely on the geometric realization for one-dimensional tiling spaces, which is not well understood in higher dimensions. Instead we construct the Branch Locus by introducing structure to the Anderson-Putnum complex that shadows the asymptotic behavior. This construction allows us to generalize the results to higher dimensions.

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**Math Seminars**  
**From Cells to Communities, Applications of Metabolic Systems Analysis**  
Dr. Ross Carlson - Department of Chemical and Biological Engineering and Center for Biofilm Engineering, MSU  
*When:* Thursday, March 11, 2010 03:10PM to 04:00PM  
*Where:* Wilson Hall 1-144  
*Details:* The bioinformatics age continues to generate enormous volumes of data. A systems-based analysis is often required to extract biologically relevant insight from this data. An in silico approach known as elementary mode analysis (EMA) has been used
to explore microbial metabolic networks by first decomposing the highly branched and highly redundant networks into their simplest, functional flux units (a mathematically defined biochemical pathway). The physiological properties of each nondivisible unit are then used as coordinates to plot the data in a multidimensional space where biologically competitive strategies can be quickly and efficiently identified. A ‘bottom-up’ systems biology approach is then applied to reconstruct complex microbial behaviors using these simplest components as building blocks. Applications of this approach on systems ranging from individual cells to microbial communities will be presented.

Math Seminars
Branch Locus in Substitution Tiling Spaces
Carl Olimb - Department of Mathematical Sciences, MSU
When: Monday, March 08, 2010 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars
Cahn-Hilliard vs Singular Cahn-Hilliard Equations in Phase Field Modeling
Dr. Tianyu Zhang - Department of Mathematical Sciences, MSU
When: Thursday, March 04, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The Cahn-Hilliard equation is often used to describe evolution of phase boundaries in phase field models for multiphase fluids. In this talk, we compare the use of the Cahn-Hilliard equation (of a constant mobility) for the phase variable with that of the singular or modified Cahn-Hilliard equation (of a variable mobility) in the context of physical derivation of the transport equation and numerical simulations of immiscible binary fluids. We show numerically that (i) both equations work fine for interfaces of small to moderate curvature in short to intermediate time scales; (ii) the Cahn-Hilliard equation renders strong dissipation in simulations of small droplets leading to small droplets dissolution into the surrounding fluid and/or absorbed by larger droplets nearby, an artifact for immiscible binary fluids; whereas, the singular Cahn-Hilliard equation can significantly reduce the numerical dissipation around small droplets to yield physically acceptable results in intermediate time scales; (iii) the size of droplets that can be simulated by the Cahn-Hilliard equations scale inversely with the strength of the mixing free energy. Since the intermediate timescale is the time scale of interest in most transient fluid simulations, the singular Cahn-Hilliard equation proves to be the more accurate phase transporting equation for immiscible binary fluids.

Math Seminars
An Introduction to the Ext Functor
Scott Schmieding - Department of Mathematical Sciences, MSU
When: Monday, March 01, 2010 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244
Math Seminars
Quorum Sensing and Biofilm Modeling
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, February 25, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Many bacteria use the size and density of their colonies to regulate the production of a large variety of substances. This phenomenon is called quorum sensing. We present a review of mathematical models of quorum sensing and their use in biofilm Modeling.

Math Seminars
Graphics in the Stat Program R
Kezia Manlove - Department of Mathematical Sciences, MSU
When: Monday, February 22, 2010 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars
A Homotopy Approach to Cohomology
Scott Schmieding - Department of Mathematical Sciences, MSU
When: Monday, February 15, 2010 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars
Mathematical Structure and a Unified Field Theory
Dr. Leroy Amunrud -
When: Thursday, February 11, 2010 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Familiar entities like matches, numbers, and kinetic energy are used to illuminate the important role structures play in the world of mathematics. Weak structures are produced to illustrate the way a person can be trapped into attempting the impossible. A structure for our universe is informally obtained using observations and logic. This informally obtained structure, which also happens to be derivable rigorously, is demonstrated to be strong enough to carry a complete unified field theory.

Undergrad Workshop
Preparing for the Career Fair
Dr. Christina Hayes - Department of Mathematical Sciences, MSU
When: Tuesday, February 09, 2010 05:00PM to 06:00PM
Where: Hurst Conference Room, Wilson Hall 2-244
Details: Do you know what it takes to be successful at the Career Fair? Do you know how to make the "right" first impression? Join us as we discuss what you need to do in order to be ready for the "Almost Spring" Job & Internship Fair. This talk is specifically geared toward Mathematical Sciences majors.

Math Seminars
An Introduction to Filters and Ultrafilters, Part II
Seth Chart - Department of Mathematical Sciences, MSU
When: Monday, February 08, 2010 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244 Details: Submitted by: Ken Bowers

Undergrad Workshop
An Exploration for Mathematical Sciences Majors
Erin McCormick - Career & Internship Services, MSU
When: Thursday, February 04, 2010 05:00PM to 06:00PM
Where: Hurst Conference Room, Wilson Hall 2-244
Details: Do you enjoy working with your hands? Like everything to be organized and completed in an orderly manner? Do you like to solve complex problems or would you rather create something for others to enjoy? Your interests matter as you consider your options in the world of work. Career & Internship Services is here to help you explore YOUR interests and provide you with the resources to match those interests with opportunities available in the world of work. Erin McCormick from Career & Internship Services has geared this talk to freshmen, sophomores, juniors and seniors interested in majoring in the Mathematical Sciences.

Math Seminars
An Introduction to Filters and Ultrafilters, Part I
Seth Chart - Department of Mathematical Sciences, MSU
When: Monday, February 01, 2010 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Undergrad Workshop
Math Sciences Majors Study Abroad Info Session
Dr. Christina Hayes - Department of Mathematical Sciences, MSU
When: Wednesday, January 27, 2010 05:00PM to 06:00PM
Where: Hurst Conference Room, Wilson Hall 2-244
Details: Mathematical Sciences Majors, * Do you want to travel to cool places WHILE earning college credit? * Have you thought about studying abroad but don't know where or how to begin? * Worried about choosing a location that will offer courses in your major? Join us for a Study Abroad INFO SESSION on Wednesday, January 27th to
learn more about how to begin your study abroad adventure! We’ll talk about where you can go, application deadlines, scholarships and financial aid, and matching programs to fit your math sciences major.

**Undergrad Workshop**
**What Are You Doing This Summer? Research and Other Special Summer Programs for Undergraduates in Mathematical Sciences**
**Dr. Christina Hayes - Department of Mathematical Sciences, MSU**
**When:** Tuesday, December 08, 2009 05:00PM to 06:00PM
**Where:** Hurst Conference Room, Wilson Hall 2-244
**Details:** Have you considered participating in a summer research program? Did you know many programs pay between $3000 and $5000 for 4-8 weeks’ worth of work? Depending on your interests, career goals, geographic preference, year of study and major there is a program for you! I’ll go over some of the opportunities that exist for undergraduates in the mathematical sciences -- and what you need to do to get in. (It’s not early to start thinking about next summer -- some deadline for applications are as early as 31 January).

**Math Seminars**
**Modeling Complexity of Physiological Time Series In-silico**
**Jesse Berwald - Department of Mathematical Sciences, MSU**
**When:** Monday, December 07, 2009 04:10PM to 05:00PM
**Where:** Hurst Conference Room, Wilson Hall 2-244

**Math Seminars**
**The Equality Problem for Cocyclic Subshifts is Undecidable**
**David Buhanan - Department of Mathematical Sciences, MSU**
**When:** Friday, December 04, 2009 03:10PM to 04:00PM
**Where:** Wilson Hall 1-139
**Details:** I will give an introduction to cocyclic subshifts, including basic theorems and examples. I will then discuss Hilbert’s tenth problem and the relationship between the tenth problem and the celebrated DPRM theorem. This discussion will culminate in explaining how DPRM implies that Hilbert’s tenth problem is undecidable. I will apply this result to the problem of equality of cocyclic subshifts. As time allows we may discuss possible interpretations of the result in applications.

**Math Seminars**
**Introduction to Spectral Sequences**
**Scott Schmieding - Department of Mathematical Sciences, MSU**
**When:** Monday, November 30, 2009 04:10PM to 05:00PM
**Where:** Hurst Conference Room, Wilson Hall 2-244
Math Seminars
Discontinuous Galerkin Finite Element Method
Jennifer Thorenson - Department of Mathematical Sciences, MSU
When: Monday, November 23, 2009 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars
A Bayesian Two-step: Estimating Trout Populations and the Effects of Whirling Disease
Dr. Jim Robison-Cox - Department of Mathematical Sciences, MSU
When: Thursday, November 19, 2009 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: Whirling Disease was first found in Montana Rivers in 1995. With ecologists Tom McMahon and Billie Kerans we have explored the distribution of the disease and its impact on trout populations. A contribution to the analysis of mark-recapture data will be described, and a procedure to combine information from several posterior distributions to obtain a posterior on parameters of interest.

Math Seminars
MOOSE: A Parallel Solution Framework for Multiscale Multiphysics Applications
Glen Hansen - Department of Mathematical Sciences, MSU
When: Thursday, November 19, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: MOOSE (Multiphysics Object Oriented Simulation Environment) is a software framework targeted at the development of implicit, tightly coupled Multiphysics applications. It is designed to support the solution of finite element problems and provides an element library, input and output capabilities, mesh adaptation, and a set of parallel nonlinear solution methods. It is based on a physics-based preconditioned Jacobian-free Newton Krylov (JFNK) approach to support rapid application development and provide the robustness needed for engineering analysis and design. The JFNK abstraction results in a clean and extensible architecture for tackling a variety of Multiphysics and multiscale problems. MOOSE has redefined the development of Multiphysics applications at INL by simplifying and accelerating the construction of new analysis tools. It now serves as the host for three major application codes that have been developed over the last year. This talk concludes by summarizing a set of applications under development at INL that are based on MOOSE.

Math Seminars
Infinite Galois Theory, Part II
Math Seminars

Topological Symmetry and Rigidity of Aperiodic Tilings
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Thursday, November 12, 2009 04:10PM to 05:00PM
Where: Roberts Hall 312
Details: The talk will focus on tilings of the plane (or other Euclidean space) that are almost periodic. Such tilings serve as models of ideal quasi-crystals and have symmetry properties unseen in periodic tilings (which model ideal crystals). I will illustrate the subject by recounting Penrose’s discovery of his famous example and follow with an explanation of the concept of a tiling space. This will frame some new results about linear and nonlinear symmetries of aperiodic tilings and about their topological rigidity.

Math Seminars

Modeling Results for Deformable Mirrors Used in Adaptive Optics
Dr. Curt Vogel - Department of Mathematical Sciences, MSU
When: Thursday, November 12, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Adaptive optics is revolutionizing scientific fields ranging from ground-based astronomy to biomedical imaging. In this talk, we will present recent modeling results for an important component of an adaptive optics system known as a deformable mirror. The talk will be highly interdisciplinary, touching on aspects of continuum mechanics, partial differential equations, computational mathematics, and electrical engineering.

Math Seminars

Infinite Galois Theory, Part I
Scott Schmieding - Department of Mathematical Sciences, MSU
When: Monday, November 09, 2009 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars

How does Bacteriophage Lambda Count to 3?
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, November 05, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: After infection of E. coli, phage lambda decides whether to follow lysogenic or lytic pathways. If there are multiple phages (>3) infecting at the same time, the probability is quite high that phage will go to lysogen; while single infection usually
results in the lytic pathway. I will present some preliminary results that try to explain how phage lambda, who’s DNA consist of about 40 genes, achieves this quorum-sensing feat.

**Math Seminars**

**Multivariate Calculus**

Hannah Sobek - Department of Mathematical Sciences, MSU

When: **Monday, November 02, 2009 04:10PM to 05:00PM**

Where: Hurst Conference Room, Wilson Hall 2-244

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**Undergrad Workshop**

**Considering Graduate School in the Mathematical Sciences**

Dr. Christina Hayes - Department of Mathematical Sciences, MSU

When: **Thursday, October 29, 2009 04:30PM to 05:30PM**

Where: Hurst Conference Room, Wilson Hall 2-244

Details: Have you considered going to graduate school? Did you know that in many cases you can get your tuition paid for and earn a stipend in exchange for research or teaching work? What is the GRE and is it required for admission into graduate programs? This and many more questions will be answered during the seminar. This meeting is geared toward undergraduates considering graduate school in an area of mathematical sciences. If you are interested in learning about what graduate work in the mathematical sciences might entail and what the application process has in store for you, JOIN US. There will be an opportunity to ask current students and faculty questions.

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**Math Seminars**

**Using Linear Solvers to Sample Large Gaussians**

Dr. Al Parker - Center for Biofilm Engineering, Montana State University; New Zealand Institute of Mathematics, University of Auckland; and Department of Physics, University of Otago

When: **Thursday, October 29, 2009 03:10PM to 04:00PM**

Where: Wilson Hall 1-144

Details: Generating samples from large multivariate normal (Gaussian) distributions is useful for simulating Gaussian Processes and Gauss-Markov Random Fields, which are commonly used in conjunction with Markov Chain Monte Carlo methods. Techniques from numerical linear algebra to solve linear systems are the same methods which are used to produce samples from Gaussian distributions. For example, the Cholesky factorization, the preferred method of solving linear systems for moderately sized problems, is the conventional way to produce samples from a Gaussian. For linear systems and Gaussian models with dimension 106 or more (e.g. models of global total column ozone, tropical ocean surface winds, or the structure of the Earth’s mantle and
outer core), iterative linear solvers and iterative samplers are the only feasible option due to their inexpensive cost per iteration, and small computer memory requirements. Motivated by ample examples, I will provide an explicit recipe which shows how to convert any stationary linear solver into an iterative sampler of a multivariate normal distribution, which has the same convergence properties as the corresponding linear solver. The last fifty years has seen an explosion of theoretical results and algorithmic development making linear solvers faster and more efficient, so that for large problems, stationary processes are used as pre-conditioners at best, while the method of conjugate gradients and polynomial accelerators are the current state-of-the-art for solving linear systems in a finite number of steps. Perhaps less well known is that iterative samplers are merely stationary processes, which were used as very slow (i.e. geometrically converging) linear solvers in the 1950s. I will show how iterative samplers can be sped up appreciably by using common acceleration techniques from numerical linear algebra such as successive over-relaxation (SOR) and polynomial preconditioning. Some samplers which will be presented are derived from Chebyshev accelerated symmetric-SOR, the method of conjugate gradients, and the Lanczos method for estimating the extreme eigenvalues of a matrix.

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**Math Seminars**

**Visualizing Asymptotic Structure in Tiling Spaces, Part II**
Carl Olimb - Department of Mathematical Sciences, MSU
*When:* Monday, October 26, 2009 04:10PM to 05:00PM
*Where:* Hurst Conference Room, Wilson Hall 2-244

**Math Seminars**

**Bayesian Hierarchical Models: From Trends to Ecosystems**
Dr. Jay Ver Hoef - National Marine Mammal Lab
*When:* Thursday, October 22, 2009 03:30PM to 04:30PM
*Where:* Procrastinator Theater (SUB)
*Details:* Analyses of ecological data should account for the uncertainty in the process(es) that generated the data. Probability and statistics provide a framework that accounts for multiple sources of uncertainty, and a Bayesian hierarchical model allows for efficient and valid scientific inferences and forecasts. In this talk, Dr. Ver Hoef will provide several examples of hierarchical statistical modeling for ecological data. The simplest model is a trend model, where annual estimates have measurement (sampling) error, and there is additional variation in the true population fluctuation around the assumed trend model. This model is generalized for multiple sites in a more complex hierarchical model. A final example is an ecosystem model for Antarctic data, where he links sea ice extent, prey abundance, foraging effort, maternal weights, and pup growth for Antarctic fur seals. Dr. Ver Hoef will conclude with a general discussion of ecosystem models, including advantages and disadvantages of statistical vs. deterministic, simple vs. complex, and Bayesian vs. non-Bayesian models.
Math Seminars
Visualizing Asymptotic Structure in Tiling Spaces, Part I
Carl Olimb - Department of Mathematical Sciences, MSU
When: Monday, October 19, 2009 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars
Physical-Chemical Based Modeling of Biofilm Induced Mineralization
Dr. Tianyu Zhang - Department of Mathematical Sciences, MSU
When: Thursday, October 15, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We consider the following biomineralization problem. Urea hydrolysis catalyzed by biofilm increases the pH value and produces carbonate ions. In the presence of calcium ions, calcite ($\text{CaCO}_3$) will precipitate and form crystal once its saturation index exceeds certain critical value. We present a mathematical model including the important chemical, physical and biological processes (Ureolysis and pH value change, advection, diffusion and crystal precipitation, biofilm growth and deformation) involved in the problem. Some computation results and discussion will also be given.

Math Seminars
Valuations, Part II: An Application of Valuations to the Rauzy Fractal
Adrian Soto - Department of Mathematical Sciences, MSU
When: Monday, October 12, 2009 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars
Valuations, Part I: An Introduction to Valuations
Adrian Soto - Department of Mathematical Sciences, MSU
When: Monday, October 05, 2009 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244

Math Seminars
Magnetic Resonance Imaging and Modeling of Water Transport in Controlled Release Pharmaceutical Tablets
Amber Broadbent - Department of Chemical & Biological Engineering, MSU
When: Thursday, October 01, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk, I present how the hydration of 4mg Cardura XL (Pfizer~Y), a commercially available gastrointestinal therapeutic system (GITS) tablet, was
investigated using magnetic resonance imaging (MRI) and basic applied mathematical techniques, e.g. using a separation of variables and Fourier series solution to the one-dimensional diffusion equation. Background information regarding GITS controlled release (CR) pharmaceutical tablets, tablet characterization methods and MR imaging theory and techniques will be presented. Then the MR images of Cardura XL tablet hydration, from which signal intensity profiles were generated, will be shown. I describe how the signal intensity profiles were compared to a one-dimensional mass conservation model which incorporated both molecular diffusion and osmotic pressure driven flux, in order to determine the dominant transport mechanisms as well as to estimate diffusion and osmotic rate coefficients for water in both the drug and polymersweller layers of the tablet. Finally, I will discuss the relevance of this work to the pharmaceutical industry, particularly for controlled release tablet design and formulation efforts. GITS Tablet Background Information: Gastrointestinal therapeutic system tablets utilize osmotic pressure and polymer swelling to deliver active pharmaceutical ingredients in a controlled, steady and reproducible manner. Typically, these tablets consist of two osmotic layers - a drug layer and a water-swellable polymer layer, which are compressed to form a tablet core. The core is coated with a hard cellulosic membrane that is permeable to water but impermeable to ions, the drug and osmotic excipients. The coating contains one or more delivery ports through which the swelling polymer layer pushes the drug suspension after sufficient tablet hydration. When a GITS tablet is placed in an aqueous environment, an osmotic pressure gradient arising due to the presence of osmotic excipients in both of the tablet’s layers, draws water into the tablet. A suspension of micronized drug forms in the drug layer while the water swellable polymer in the push layer begins to expand. As the sweller layer expands, the drug suspension is released through the delivery orifice.

Math Seminars
Product Structure of 2x2 Unitary Matrices Using Vector States
Adam Forland - Department of Mathematical Sciences, MSU
When: Monday, September 28, 2009 04:10PM to 05:00PM
Where: Hurst Conference Room, Wilson Hall 2-244 Details:

Math Seminars
The Importance of Downward Mobility in the Biofilm Lifestyle
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, September 24, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144 Details: Most microbes live in spatially structured communities where physical phenomena (such as reaction-diffusion limitation) cause environmental variation, and hence niche differentiation in space. In this talk, we will consider simple 1D models of biofilms (communities of microbes bound together by self-secreted substances) in the context of their basic ecology. It will be shown via an exclusion principle that the
simplest models lead to excessive restrictions on ecological structure. Instead, it will be argued that some form of downward mobility, against the favorable gradient direction, is necessary at least in the models and possibly in actuality.

Math Seminars
Using Sensitivity Analysis to Predict Transition for a Nonlinear Parabolic Partial Differential Equation
Dr. Lisa Davis - Department of Mathematical Sciences, MSU
When: Thursday, September 17, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk, I illustrate how sensitivity calculations can provide a practical precursor to dynamic transitions in a parameterized nonlinear parabolic partial differential equations. The Chaffee-Infante equation is explored as a model problem, and numerical examples show that sensitivity computations indicate that a transition is about to occur well before the numerical simulation of the system indicates a transition. I will explore sensitivity calculations with respect to a couple of different parameters. These calculations give similar information in terms of their long-term behavior. A parameterized boundary condition gives the most dramatic results, but similar behavior is observed in the other case. The ultimate goal is to understand how to use this type of sensitivity information to determine when to turn on a controller to prevent transition in the original PDE system, but I won't be discussing any aspects of the control problem in this presentation.

Math Seminars
Mathematical Foundations for Atomistic to Continuum Hybrid Methods
Dr. Mitchell Luskin - School of Mathematics, University of Minnesota
When: Tuesday, September 01, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Many materials problems require the accuracy of atomistic modeling in small regions, such as the neighborhood of a crack tip. However, these localized defects typically interact elastically with a much larger region which cannot be computed atomistically. Materials scientists have attempted to compute solutions to these multiscale problems by coupling atomistic models near the localized defect with continuum models where the deformation is nearly uniform. I will give an introduction to the need for atomistic to continuum methods and to our research to develop a mathematical foundation for atomistic to continuum methods such as the quasicontinuum method.

Math Seminars
Multicellular Mathematical Models of Somitogenesis
Mark Campanelli - Department of Mathematical Sciences, MSU
When: Friday, August 28, 2009 10:00AM to 11:00AM
Where: Wilson Hall 1-144
Details: Somitogenesis is an important pattern formation process in the developmental biology of vertebrates. The phenomenon has received wide attention from experimental, theoretical, and computational biologists. Numerous mathematical models of the process have been proposed, with the clock and wavefront mechanism rising to prominence over the last ten years. This work presents two multicellular mathematical models of somitogenesis. The first is a phenomenological phase oscillator model that reproduces both the clock and wavefront aspects of somitogenesis, but lacks a biological basis. The second is a biologically informed delay differential equation model of the clock-wave that is produced by coordinated oscillatory gene expression across many cells. Careful and efficient model construction, parameter estimation, and model validation identify important nonlinear mechanisms in the genetic control circuit of the somitogenesis clock. In particular, a graded control protein combined with differential decay of clock protein monomers and dimers is found to be a key mechanism for slowing oscillations and generating experimentally observed waves of gene expression. This represents a mode of combinatorial control that has not been previously examined in somitogenesis, and warrants further experimental and theoretical investigation.

Math Seminars
Determining the Biomechanical Response of a Filiform Hair Array: A Low Reynolds Number Fluid-Structure Model
Bree Cummins - Department of Mathematical Sciences and Center for Computational Biology, MSU
When: Wednesday, August 19, 2009 10:00AM to 11:00AM
Where: Wilson Hall 1-144
Details: A great deal of important scientific research has been done on simple "model" biological preparations, which offer advantages of enhanced experimental tractability over more complex systems. One model system that has been the subject of many anatomical, developmental, functional, and theoretical studies over the last 30 years is the cercal sensory system of the cricket. The cercal system is composed of two antenna-like appendages covered with hundreds of filiform mechanosensory hairs and functions as a low-frequency, near-field extension of the animal's auditory system, encoding accurate and precise information about low-velocity air currents. The encoding is governed by the directional and frequency sensitivities of the hair population, which are determined by the biomechanical properties of the hairs. This first layer of the cercal system is still poorly understood, primarily because accurate experimental measurements of the air-current-driven movements of the hairs are difficult to obtain, and adequate mathematical tools for modeling arbitrarily complex hair-to-hair interactions within the canopy have been absent. The study presented here solves fundamental problems in both of these areas. Previous studies have characterized the biomechanics of the filiform hairs using a variety of experimental and computational approaches, but only one included a consideration of the fluid-mediated interaction of closely packed hairs at the proximal end of the cercus. A major goal of our work is to model the motion of a dense patch of thin structures driven by bulk fluid flow, in a
context that is immediately relevant to the cricket cercal system. In order to understand the function of the sensory epithelium as a whole, we developed a sophisticated numerical model based on a novel mathematical tool: the method of regularized unsteady Stokeslets. This method is generally applicable to low Reynolds number fluid flow in domains that are subject to periodic forcing along the boundary. The numerical scheme associated with our mathematical model is fast, scalable, accounts for the interaction between arbitrary arrangements of hairs, and models biologically realistic stimuli. We measured the biomechanical stimulus-response properties of 19 filiform hairs, and used that data to fit parameters to our mathematical model. We demonstrate for the first time that one of the mechanical parameters controlling filiform hair motion depends on the frequency of the air stimulus. Our numerical simulations demonstrate that damped and synergistic hair interactions can occur between closely-packed hairs. Low frequency signals (< 50 Hz) are damped, and higher frequency signals (50-200 Hz) are amplified. We hypothesize that the characteristic dense patch of hairs at the proximal end of the cercus acts as a noise cancellation filter that removes low frequency components of ambient environmental stimuli.

Math Seminars

Gene Regulation in the LAC Operon
Kate Patterson - Department of Mathematical Sciences, MSU
When: Tuesday, July 07, 2009 02:10PM to 03:00PM
Where: Wilson Hall 1-144
Details: The lac operon, a jointly controlled series of genes in the bacteria E. coli, has been studied extensively since the 1940's. The lac operon genes code for proteins that are needed for transport and digestion of lactose. It is activated in the presence of lactose after glucose, the preferred carbon source, has been expended. In this thesis, we introduce a biophysical model using the Shea-Ackers framework for modeling promoter dynamics. The model spans two scales: the inputs are biophysical parameters of molecular interactions and the result is a level of gene expression - a macroscopic behavior of the cell. We include all experimentally suggested control mechanisms into the model, even though the experimental evidence is stronger for some of these mechanisms than others. We compare our model to experimental data and explore the individual contribution of the proposed mechanisms by removing them one by one and testing the reduced model’s T to the data. Finally, we nd a minimal model which faithfully represents the available data, yet includes only the minimal number of control mechanisms.

Math Seminars

Classical Mechanics with Dissipative Constraints
Shaun Harker - Department of Mathematical Sciences, MSU
When: Thursday, June 11, 2009 02:10PM to 03:00PM
Where: Wilson Hall 1-144
Details: The aim of this thesis is to consider the mathematical treatment of mechanical systems in the presence of constraints which are energetically dissipative. Constraints may be energetically dissipative due to impacts and friction. In the frictionless setting, we generalize Hamilton's principle of stationary action, central to the Lagrangian formulation of classical mechanics, to reflect optimality conditions in constrained spaces. We show that this generalization leads to the standard measure theoretic equations for shocks in the presence of unilateral constraints. Previously, these equations were simply postulated; we derive them from a fundamental variation principle. We also present results in the frictional setting. We survey the extensive literature on the subject, which focusses on existence results and numerical schemes known as time-stepping algorithms. We consider a novel model of friction (which is more dissipative than standard Coulomb friction) for which we can give better well-posedness results than what is currently available for the Coulomb theory. To this end, we study multi-valued maps, differential inclusions, and optimization theory. We construct a differential inclusion we call the feedback problem, for which the multi-valued map is the solution set of a convex program. We give existence and uniqueness results regarding this feedback problem. We cast the persistent contact evolution problem of our novel model of friction into the form of a feedback problem to derive an existence result.

Math Seminars

Computational Methods for Positron Emission Tomography
Dr. John Bardsley - Department of Mathematical Sciences, University of Montana
When: Thursday, April 30, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I'll spend a fair amount of time discussing the mathematical models behind the CT (computed tomography) and PET (positron emission tomography) imaging modalities, with the goal of bringing the audience along for as much of 50 minutes as possible. At some point, however, I'll dive into my own recent (and somewhat obscure) computational math research focusing on the PET imaging problem.

Math Seminars

The Gap Labeling Theorem: History and Present
Dr. Jean Bellisard - Schools of Mathematics and Physics, Georgia Institute of Technology
When: Wednesday, April 29, 2009 04:10PM to 05:00PM
Where: Procrastinator Theater, SUB
Details: The Gap Labeling Theorem is one of the earliest examples of intrusion of topological invariance in Solid State Physics. Initially defined through K-theory of C*-algebras, it is today seen more as a cohomological invariant for compact topological spaces. The discovery of this concept will be described, meandering from the theory of crystal electrons in a magnetic field to the more recent developments about the topology
of tiling spaces. Along the way few examples of applications will be provided while keeping in mind the parallel with the history of Atiyah-Singers Index Theorem.

Math Seminars
Active Learning - It's not just for 7th Graders anymore!
Roger Fischer - Department of Mathematical Sciences, MSU
When: Monday, April 27, 2009 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: After my traumatic experience of teaching middle school, I returned to my alma mater to earn a master’s degree in math education. In a desire to improve my teaching abilities and to silence my inner critic, I studied the effectiveness of active learning techniques in a remedial mathematics classroom. Results indicated that (i) my students thought I was weird and (ii) active learning had a significant impact on certain aspects of student performance and not others, as well as a surprise result thrown in for free!

Math Seminars
Asymptotic Approximations for Electrode Models (work in progress)
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU
When: Thursday, April 23, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In the medical sciences researchers have studied the viability of Electrical Impedance Tomography (EIT) as a means of non-invasively imaging the interior of the body. There, small electrodes are attached, currents applied and voltages measured. We study a very simple related problem where multiple electrodes may be used to determine nerve depth or properties. Simplified models involve Laplace’s equation with mixed and nearly singular nonhomogeneous boundary conditions. In the small electrode limit numerical solutions are not dependable and Fourier series converge slowly. Therefore, we seek asymptotic approximations. The bulk of the work revolves around determining an outer solution to complete the inner approximation where the voltage is measured. The outer solution is found using rapidly convergent series representations of various Green’s functions.

Math Seminars
Playing Games and Catching Fish: A Quick Review of Jamaican Fishing through Game Theory
Luke Shorty - Department of Mathematical Sciences, MSU
When: Monday, April 20, 2009 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Howdy all, as spring approaches I know what we are all feeling like: fishing in the Caribbean! I may not have a magical ticket to Jamaica, but let me bring Jamaica to
you with a two person zero sum game! Doesn't that sound fun? Here we will revisit Davenport's controversial paper of the 1960's: "Jamaican Fishing: A game theory analysis". No fishing or game theory experience required.

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**Math Seminars**

*Program MARK: Unsolved Issues that Need Further Research*

Dr. Gary White - Colorado State University

**When:** Friday, April 17, 2009 03:10PM to 04:00PM

**Where:** Wilson 1-144

**Details:** Four potential research areas will be discussed that are issues in the analysis of mark-encounter data: 1) goodness of fit and estimation of the over dispersion parameter; 2) model selection and sample size for multi-level models; 3) estimation of variable importance with a large number of variables; and 4) determination of the number of parameters estimated from an estimated Fisher information matrix. Current approaches to these issues will be presented, but with the hope of instigating new research on these topics.

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**Math Seminars**

*Ricci Flow and the Determinant of the Laplacian on Noncompact Surfaces*

Dr. Pierre Albin - MIT

**When:** Friday, April 17, 2009 03:10PM to 04:00PM

**Where:** Wilson Hall 1-139

**Details:** Defining the determinant of the Laplacian on a surface is somewhat intricate because it has infinitely many eigenvalues. I'll explain how to define it when on top of eigenvalues, the Laplacian has continuous spectrum. On surfaces (even non-compact) this determinant has a simple variation when the metric varies conformally. I'll explain how one can use Ricci flow to see that the largest value of the determinant occurs at constant curvature metrics.

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**Math Seminars**

*Bose-Einstein Condensation: From Many Quantum Particles to a Quantum "Super-Particle"*

Dr. Kay Kirkpatrick Albin - MIT

**When:** Thursday, April 16, 2009 04:10PM to 05:00PM

**Where:** Wilson Hall 1-144

**Details:** Bose-Einstein condensation is a strange state of matter that forms near absolute zero and exhibits quantum behavior macroscopically. In particular, it is a superfluid and not affected by friction. Certain aspects of this phenomenon are nicely understood by the fundamental approach of statistical mechanics: deriving macroscopic PDE descriptions from the microscopic first principles governing interactions between particles. I'll describe two such derivations for systems of many quantum particles: as a
first approximation, particle interactions that are averaged out; and more realistically for Bose-Einstein condensation, interactions that become localized. I'll summarize joint work with Benjamin Schlein and Gigliola Staffilani, where we handled Bose-Einstein condensation on the plane and the torus. The toroidal case is especially interesting, because it involves a bit of analytic number theory.

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**Math Seminars**

**Program MARK Overview and Recent Additions.**

**Dr. Gary White - Department of Fish, Wildlife, and Conservation Biology, Colorado State University**

**When:** Thursday, April 16, 2009 03:30PM to 04:30PM

**Where:** Lewis 304

**Details:** Program MARK, a Windows Vista or XP program, provides parameter estimates from marked animals when they are re-encountered at a later time. Reencounters can be from dead recoveries (e.g., the animal is harvested), live recaptures (e.g. the animal is re-trapped or re-sighted), radio tracking, or from some combination of these sources of re-encounters. The time intervals between re-encounters do not have to be equal, but are assumed to be 1 time unit if not specified. More than one attribute group of animals can be modeled, e.g., treatment and control animals, and covariates specific to the group or the individual animal can be used. The basic input to MARK is the encounter history for each animal. MARK can also provide estimates of population size for closed populations, including robust design versions of multi-state models. Parameters can be constrained to be the same across re-encounter occasions, or by age, or by group, using the parameter index matrix (PIM). Besides the logit function to link the design matrix to the parameters of the model, other link functions include the log-log, complimentary log-log, sine, log, and identity. Program MARK computes the estimates of model parameters via numerical maximum likelihood techniques. The FORTRAN program that does this computation also determines numerically the number of parameters that are estimable in the model, and reports its guess of one parameter that is not estimable if one or more parameters are not estimable. The number of estimable parameters is used to compute the quasi-likelihood AIC value (QAICc) for the model. Outputs for various models that the user has built (fit) are stored in a database, known as the Results Database. The input data are also stored in this database, making it a complete description of the model building process. The database is viewed and manipulated in a Results Browser window. Summaries available from the Results Browser window include viewing and printing model output (estimates, standard errors, and goodness-of-fit tests), deviance residuals from the model (including graphics and point and click capability to view the encounter history responsible for a particular residual), likelihood ratio and analysis of deviance (ANODEV) between models, and adjustments for over dispersion. Models can be retrieved and modified to create additional models. Context-sensitive help screens are available with Help click buttons and the F1 key. The Shift-F1 key can also be used to investigate the function of a particular control or menu item. Help screens include hypertext links to other help screens, with the intent to provide all the necessary
program documentation on-line with the Help System. Recent additions to MARK include Bayesian inference with a Markov Chain Monte Carlo algorithm, new data types including mark-resight models and multistate models with uncertain identification of states, and the capability to run all possible subsets of a set of variables in the design matrix.

**Math Seminars**

**Particle-Based Reinforcement Learning for Energy-Aware Routing in Wireless Sensor Networks**

Dr. John W. Sheppard - Department of Computer Science, MSU  
When: **Thursday, April 16, 2009 03:10PM to 04:00PM**  
Where: Wilson Hall 1-144  
Details: Sensor networks are traditionally built using battery-powered, collaborative devices. These sensor nodes do not rely on dedicated infrastructure services (e.g., routers) to relay data. Rather, a communal effort is employed where the sensor nodes both generate data as well as forward data for other nodes. A routing protocol is needed in order for the sensors to determine viable paths through the network, but routing protocols designed for wired networks and even ad hoc networks are not sufficient given the energy overhead needed to operate them. We present an energy-aware routing protocol, based on concepts from reinforcement learning and particle swarm optimization that offers reliable path selection while reducing the energy consumption for the route selection process. Our Particle-based Routing with Overlapping Swarms for Energy-Efficiency (PROSE) algorithm is compared to three other routing protocols used in WSNs. In these comparisons, we show that the algorithm succeeds in extending the life of battery-powered networks while still providing robust routing functionality to maintain network reliability. This is work done in collaboration with Brian Haberman at the Johns Hopkins University.

**Math Seminars**

**Effects of Whirling Disease on Trout Populations**

Dr. Jim Robison-Cox - Department of Mathematical Sciences, MSU  
When: **Tuesday, April 14, 2009 04:10PM to 05:00PM**  
Where: Wilson Hall 1-144  
Details: Whirling Disease was first observed in Montana Rivers around 1995. This talk introduces methods used to estimate fish populations and from them to estimate effects of the disease on Rainbow and Brown trout populations.

**Math Seminars**

**Principal Component Models Applied to Confirmatory Factor Analysis**

Yin Chang - Department of Mathematical Sciences, MSU  
When: **Monday, April 13, 2009 04:10PM to 05:00PM**  
Where: Wilson Hall 2-244
Details: This will be a practice run-through of Yin's oral exam.

**Math Seminars**

**From Cells to Communities, Applications of Metabolic Systems Analysis**
Dr. Ross Carlson - Department of Chemical and Biological Engineering and CBE, MSU
When: **Thursday, April 09, 2009 03:10PM to 04:00PM**
Where: Wilson Hall 1-144
Details: The bioinformatics age continues to generate enormous volumes of data. A systems-based analysis is often required to extract biologically relevant insight from this data. An in silico approach known as elementary mode analysis (EMA) has been used to explore microbial metabolic networks by first decomposing the highly branched and highly redundant networks into their simplest, functional flux units (a mathematically defined biochemical pathway). The physiological properties of each nondivisible unit are then used as coordinates to plot the data in a multidimensional space where biologically competitive strategies can be quickly and efficiently identified. A 'bottom-up' systems biology approach is then applied to reconstruct complex microbial behaviors using these simplest components as building blocks. Applications of this approach on systems ranging from individual cells to microbial communities will be presented.

**Math Seminars**

**Rotation and Dynamics for Simple Solenoidal Maps of Tori**
Mark Mathison - Department of Mathematical Sciences, MSU
When: **Friday, April 03, 2009 03:10PM to 04:00PM**
Where: Wilson Hall 1-144
Details: Each orbit of a Simple Solenoidal Map on T^d, when lifted to R^d is confined to one member of a family of lines. This reduces the study of the dynamics of the map on the whole space to the study of a family of related maps on the real line. A few pictures will be shown, some results will be given, and a few proofs will be hinted at. This talk is the open portion of an oral Ph.D. exam.

**Math Seminars**

**An Alternating-Direction Sinc-Galerkin Method for Elliptic Problems on Finite and Infinite Domains**
Mr. Nicomedes Alonso - Department of Mathematical Sciences, MSU
When: **Thursday, April 02, 2009 03:10PM to 04:00PM**
Where: Wilson Hall 1-144
Details: Alternating-Direction Implicit (ADI) schemes are a class of very efficient algorithms for the numerical solution of differential equations. Sinc-Galerkin schemes employ a sinc basis to produce exponentially accurate approximate solutions to differential equations even in the presence of singularities. After a brief discussion about
ADI and Galerkin schemes and an introduction to the Kronecker product, a new Alternating-Direction Sinc-Galerkin method based on these two types of schemes will be derived. We will show that when a symmetric Sinc-Galerkin method is employed, the resulting Sylvester equation can be classified as an ADI model problem. We end by applying ADSG to a variety of problems on finite and infinite domains, comparing its performance to standard techniques.

**Math Seminars**

**An Integrative Model of Lamprey Swimming**
*Dr. Lisa Fauci - Mathematics Department, Tulane University*
**When:** Friday, March 27, 2009 03:00PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** Swimming due to body undulations is observed across the full spectrum of swimming organisms, from microscopic flagella to fish. These undulations are due to internal force generating mechanisms, which, in the case of lamprey are due to a wave of neural activation from head to tail. Here we present recent results on a computational model of a swimming lamprey that couples activation of discrete muscle segments, passive elastic forces, and a surrounding viscous, incompressible fluid. The fluid dynamics are modeled by the Navier-Stokes equations at appropriate Reynolds numbers, where the resulting flow field and vortex shedding may be measured.

**Math Seminars**

**Interaction of Elastic Biological Structures with Complex Fluids**
*Dr. Lisa Fauci - Mathematics Department and Center for Computational Science, Tulane University*
**When:** Thursday, March 26, 2009 04:10PM to 05:00PM  
**Where:** Procrastinator Theater, SUB  
**Details:** The biofluid dynamics of reproduction provide wonderful examples of fluid structure interactions. Peristaltic pumping by wave-like muscular contractions is a fundamental mechanism for ovum transport in the oviduct and uterus. While peristaltic pumping of a Newtonian fluid is well understood, in many important applications the fluids have non-Newtonian responses. Similarly, mammalian spermatozoa encounter complex, non-Newtonian fluid environments as they make their way through the female reproductive tract. The beat form realized by the flagellum varies tremendously along this journey. We will present recent progress on the development of computational models of pumping and swimming in a complex fluid. An immersed boundary framework is used, with the complex fluid represented either by a continuum Oldroyd-B model, or a Newtonian fluid overlaid with discrete viscoelastic elements.

**Math Seminars**

**Climate Past, Present and Future**
*Dr. Doug Nychka - Institute for Mathematics Applied to Geosciences and National*
Center for Atmospheric Research  
When: **Monday, March 23, 2009 04:00PM to 05:00PM**  
Where: Procrastinator Theater (SUB)  
Details: A grand scientific challenge for this century is to understand the complex interrelationships among the physical processes, and human activities that define the Earth's climate. One specific concern is the warming of our climate brought about the increase of greenhouse gases, such as carbon dioxide, being released into the atmosphere. What do we know about the Earth's past climate and is the global warming over the last century real? What is a climate model and how is it used to understand changes to climate for the future? For each of these questions statistical science can play a role in quantifying the uncertainty in scientific conclusions, for combining different kinds of information and summarizing complex data sets.

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**Math Seminars**

**Black Diamond Ski Runs, the Fields R Package, and Inference for Large Spatial Data Sets**

Dr. Doug Nychka - Institute for Mathematics Applied to Geosciences and National Center for Atmospheric Research  
When: **Monday, March 23, 2009 02:10PM to 03:00PM**  
Where: Wilson Hall 1-144  
Details: The statistical analysis of large spatial datasets is an important challenge for the study of large geophysical simulations and climate data records. This talk will illustrate some statistical methods and software tools using a large elevation data set, although the principles extend easily to more scientific contexts. Showcased here are methods of conditional simulation that provide useful measures of uncertainty for an estimated function and also spatial methods that use sparse matrix representations to handle large numbers of locations.

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**Math Seminars**

**Niche Partitioning of Synechococcus Species in Yellowstone Hot Springs**

Shane Nowack - Department of Mathematical Sciences, MSU  
When: **Thursday, March 12, 2009 03:10PM to 04:00PM**  
Where: Wilson Hall 1-144  
Details: The Ward Lab from the department of Land Resources and Environmental Sciences at Montana State University has been studying Synechococcus species inhabiting the effluent channels of Yellowstone hot springs for several years. One of their primary goals is to develop a theory of niche structure based on the physical and chemical realities of this microbial community. This work is closely related to a topic of considerable interest in the field of mathematical ecology: understanding discrete speciation of asexual populations in a continuously varying environment. Previous speciation models assume a growth rate function, usually a Gaussian, and attempt to model species population. In other words, they define a niche and ask the question:
Who lives here? Our collaboration with the Ward Lab has led us to believe that, in this system, growth with respect to varying environmental conditions may not be accurately modeled by a Gaussian curve. Our alternative approach is to let the growth rate function choose itself. Given a set of relative constraints and histories of environmental conditions, what growth rate should a species have in order to maximize population? In this talk I will discuss our initial attempts to solve this optimization problem by studying a toy chemostat model where temperature is the continuously varying parameter. In addition to the model results I will also discuss the work I have done in the field, my laboratory efforts, and future directions of this project.

Math Seminars
An Introduction to Tiling Spaces
Carl Olimb - Department of Mathematical Sciences, MSU
When: Monday, March 09, 2009 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: A brief introduction to tiling spaces

Other
Introduction to LaTeX: Part III
Dr. John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, March 03, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This seminar is a continuation of an introduction to using LaTeX to prepare mathematical and scientific documents. Part III will focus on the math mode. This includes: mathematical font sets; subscripts and superscripts; fractions; equations (numbered and unnumbered); variable size brackets, braces, and parentheses; equation arrays; matrices; labeling theorems, corollaries, and lemmas; Maple-to-LaTeX conversions; compiling multiple LaTeX files.

Math Seminars
On the Tractability of Maximal Strip Recovery
Dr. Binhai Zhu - Department of Computer Science, MSU
When: Thursday, February 26, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Given two genomic maps G and H represented by a sequence of \(n\) gene markers, a *strip* (syntenic block) is a sequence of distinct markers of length at least two which appear as subsequences in the input maps, either directly or in reversed and negated form. The problem *Maximal Strip Recovery* (MSR) is to find two subsequences \(G'\) and \(H'\) of \(G\) and \(H\), respectively, such that the total length of disjoint strips in \(G'\) and \(H'\) is maximized (or, conversely, the number of markers hence deleted, is minimized). Previously, besides some heuristic solutions, a factor-4 polynomial-time approximation is known for the MSR problem; moreover, several close
variants of MSR, MSR-d (with $d > 2$ input maps), MSR-DU (with marker duplications) and MSR-WT (with markers weighted) are all shown to be NP-complete. Before this work, the complexity of the original MSR problem was left open. In this talk, I will show how to solve the open problem by showing that MSR is NP-complete, using a polynomial time reduction from One-in-Three 3SAT. We also solve the MSR problem and its variants exactly with FPT algorithms, i.e., showing that MSR is fixed-parameter tractable. Let k be the minimum number of markers deleted in various versions of MSR, the running time of our algorithms are $O(2^{2.73k}n+n^2)$ for MSR, $O(2^{2.73k}dn+dn^2)$ for MSR-d, and $O(2^{5.46k}n+n^2)$ for MSR-DU.

Math Seminars

**Numerical Approximation of Stochastic Differential Equations**
Dr. Tianyu Zhang - Department of Mathematical Sciences, MSU
When: **Thursday, February 19, 2009 03:10PM to 04:00PM**  
Where: Wilson Hall 1-144  
Details: We will discuss the numerical approximation of some linear stochastic partial differential equations with additive noises. A special representation of the noise is considered, and it is compared with general representations of noises in the infinite dimensional setting. Convergence analysis and error estimates are presented for the numerical solution based on the standard finite difference and finite element methods. The effects of the noises on the accuracy of the approximations are illustrated. Results of the numerical experiments are provided.

**Other**

**Introduction to LaTeX: Part II**
Dr. John Borkowski - Department of Mathematical Sciences, MSU  
When: **Tuesday, February 17, 2009 03:10PM to 04:00PM**  
Where: Wilson Hall 1-144  
Details: This seminar is a continuation of an introduction to using LaTeX to prepare mathematical and scientific documents. Part II will focus on making tables and incorporating figures (importing graphics) into a LaTeX document.

**Other**

**Introduction to LaTeX: Part I**
Dr. John Borkowski - Department of Mathematical Sciences, MSU  
When: **Tuesday, February 10, 2009 03:10PM to 04:00PM**  
Where: Wilson Hall 1-144  
Details: This seminar provides an introduction to using LaTeX to prepare mathematical and scientific documents. Part I will focus on the structure of a LaTeX document (the preamble, creating numbered sections), modifying text (font size, font type, line spacing), and creating itemized lists (bulleted, numbered, nested). If you plan to attend, please print out a copy of the seminar notes from my departmental webpage.
Relaxation Oscillations and a Cell Cycle Oscillator
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, February 05, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We study a finite dimensional monotone system coupled to a slowly evolving scalar differential equation which provides a negative feedback to the monotone system. We use a theory of multi-valued characteristics to show that this system admits a relaxation periodic orbit if a simple model system in $\mathbb{R}^2$ does. Our construction can be used to prove existence of periodic orbits in slow-fast systems of arbitrary dimension. We apply our theory to a model of a cell cycle in Xenopus embryos. Abrupt changes in signals upon entry to mitosis suggests that the cell cycle is generated by a relaxation oscillation. Our results show that the cell cycle orbit is not a relaxation oscillator. However, we construct a closely related system that exhibits relaxation oscillations and that approximates the cell cycle oscillator for an intermediate range of negative feedback strengths. We show that the cell cycle oscillation disappears if the negative feedback is too weak or too strong.

Componentwise Variance Dispersion Graphs for Mixture Experiments
Dr. John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, February 03, 2009 03:00PM to 04:00PM
Where: Wilson Hall 1-144
Details: Consider a q-component mixture experiment with constraints defined by lower and upper bounds for each component proportion creating a design region that is some irregularly-shaped polyhedral sub region of a simplex. The research problem of interest is the extension of variance dispersion graphs (VDGs) to experiments involving mixtures. As an alternative to studying the prediction variance on shrunken polyhedral spaces (Piepel and Anderson 1993) or to the prediction variance trace (PVT) plots involving Cox directions (Vining, Cornell, and Myers 1993), a new graphical tool, called the component wise variance dispersion graph (CVDG), will be proposed. A CVDG contains component wise plots of the variability throughout the entire polyhedral design space. Examples of CVDGs are presented.

An Introduction to Set Theory, the Axiom of Choice, and Zorn’s Lemma
Kevin Joyce - Department of Mathematical Sciences, MSU
When: Monday, February 02, 2009 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: In this talk I will introduce some of the ideas and methods involved in mathematical foundations based in set theory. In particular, I will give a brief
introduction to the Zermelo-Frankel axiom system. As time permits, we will outline some classical applications of Zorn's Lemma as well as a proof that it is implied by the Axiom of Choice.

Math Seminars
The Stereo Disparity Problem and Image Registration
Dr. Curtis Vogel - Department of Mathematical Sciences, MSU
When: Thursday, January 29, 2009 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Given a pair of similar images, stereo disparity refers to the problem of computing a vector field, or displacement map, which transforms pixels in one image to corresponding pixels in the second image. In this talk we will review standard computational approaches to disparity, with an emphasis on multichannel correlation techniques. We will also present several applications, including the registration of LIDAR (laser reflectance) data to standard camera image data.

Math Seminars
Evaluating and Comparing Properties of Response Surface Designs
Dr. John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, January 27, 2009 03:00PM to 04:00PM
Where: Wilson Hall 1-144
Details: This seminar contains an introduction to one current area of research in response surface methodology (RSM) related to the development of graphical methods for studying the prediction variance properties of response surface designs. The following topics will be discussed: an introduction to RSM, the prediction variance function, design optimality criteria, and spherical prediction variance functions. This introductory material provides motivation for the development of the variance dispersion graph (VDG), the fraction of design space (FDS) plot, and the quantile dispersion graph (QDG). Example of VDGs, FDS plots, and QDGs will be presented. The content from this seminar will serve as a foundation for the second seminar Component wise Variance Dispersion Graphs for Mixture Experiments.

Math Seminars
Constructible Objects`
Scott Schmieding - Department of Mathematical Sciences, MSU
When: Monday, January 26, 2009 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: We will investigate what sorts of things are impossible to construct with only a ruler and a compass.
Microbial-Induced Mineralization in Biofilms
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, December 04, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The familiar view of microbes in their free (planktonic) state is not the norm; rather it is believed that much of the microbial biomass, perhaps 95-99%, is located in close-knit communities, designated biofilms and microbial mats, consisting of large numbers of organisms living within self-secreted matrices constructed of polymers and other molecules. (Microbes in collective behave very differently from their planktonic state; even genetic expression patterns change.) These matrices serve the purposes of anchoring and protecting their communities in favorable locations while providing a framework in which structured populations can differentiate and self-organize. One of the salient features of biofilms is their spatial heterogeneity; they are not uniform, well mixed systems like many laboratory microbial communities are. Because of spatial variation, advective and diffusive processes become influential. Further, when ionic quantities are important, these processes in turn can lead to electric field effects becoming significant. These issues are discussed in the context of a particular phenomenon, namely mineralization resulting from biological activity in biofilms.

Math Seminars
An Exponentially Accurate Numerical Method for Elliptic Problems on Infinite Domains
Nick Alonso - Department of Mathematical Sciences, MSU
When: Monday, December 01, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Application of the symmetric Sinc-Galerkin method to an elliptic PDE leads to an ADI model problem in the form of a Lyapunov equation, AX+XA=C, where A is a symmetric matrix. I will introduce a new iterative scheme, the Alternating-Direction SincGalerkin (ADSG) method, which accurately solves the Lyapunov equation while avoiding both the very large matrices that result when the Kroneunov equation is used, and the computation of eigenvalues and eigenvectors required when matrix diagonalization is used.

Math Seminars
A Mathematical Model for the Onset of Water Flooding in the Cathode of a Proton Exchange Membrane Fuel Cell
Daniel Kanewske - Department of Mathematical Sciences, MSU
When: Thursday, November 20, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This work constructs a mathematical model for the onset of water flooding of the cathode gas diffusion medium in a proton exchange membrane fuel cell. The model results include a coupled system of partial differential equations that govern diffusion
driven mass transport. These equations are solved using finite difference approximations of the derivatives and the numeric solution is implemented with a Matlab algorithm. Using this algorithm, we obtain time estimates for the onset of flooding for a range of current densities and relative humidities. Taken together, these estimates form a time surface for the onset of flooding which characterizes proton exchange membrane fuel cell flooding behavior. Furthermore, this shows that the use of concentration dependent ternary diffusion coefficients generates a solution which requires fewer approximations of the governing laws, providing a more direct representation of proton exchange membrane fuel cell flooding dynamics.

Math Seminars
Numerical Approximation of Nonhomogeneous Heat Equation
Jennifer Thorenson - Department of Mathematical Sciences, MSU
When: Monday, November 17, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: An introduction to the finite element method and sensitivity analysis in the context of a nonhomogeneous heat equation.

Math Seminars
Geometric Origami
Andy Bouwm - Department of Mathematical Sciences, MSU
When: Monday, November 10, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: I'll demonstrate some methods for constructing certain polyhedra, and talk about why they work. I'll also briefly talk about a few fundamental axioms of origami geometry.

Math Seminars
Computing Quasi-steady State Protein Concentrations as a Globally Asymptotically Stable Fixed Point of a Nonlinear Discrete Dynamical System
Mark Campanelli - Department of Mathematical Sciences, MSU
When: Monday, November 03, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: A common approximation in math biology is the "quasi-steady state", which occurs in biochemical systems with both fast and slow timescales. In many biochemical systems, certain biochemical reactions occur much more quickly than others. On short timescales, these reactions reach chemical equilibrium quickly, while the remaining reactions only significantly change the system's state over larger timescales. I have extended a mathematical model of biological pattern formation to include competitive dimerization of two proteins. The model is a system of delay-differential equations that
assumes the chemical equilibration of protein monomers, homodimers, and heterodimers occurs quickly as compared to other reactions, such as mRNA/protein production and decay. At each time step of the delay-differential equation solver, the quasi-steady state approximation requires solving a nonlinear algebraic system of equations for the protein monomer and dimer concentrations of the fast subsystem. I have developed an iterative numerical scheme that computes these concentrations as a globally asymptotically stable fixed point of a map from the closed positive quadrant of $\mathbb{R}^2$ into itself. Under certain conditions on the system parameters, the map is a contraction, and the Banach Fixed Point Theorem applies. More generally, I have proved the positive fixed point is globally asymptotically stable even when the map is not a contraction. Finally, I will discuss approaches to generalizing this method for three or more proteins, especially with respect to finding a Liapunov function that guarantees convergence to a unique positive fixed point.

Math Seminars
Connected Sums of 1-Forms, Part III
Andy Bouwman - Department of Mathematical Sciences, MSU
When: Thursday, October 30, 2008 04:10PM to 05:00PM
Where: Wilson Hall 1-124
Details: In a paper published in 2007, Curtis McMullen gave a proof that any holomorphic 1-form of genus 2 can be written in infinitely many ways as a connected sum of forms of genus 1. I will present this proof, along with some necessary background information and several drawings.

Math Seminars
Numerical Issues in the Modeling of Biological Fluid Flows
Dr. Jeffrey J. Heys - Department of Chemical and Biological Engineering, MSU
When: Thursday, October 30, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Biological fluid flows, which are often mechanically coupled to an elastic tissue, can be mathematically modeled using a number of different approaches depending on the physical characteristics of the problem being solved. We are interested in systems consisting of a Newtonian fluid, modeled using the Navier-Stokes equations, and a linear elastic material with properties similar to a soft tissue. These coupled fluid-elastic problems are inherently nonlinear because the shape of the fluid domain is not known a priori, and the computational grid must be moved or mapped. We typically use elliptic grid generation (EGG) to map the physical domain to a fixed computational domain. A least-squares formulation of the Navier-Stokes, EGG, and linear elasticity equations provides a number of benefits to solving coupled systems problems, including: optimal finite element approximation in a desirable norm ($H^1$), optimal multilevel solver performance, optimal scalability, and a sharp a posteriori error measure. The optimality and performance of the formulation has been demonstrated extensively in 2-D for a variety of problems, including the fully coupled fluid-elastic system. However, as
expected, the extension to 3-D brings new challenges for both the whole and the individual parts of the coupled system. Some of the issues associated with the extension to 3-D have been partially or fully addressed, such as: growing complexity in the multilevel solver, iteration schemes between the components of the fully coupled system, extension to parallel computers, and proper scaling of the equations. Other questions we are only beginning to answer, including the handling of singularities, prefinement and choice of least-squares formulation.

**Math Seminars**

**Mathematical Sciences Colloquium Series: What Can We Learn From Research About Effective Mathematics Teaching?**

Dr. James Hiebert - Robert J. Barkley Professor of Education, University of Delaware

When: **Monday, October 27, 2008 04:10PM to 05:15PM**

Where: Procrastinator Theater, SUB

Details: What makes mathematics teaching effective? Does the research literature provide any help for improving how effectively we teach? This presentation will summarize a few key findings from research on teaching and learning mathematics in the U.S. and in other countries. The findings point to several aspects of mathematics teaching, at any level, that are critical for students' learning and that could be improved.

**Math Seminars**

**Connected Sums of 1-Forms, Part II**

Andy Bouwman - Department of Mathematical Sciences, MSU

When: **Thursday, October 23, 2008 04:10PM to 05:00PM**

Where: Wilson Hall 1-124

Details: In a paper published in 2007, Curtis McMullen gave a proof that any holomorphic 1-form of genus 2 can be written in infinitely many ways as a connected sum of forms of genus 1. I will present this proof, along with some necessary background information and several drawings.

**Math Seminars**

**Senescence and Microbial Persistence**

Dr. Jack Dockery - Department of Mathematical Sciences, MSU

When: **Thursday, October 23, 2008 03:10PM to 04:00PM**

Where: Wilson Hall 1-144

Details: It has been known for many years that small fractions of persister cells resist killing in many bacterial colony-antimicrobial confrontations. These persisters are not mutants. Rather it has been hypothesized that they are phenotypic variants. Current models allow cells to switch in and out of the persister phenotype. We suggest a different explanation, namely senescence, for persister formation. Using several mathematical models including age structure, we show that senescence provides a
natural explanation for persister-related phenomena including the observations that persister fraction depends on growth phase in batch culture and dilution rate in continuous culture. Along the way we have some new theoretical results for the Chemostat.

**Math Seminars**

**Acoustics of the Flute**  
*Hannah Sobek* - Department of Mathematical Sciences, MSU  
*When:* Monday, October 20, 2008 04:10PM to 05:00PM  
*Where:* Wilson Hall 2-244  
*Details:* I'm planning to give a summary of a research project I did in my undergrad program. It is about the acoustics of the flute. My study began with a review of the wave equation and then I looked into how musical intervals are mathematically defined, and finally I did a short research project on the flute. My paper included a brief history on the flute and then investigated the calculation of tone hole placement.

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**Math Seminars**

**Dynamics of Cortico-Cortical Interactions in the Macaque**  
*Dr. Charles Gray* - Department of Cell Biology and Neuroscience, MSU  
*When:* Thursday, October 16, 2008 03:10PM to 04:00PM  
*Where:* Wilson Hall 1-144  
*Details:* It is well established that perceptual and cognitive processes involve the coordinated activity of large populations of neurons distributed over multiple cortical regions. However, we remain surprisingly ignorant of the spatio-temporal organization of these processes, their underlying neuronal mechanisms, and their relation to behavior. This gap in understanding stems largely from the complex and non-stationary nature of distributed cortical activity and from technical limitations in our ability to make appropriate electrophysiological measurements. In my presentation, I will present new experimental findings, from large scale multi-electrode recordings in macaque monkeys that provide insight into the dynamics of cortico-cortical interactions. In one study, we recorded neuronal activity from a closely-spaced array of 60 microelectrodes in extrastriate visual cortex of an alert monkey while the animal viewed a time-varying natural scene. Analysis of these data reveal highly dynamic patterns of synchronous activity that rapidly change their spatial organization as a function of the stimulus and oculomotor behavior. In a second study, we have measured neuronal activity from multiple sites in prefrontal and posterior parietal cortex in monkeys performing a visual working memory task. These data reveal robust, long-range, task-dependent patterns of cortico-cortical synchronization that correlate with the temporary storage of visual information. Together our findings indicate that perceptual and cognitive processes involve large-scale, distributed patterns of synchronization that occur within and between multiple cortical areas. These patterns of correlated activity are non-stationary, occur in multiple frequency bands, and reflect the time course of sensory and behavioral events.
Math Seminars
Algebras
Joe Manlove - Department of Mathematical Sciences, MSU
When: Monday, October 13, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: I will talk about algebras.

Math Seminars
Connected Sums of 1-Forms
Andy Bouwman - Department of Mathematical Sciences, MSU
When: Thursday, October 09, 2008 04:10PM to 05:00PM
Where: Wilson Hall 1-124
Details: In a paper published in 2007, Curtis McMullen gave a proof that any holomorphic 1-form of genus 2 can be written in infinitely many ways as a connected sum of forms of genus 1. I will present this proof, along with some necessary background information and several drawings.

Math Seminars
Numerical Simulation of Ferromagnetic Shape Memory Thin Film
Dr. Tianyu Zhang - Department of Mathematical Sciences, MSU
When: Thursday, October 09, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We propose an energy model for ferromagnetic shape memory thin film (including both sharp interface and strain gradient models for surface energy). Finite element approximation of the energy is given and second order convergence of the approximation energy is proved. Nonlinear Conjugate Gradient method is used to minimize the approximation energy and our numerical results confirm the proven convergence order. We then apply the model to Ni2MnGa with quasi-static continuation technique to simulate the formation of a tunnel under applied magnetic field.

Math Seminars
Intro to Galois Theory, pt II
Scott Schmieding - Department of Mathematical Sciences, MSU
When: Monday, October 06, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: The goal is an introduction to some field theory leading up to and including the basic ideas behind Galois Theory. We will take a look at definitions and theorems that help pave the way, and also the main theorem of Galois Theory itself. Many examples will be provided, and computation of some basic Galois groups will follow, along with some examples of the applications.
The Deformable Mirror Fitting Problem
Prof. Curt Vogel - Department of Mathematical Sciences, MSU
When: Thursday, October 02, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Our goal is to compute actuator "commands", or voltages, which will cause a deformable mirror to take on a certain prescribed shape. In order to model deformable mirrors, we make use of an existing 4th order PDE plate model and couple it with an algebraic actuator model. We introduce a multigrid scheme for the efficient solution to (a linearization of) the resulting coupled system. We will also pose the actuator control problem as a quadratic minimization problem and discuss its numerical solution.

Intro to Galois Theory
Scott Schmieding - Department of Mathematical Sciences, MSU
When: Monday, September 29, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: The goal is an introduction to some field theory leading up to and including the basic ideas behind Galois Theory. We will take a look at definitions and theorems that help pave the way, and also the main theorem of Galois Theory itself. Many examples will be provided, and computation of some basic Galois groups will follow, along with some examples of the applications.

The Atmospheric Turbulence Tomography Problem
Dr. Curt Vogel - Department of Mathematical Sciences, MSU
When: Thursday, September 25, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: In this talk we will review the main concepts underlying a multi-conjugate adaptive optics system for the proposed 30-meter telescope. We will focus on the optimal estimation of the atmospheric turbulence profile from sensor measurements and present some recent numerical results.

UNIX, LaTeX, and other Computer-y Things
Kevin Joyce - Department of Mathematical Sciences, MSU
When: Monday, September 22, 2008 04:10PM to 05:00PM
Where: Wilson Hall 1-144
**Details:** Come to learn about UNIX, LaTeX, and other computer-y things

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**Math Seminars**

**Bayesian Modeling for Non-Statisticians: Some Pedagogical Challenges**  
Dr. Alix Gitelman - Statistics Dept., Oregon State University  
When: Monday, September 15, 2008 04:10PM to 05:00PM  
Where: Wilson Hall 1-132  
Details: Statistical analyses using Bayesian methods appear more and more in the scientific (i.e., non-Statistics) literature. With the easy availability of WinBUGS, a freeware package for automating Markov Chain Monte Carlo (MCMC), anyone with a computer, a little programming know-how and a little statistical know-how can fit fairly sophisticated Bayesian models. Or can they? In this talk, I'll describe a book I'm working on about Bayesian modeling for non-statisticians. I'll argue for the necessity of such a book, but also describe some of the real challenges with making Bayesian methods in general, and MCMC specifically, accessible to an audience with little or no background in mathematical statistics. I hope that some of these challenges will stimulate an exchange of ideas on the subject.

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**Math Seminars**

**Comparing Performance of Independent and Correlated Gene Flow Models in Spatially Demarcating Between Populations**  
Kezia Manlove - Department of Mathematical Sciences, MSU  
When: Monday, September 15, 2008 04:10PM to 05:00PM  
Where: Wilson Hall 2-244  
Details: Genetic variation across a landscape can be used to make inferences about the underlying patterns of gene flow. By combining genetic and spatial information on an individual, in the form of an individual's location and genotype, we can make inference about its population of origin.

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**Math Seminars**

**Li-Yorke Chaos and Cantor Attractors for Maps on the Interval**  
Dr. Henk Bruin - University of Surrey, Guildford, Surrey, United Kingdom  
When: Wednesday, June 04, 2008 02:10PM to 03:00PM  
Where: Wilson Hall 1-139  
Details: Whereas most unimodal interval maps are either chaotic in any mathematical sense of the word, or have periodic attractors attracting almost every point, there are unimodal maps with more interesting attractors. Such attractors are Cantor sets, and the dynamics on them is less chaotic: e.g. entropy and Lyapunov exponents are 0. In this talk, I want to explain that regarding the existence of Li-Yorke pairs (i.e., points $x,y$ such that $0 = \liminf |f^n(x)-f^n(y)| < \limsup |f^n(x)-f^n(y)|$), these attractors can still be quite interesting.
Math Seminars
Monotone Biological Control Systems
Mark Campanelli - Department of Mathematical Sciences, MSU
When: Monday, April 28, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Many biochemical systems consist of cascades of positive feedback loops, which can create bi- or multi-stability in the system. If the positive feedback is in some sense "strict", then the system may be classified as "monotone". This essentially means that 1) any element of the system can regulate another element in only "one" direction (say up OR down), and 2) there can be no loops in the system with a net negative feedback behavior. Such conditions can be determined from a system of differential equations defining the system. If these conditions are met, then a system’s endbehavior can be analyzed (in a control theory sense) by its open-loop, input-output characteristic curve. Even for higher dimensional systems, this curve is typically two-dimensional, and thus provides a great simplification in the analysis. Furthermore, monotone systems are "modular", and biological cascades of monotone systems can be "strung together" and their individual characteristics mathematically composed to retain a 2D analysis.

Math Seminars
TA Instructional Training
Jerome Trouba - Department of Mathematical Sciences, MSU
When: Monday, April 28, 2008 03:30PM to 04:30PM
Where: Wilson Hall 1-139

Math Seminars
Somitogenesis: Biological Pattern Formation via Coupled, Nonlinear, Cellular Oscillations
Mark Campanelli - Department of Mathematical Sciences, MSU
When: Thursday, April 24, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Somitogenesis is a key event in the embryonic development of vertebrate species, forming repeated blocks of differentiated cells called somites. This initial somite pattern represents a fundamental organizational plan for the growing embryo. Biological research on somitogenesis has identified: 1) Intracellular oscillatory gene expression in the embryonic cells that become somites; and 2) An intercellular communication mechanism that synchronizes expression between cells. Concurrently, mathematical models have been developed to better understand the sequence of events that produces somites. Current models use systems of delay differential equations with feedback control and do a good job explaining: 1) How gene expression oscillates within a cell; and 2) How adjacent cells can synchronize their gene expression. An open biological question is: How do oscillations arrest in the cells to form the stabilized, "hi-lo"
gene expression pattern found in nascent somites? Current mathematical models do not produce this pattern. Building upon an existing two-cell mathematical model for zebrafish somitogenesis by Lewis (2003), I seek an improved model which reproduces the key spatio-temporal dynamics of somite formation.

Math Seminars
Population Genetics
Kezia Manlove - Department of Mathematical Sciences, MSU
When: Monday, April 21, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: The plan is to do a quick overview of molecular genetics, and then to move on to population genetics (model assumptions for population genetics; how do describe a population's genetic structure in terms of probability densities; how to classify new individuals to pre-defined populations, etc.). If time allows, from there I want to talk about modeling differences between two populations' genetic structures by the spatial distance between those populations and a matrix of present but potentially unidentified barriers to gene flow.

Math Seminars
Semi-Equivariant Lifts of Graph Maps
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, April 18, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Starting with graph maps f_\phi following "wrapping rules" \phi from a proper substitution, we find some new invariants for conjugate inverse limit spaces. These invariants involve lifting f_\phi and shift equivalence maps to Cayley graphs associated with subgroups of the Bowen Franks group. These larger graphs have easily computable homology, and probably Čech cohomology. Further Questions: (1) Relation to Fox Calculus, if any. (2) Direct limits of these lifts to the universal cover.

Math Seminars
Mathematical Formulations of Frictional Contact
Shaun Harker - Department of Mathematical Sciences, MSU
When: Thursday, April 17, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The problem of finding an appropriate formulation for the dynamics of a mechanical system subject to unilateral constraints with Coulomb friction is considered for both the single and multiple contact case. In the last twenty years, considerable work has been done in this area, which is reviewed. An alternative generalization of the Coulomb law to the case of multiple contacts is considered, which leads to a different mathematical model than usually considered. This model appears to have nicer
mathematical properties involving well-posedness and numerics. It is proposed for thesis study.

Math Seminars
Online Tasks and Cognitive Presence
Diana Colt - Department of Mathematical Sciences, MSU
When: Tuesday, April 15, 2008 10:00AM to 12:00AM
Where: Wilson Hall 2-244

Math Seminars
Uniform Tilings and Dual Solids
Mike Coury - Department of Mathematical Sciences, MSU
When: Monday, April 14, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Will talk about tilings and dual tiling spaces using regular shapes. I will look at the extension of this into 3 dimensions and consider Platonic, Archimedian, and Catalan solids. If there is time, I will draw connections to my previous seminar on Kleinian groups and hyperbolic geometry and we will look at regular tilings in hyperbolic space. Everyone is welcome and there are no prerequisites (until maybe the very end). Lots of pretty pictures!

Math Seminars
Mentoring and PD Models
DeAnna McAleer - Department of Mathematical Sciences, MSU
When: Monday, April 14, 2008 03:30PM to 04:30PM
Where: Wilson Hall 1-139

Math Seminars
Optimization for Fair Spectrum Sharing in Cognitive Radio Wireless Networks
Dr. Neil Tang - Department of Computer Science, MSU
When: Thursday, April 10, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Cognitive radio and Dynamic Spectrum Access (DSA) enable wireless users to share a wide range of available spectrums. This talk will discuss the joint spectrum allocation and scheduling problems in cognitive radio wireless networks. It will start with a novel Multi-Channel Contention Graph (MCCG) model which can characterize the impact of interference under the protocol model. Based on the MCCG, an optimal algorithm will be introduced to compute the maximum throughput solution. As simply maximizing throughput may result in a severe bias on resource allocation, optimal algorithms as well as fast heuristics will then be presented to compute fair solutions.
based on a simplified max-min fairness model and the well-known proportional fairness model. Numerical results show that the performance given by our heuristic algorithms is very close to that of the optimal solution, and our proportional fair algorithms achieve a good tradeoff between throughput and fairness. In addition, the extension to the physical interference model will be discussed.

Math Seminars
Circadian Rhythms and Systems Dynamics
Luke Shorty - Department of Mathematical Sciences, MSU
When: Monday, April 07, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: This will be a dry run for a talk I am giving at the Island School in Eleuthera, Bahamas next week. I will condense the two 25 minute to 30 minute talks (the first geared toward High School students the second a little more mathematically deep) into one Dynalite. The goal of this talk is to streamline and knock out any dents that I have missed. So I encourage you to attend, enjoy, and invite your non-math friends to attend.

Math Seminars
An Introduction to Wave Phenomena in Pancreatic Islets
Heather Moreland - Department of Mathematical Sciences, MSU
When: Thursday, April 03, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Insulin is released into the bloodstream by the pancreatic islets of Langerhans. This secretion occurs in an asynchronous manner with insulin levels oscillating on the period of an hour, while the bursting electrical activity of the individual pancreatic betacells is on a time scale of 10-20 seconds. In response to an influx of glucose, the islets start bursting oscillations of the membrane potential and the intracellular calcium concentration. However, time delays of several seconds in the activity of distant cells in the islets have been observed, indicating that electrical and calcium wave propagation through the islets can occur. We consider a biophysical (CRAC-model) of a pancreatic islet. Numerical simulations of this model exhibit wave propagation across the islet in response to an increase in extracellular glucose. To facilitate an understanding of the parameters controlling this dynamic, it is necessary to simplify the model. We undertake a systematic reduction of this model from a 2 fast/3 slow variable model into a 2 fast/2 slow model, which is considerably more amenable to analysis. This will allow the dynamics of these waves to be understood in terms of just two parameters as opposed to the numerous parameters present in the original model.

Math Seminars
Continuations and Macros
Adrian Soto - Department of Mathematical Sciences, MSU
When: Monday, March 31, 2008 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Continuations are a property of the language Scheme by which one can mimic "try" and "catch" constructions of other languages, and much more. For example, one can "save" the continuation for later. (Lisp has no continuations to my knowledge) If time permits, we will briefly mention "continuation passing style" programming. Macros in both Scheme and Lisp are a way to "create your own commands" within your computer language. We will present some examples, and hopefully keep things very simple. No assumptions about knowing a computer language will be made.

Math Seminars
Inquiry in the Classroom
Heather Mathison - Department of Mathematical Sciences, MSU
When: Monday, March 31, 2008 03:30PM to 04:30PM
Where: Wilson Hall 1-139

Math Seminars
Classification of Expansive Attractors on Surfaces
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, March 28, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: I will sketch a proof that all expansive and transitive attractors on surfaces are derived from pseudo-Anosov.

Math Seminars
Modeling Thin Hairs in Oscillatory Air Flow
Bree Cummins - Department of Mathematical Sciences, MSU
When: Thursday, March 27, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Many arthropods use thread-like hairs, called filiform hairs, as mechanoreceptors to detect air motion. In common house crickets (Acheta domestica) the hairs cover two antenna-like appendages called cerci at the rear of the abdomen. The biomechanical stimulus-response properties of individual filiform hairs have been investigated and modeled extensively by several researchers, but representations of multiple hairs have been more problematic, since the densely packed hairs are coupled across small distances through the intervening air. We have developed two models capable of simulating this coupling and the resultant motion of multiple filiform hairs in an oscillating air flow. I will briefly discuss our first model and its limitations, before explaining how we overcome these limitations with a different model.

Math Seminars
CVs, Cover Letters and Other Fun Stuff
Lisa Davis - Department of Mathematical Sciences, MSU  
When: Monday, March 24, 2008 04:10PM to 05:00PM  
Where: Wilson Hall 2-244  
Details: I give a general timeline of events for the ACADEMIC JOB SEARCH. The bulk of the presentation gives an overview of the structure and content of the essential materials for the ACADEMIC JOB SEARCH. The Curriculum Vita, Research Statement, Teaching Statement and Generic Cover Letter are discussed. Humor will be interjected at both appropriate as well as inappropriate points during the talk. There will be some profanity, but I'll try to keep it to a minimum. If you are interested in participating in the ACADEMIC JOB SEARCH in the next year, ya might want to try to show up for this one.

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**Math Seminars**  
The Effects of Discrete Release on Calcium Dynamics

Dr. James P. Keener - Distinguished Professor of Mathematics and Adjunct Professor of Bioengineering, University of Utah  
When: Thursday, March 20, 2008 03:10PM to 04:00PM  
Where: Wilson Hall 1-144  
Details: Calcium signalling is an important process in many cell types. Calcium release is governed by excitable mechanisms that share many features with other excitable behavior such as electrical activity in neural cells. Furthermore, calcium dynamics have been studied extensively using deterministic ordinary differential equation (ode) models that share many features with generic excitable systems. However, there are many experimentally observed features of whole cell calcium dynamics that cannot be explained by deterministic ordinary differential equation models. The primary reason for the discrepancy between data and models is that calcium release is via events that are stochastic in time and localized in space. Furthermore, the assumptions that permit a whole cell ode model, namely uniformly distributed calcium and the law of large numbers, do not apply under many physiological conditions. The purpose of this talk is to demonstrate how calcium release can be modelled using spatially inhomogeneous partial differential equations (diffusion-reaction equations) and to illustrate the differences in whole cell behavior that can occur as a result of spatial inhomogeneity. In particular, we show how whole cell calcium oscillations can be the result of spatial localization of calcium sources, and how these behaviors are lost by homogenization.

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**Math Seminars**  
Polynomial Generating Functions

Dr. John Borkowski - Department of Mathematical Sciences, MSU  
When: Monday, March 17, 2008 03:30PM to 04:30PM  
Where: Wilson Hall 1-139

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**Math Seminars**  
Algorithmic Aspects Communications in Multihop Wireless Networks
Dr. Brendan Mumey - Department of Computer Science, MSU
When: **Thursday, March 06, 2008 03:10PM to 04:00PM**
Where: Wilson Hall 1-144

**Details:** I will talk about some recent work on optimizing wireless networks using MIMO (multiple input, multiple output) antennas. MIMO antennas have some fixed number K degrees of freedom. Nodes can either send or receive at a given time but not both. Sending nodes can send up to K streams at one time to one or multiple receivers. Receiving nodes can receive streams from multiple sources but must null out interfering streams; the total of which can also not exceed K. I have considered two optimization problems: (1) maximize the total throughput of the network subject to a set of traffic demands in a single time slot. (2) minimize the number of time slot necessary to meet all traffic demands. I have shown problem (1) is NP-hard and have constantfactor approximations for (1) and (2). This is joint work with Neil Tang and Tim Hahn in the CS dept.

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**Math Seminars**

**Function and Limit in Calculus**
Taylor Jensen - Department of Mathematical Sciences, MSU
When: **Wednesday, March 05, 2008 03:30PM to 04:30PM**
Where: Wilson Hall 1-139

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**Math Seminars**

**Visualizing the Cech-cohomology of Tiling Spaces**
Carl Olimb - Department of Mathematical Sciences, MSU
When: **Monday, March 03, 2008 04:10PM to 05:00PM**
Where: Wilson Hall 2-244

**Details:** Anderson and Putnam showed that tiling spaces are inverse limits of branched manifolds. The Cech-cohomology then can be computed as the direct limit of the homomorphism induced by inflation and substitution on the cohomology of the complex. I will describe a modification of the Anderson Putnam complex for substitution tiling spaces that allows for easier computations and provides a means of identifying certain special features of the tiling space with particular elements of the cohomology.

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**Math Seminars**

**Professors' Conception of Proof**
Dr. David Yopp - Department of Mathematical Sciences, MSU
When: **Monday, February 25, 2008 03:30PM to 04:30PM**
Where: Wilson Hall 1-139

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**Math Seminars**

Towards Coupled Breathers in a Neural Media
Dr. Stefanos Folias - Center for Biodynamics and Dept. of Mathematics and Statistics, Boston University
When: Tuesday, February 19, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Neural network firing rate models, or neural field theories, are spatially extended integro-differential equations governing the average activity of neural tissue. Such networks support breathing pulse solutions (breathers), which are characterized as pulse-like, spatially-coherent oscillations that can arise through a Hopf bifurcation of stationary pulses. I will begin by discussing the existence and stability of breathing pulses in a two-dimensional network and show how radial symmetry of the breathers can be broken. I will then consider a one-dimensional network and examine the validity of a simplified ODE approach to both stability and higher order analysis of the breathers, as well as higher order analysis in the full spatial model. Finally, I will discuss how this work relates to future work on the coupling of breathers and its application to neuroscience.

Math Seminars
Balanced Pairs and the Rauzy Fractal
Adrian Soto - Department of Mathematical Sciences, MSU
When: Friday, February 15, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: We characterize connectedness of a Rauzy fractal in terms of the essential balanced pairs of a substitution. Next, we show that if two tiling spaces are homeomorphic via a rewriting, then we can decompose one of the fractals and rearrange the pieces to obtain the second one. We provide an example of a substitution with a connected Rauzy fractal, one of whose rewritings has a disconnected Rauzy fractal.

Math Seminars
Sensitivity Functions and Their Uses in Parameter Estimation Problems
Dr. Sava Dediu - CRSC North Carolina State University
When: Wednesday, February 13, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: One of the most important questions in parameter estimation problems for dynamical systems is: How do we choose the length $T$ of the sampling interval, such that to obtain more accurate parameter estimates when sampling data points from $[0,T]$? Another extremely important question is: Given a fixed number of measurements to be taken, what is their optimal time sampling in the interval $[0,T]$ such that to obtain the most accurate estimates, once a time limit $T$ was chosen? In this talk we will present our latest efforts to answer these questions based on the information provided by the traditional sensitivity functions (TSF) and the generalized sensitivity functions (GSF) from the perspective of least squares estimation problems for a Logistic Growth Population Model and a recently developed Agricultural Production Network Model. We
argue that TSF and GSF provide the basis for new tools for investigators in design of inverse problem studies.

Math Seminars
A Safe and Friendly Introduction to Latex
Luke Shorty and Mike Walker - Department of Mathematical Sciences, MSU
When: Monday, February 11, 2008 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: Have you ever been interested in using LaTeX, but didn’t have the programming experience? Fear no more. Luke Shorty and Mike Walker will give a quick history of LaTeX and provide a template and walk you through the necessary code so that you can make your quizzes and tests with this professional word processing software.

Math Seminars
Teacher Professional Growth
Sarah Segal - Department of Mathematical Sciences, MSU
When: Monday, February 11, 2008 03:30PM to 04:30PM
Where: Wilson Hall 1-139

Math Seminars
Phase-Field Models for Biofilm Growth, Expansion, and Biofilm-Flow Interaction
Dr. Tianyu Zhang - Department of Mathematics, Florida State University
When: Thursday, February 07, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: We derive a set of phase field models for biofilms using the one-fluid twocomponent formulation in which the combination of extracellular polymeric substances (EPS) and the bacteria are effectively modeled as one fluid component while the collective ensemble of nutrient and the solvent are modeled as the other. The biofilm is assumed an incompressible continuum. Two growth modes are identified in linearized analysis. Numerical simulations are carried out in one and two space dimension using a velocity-corrected projection method for incompressible flows. Biofilm growth, expansion, streaming, rippling, and detachment are simulated in shear cells numerically. Viscoelastic properties of the biofilm is investigated as well.

Math Seminars
Edubuntu and Its Potential for Educating
Luke Shorty - Department of Mathematical Sciences, MSU
When: Monday, February 04, 2008 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: This talk will discuss Edubuntu, a free operating system dedicated to education. I will quickly discuss the philosophy behind Edubuntu and talk about its potential for secondary schools as a cost-effective way to afford computer labs and educational tools in low income and impoverished communities. I will end the talk by demonstrating some of its Mathematical applications and perhaps some suggestions how they can be used in GTA class rooms and courses, like Math 149, 105, 170 and other courses offered here at MSU.

Math Seminars
Concrete to Abstract Connections
Dr. Beth Burroughs - Department of Mathematical Sciences, MSU
When: Wednesday, January 30, 2008 03:30PM to 04:30PM
Where: Wilson Hall 1-139

Math Seminars
Demystifying Unix
Kevin Joyce - Department of Mathematical Sciences, MSU
When: Monday, January 28, 2008 04:10PM to 05:00PM
Where: Wilson Hall 1-144
Details: The world of Unix may be intimidating, confusing, and generally mysterious. There is reason to it, and hopefully we may shed some light on some of these things and maybe learn some efficient tricks along the way. Bring questions and tricks to share for this opening Dynalite of the year. We may also talk about eunuchs...but probably not.

Math Seminars
C^*-Algebras Associated to Dynamical Systems
Dr. Soren Eilers - University of Copenhagen
When: Friday, January 25, 2008 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Herman Rings and Arnold Disks II
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Friday, December 07, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
"Proving" 1=2
Jerome Trouba - Department of Mathematical Sciences, MSU
Math Seminars
Herman Rings and Arnold Disks
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Friday, November 30, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Herman rings are doubly connected rotation domains in complex dynamics, first investigated in connection with analytic circle diffeomorphisms. We investigate a complex two-parameter family of rational maps which have Herman rings for certain parameters. In particular, we show that the components in parameter space which correspond to maps with Herman rings are embedded holomorphic disks. As a corollary we obtain asymptotic estimates of the sizes of Herman rings. We will finally show how to adapt these results to the complex version of the Arnold family of circle diffeomorphisms. This is joint work with Xavier Buff, Nuria Fagella, and Christian Henriksen.

Math Seminars
The Problem of Frictional Contact
Shaun Harker - Department of Mathematical Sciences, MSU
When: Thursday, November 29, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Proper formulation of the frictional contact problem for rigid bodies with multiple contacts is far from trivial. In this talk we discuss the issues that arise in such formulations and the emergent mathematical problems. Highlights include the appearance of linear complementarity problems and discontinuous differential equations.

Math Seminars
Two Statistical Talks for the Price of One!
Greta Linse & Glenna Gordon - Department of Mathematical Sciences, MSU
When: Monday, November 26, 2007 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: 1. Statistical Model Selection Using Cross Validation and Full Cross Validation by Glenna Gordon What is statistical model selection and who cares? Come and you'll find out about this and more. Including what cross validation and full cross validation are, and for good luck also what is AIC. 2. A "Triangular" Mesh Approach to Space Filling
Mixture Designs by Greta Linse That's a mouthful, but to demonstrate this approach I will use a contrived example based on fuel blends. Triangular meshing approaches are a good approach to nd points that cover a design region in order to have points to experiment with.

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**Math Seminars**

**Introduction to 2D Gel Analysis**  
Yin Chang - Department of Mathematical Sciences, MSU  
**When:** Monday, November 19, 2007 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-139  
**Details:** I plan to introduce 2D gel and what statistics has to do with it.

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**Math Seminars**

**Cech-Cohomology in n-Dimensional Substitution Tiling Spaces**  
Carl Olimb - Department of Mathematical Sciences, MSU  
**When:** Friday, November 16, 2007 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-139  
**Details:** Anderson and Putnam showed that tiling spaces are inverse limits of branched manifolds. The Cech-cohomology then can be computed as the direct limit of the homomorphism induced by inflation and substitution on the cohomology of the complex. In this talk I will describe a modification of the Anderson Putnam complex for substitution tiling spaces that allows for easier computation and provides a means of identifying certain special features of the tiling space with particular elements of the cohomology.

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**Math Seminars**

**An Introduction to State Space Modeling**  
Dr. Mark Greenwood - Department of Mathematical Sciences, MSU  
**When:** Thursday, November 15, 2007 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-144  
**Details:** State space models provide a flexible modeling framework for specifying many different time series model structures. These models are generally discussed, including univariate and bivariate models, along with some connections to other time series models. They are applied to estimating models for yearly Yellowstone Bison counts. Model selection and inference techniques are also discussed.

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**Math Seminars**

**Averaging Reparametrizations of Higher Dimensional Actions, Part II**  
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
Focus Tracking in Time Domain Optical Coherence Tomography Using MEMS Membrane Mirrors Operated Near Snap-Down
Dr. David L. Dickensheets - Department of Electrical and Computer Engineering, MSU

Details: High speed deformable MEMS membrane mirrors with a large displacement stroke are needed to increase the range of focus tracking and allow for higher numerical aperture, better resolution and better signal-to-noise ratio in optical coherence tomography and other related imaging systems. Electrostatically actuated MEMS devices experience a non-linearity through the displacement-dependent forcing function. This leads to instability and snap-down, limiting stable static displacement of simple gap-closing devices to 33% of the initial gap, and membrane devices to 44% of the initial gap. With a periodic forcing function stable membrane oscillation may have an amplitude that exceeds the static maximum stable displacement. We investigated the available range of motion using air-damped, non-resonant membrane mirrors, and found that stable displacements exceeding 70% of the air gap are possible using a sinusoidal forcing function, but membrane motion is badly distorted and the surface is aberrated. Using a dynamic membrane model we calculated drive waveforms that correct for both the time-domain distortion and the surface aberrations. Using experimental membranes with resonant frequency $f_0 = 120$ kHz and $Q = 0.26$ we demonstrated distortion-compensated nearly sinusoidal motion at 10 kHz at an amplitude of 50% of the air gap. This seminar will discuss the imaging application, the MEMS device structure and models, and the method of analysis used to investigate device behavior, as well as the experimental results confirming the model applicability for our devices. Time permitting I'll discuss future plans to incorporate feedback control that may improve our utilization of the air gap to better than 90%.
Math Seminars
Quorum Sensing and Biofilm Modeling
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: **Thursday, November 01, 2007 03:10PM to 04:00PM**
Where: Wilson Hall 1-144
Details: The bacteria Pseudomonas Aeruginosa use the size and density of their colonies to regulate the production of a large variety of substances. This phenomenon is called quorum sensing. We give a overview of several different mathematical models of quorum sensing.

Math Seminars
Computation of the Cech Cohomology of Tiling Spaces with Some Forcing
Carl Olimb - Department of Mathematical Sciences, MSU
When: **Monday, October 29, 2007 04:10PM to 05:00PM**
Where: Wilson Hall 1-139

Math Seminars
Computational Issues for Sensitivity Calculations for Smart Material Systems
Dr. Lisa Davis - Department of Mathematical Sciences, MSU
When: **Thursday, October 25, 2007 03:10PM to 04:00PM**
Where: Wilson Hall 1-144
Details: This talk describes some difficulties related to computational algorithms for the numerical approximation of sensitivities with respect to a parameter dependent interface location. Motivated by sensitivity analysis with respect to piezoelectric actuator placement on an Euler-Bernoulli beam, this work illustrates the key concepts related to sensitivity equation formulation for interface problems where the parameter of interest determines the location of the interface. A simple fourth order model problem is considered, and two "natural" algorithms for sensitivity computation are constructed using standard finite element methods. Numerical results show that both methods completely fail to approximate the true sensitivity. I will explain the failure of these methods and show that the proper mathematical formulation of the sensitivity equation enables us to construct a convergent numerical sensitivity approximation.

Math Seminars
Finding Patterns in Biological Signals
Jesse Berwald - Department of Mathematical Sciences, MSU
When: Monday, October 22, 2007 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Does your body really live in some equilibrium? The long-range correlation behavior of a healthy heartbeat seems to say no, at least for that little organ. We'll look at how biologists have turned (once again) to math to try to answer the simply question above.

Math Seminars
Counting, and Other Interesting Things
Luke Shorty - Department of Mathematical Sciences, MSU
When: Monday, October 15, 2007 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Come One, Come Two, Come Three, and Come More. To a great talk on counting, you've never seen before. There will be magical vases, cards and birthdays for all. Special Guests: Kalmogrov, Kafka, and even Monty Hall. If you're new to the department and scared like a quail. I promise you no scary Mathematics to make you all wail. So roll up your sleeves, there are Supertasks to be done. I'll teach you to count, to laugh, to dream, and have fun.

Math Seminars
Adventures in Applied Mathematics: Real-Time Estimation and Control for the Thirty Meter Telescope Project
Dr. Curt Vogel - Department of Mathematical Sciences, MSU
When: Thursday, October 11, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The Thirty Meter Telescope Project (TMT) has the abitious goal of delivering diffraction-limited images with light collected from a ground-based telescope with a large aperature (30 meters) over a relatively large field of view (a few arc-minutes for near infrared imaging). Achieving this goal requires the use of an emerging technology known as multi-conjugage adaptive optics (MCAO). In this talk we will sketch the mathematics involved in state estimation and control for a proposed MCAO system for TMT. We will also describe the role of applied mathematicians in past and on-going feasibility studies for a real-time computing system for TMT.

Math Seminars
Two Geometrical Configuration Theorems and Some Interesting Rsults
Greta Linse - Department of Mathematical Sciences, MSU
When: Monday, October 08, 2007 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Given two distant points, P and Q, how can you connect the points given only a straight edge which doesn't happen to be long enough? A very clever method for solving this problem will be given. Also I will introduce a puzzle that demonstrates the connection between the geometric nature of point and line configurations and their array representation.

Math Seminars
A Collaboration between Nervonix and an Applied Mathematician
Dr. Phil Cory, M.D. and Dr. Mark Pernarowski - Nervonix Co. and the Department of Mathematical Sciences, MSU
When: Thursday, October 04, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: This talk is meant to demonstrate how applied mathematicians can interact with business in meaningful ways to create medically useful products that are interesting mathematically. Phil Cory, M.D. is the President of a local biomedical company Nervonix. He designs, patents and licenses technology to third parties with the goal of bringing new medical devices to the marketplace to improve medical care in a financially profitable fashion. Currently, Dr Cory, Dr Pernarowski and two others have a patent in the publication stage in both the US and World markets. The device we are currently working on uses non-invasive technology (electrode arrays with apply currents at various frequencies when attached to the patient's skin). Various mathematical models ranging from Maxwell's equations for anisotropic media to simple RC circuit theory can be used to model and predict nerve location using the data collected from electrode arrays. The goal of locating nerves is important medically for both diagnostic and therapeutic purposes since (at the very least) it is undesirable to cut important nerves during surgery, and is critical to accurately locate nerves for nerve-related treatments.

Math Seminars
Cellular Oscillators, or How I learned to Stop Worrying and Love Delay Differential Equations.
Mark Campanelli - Department of Mathematical Sciences, MSU
When: Monday, October 01, 2007 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Many biological systems exhibit oscillatory behavior. Examples include circadian rhythms, hormonal cycles, and neural impulses. Oscillations in cellular protein levels are ultimately responsible for many of these phenomena. This talk will discuss a model of protein oscillations in embryonic cells that generate somites in vertebrate animals. Somites are key elements in the developmental path that define the vertebrate body plan. I will discuss a mathematical model of a cellular oscillator that is a nonlinear system of ordinary differential delay equations. This model is capable of producing sustained oscillations (i.e., a stable limit cycle), whereas the corresponding model without delays cannot sustain such oscillations. Thus, the dynamics of delay differential
equations is "richer" than ordinary differential equations. Also, numerical tools exist which make the investigation of such systems straightforward.

Math Seminars
When Activators Repress and Repressors Activate: A Qualitative Analysis of the Shea-Ackers Model
Kathryn Patterson - Department of Mathematical Sciences, MSU
When: Thursday, September 27, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The concept of activation in transcriptional regulation is based on the assumption that mRNA concentration increases monotonically as a function of regulator concentration. Though this assumption is valid for Hill function based models, the Shea-Ackers model of transcription suggests a more realistic choice of nonlinearity. We show the monotonicity assumption is only correct for the simplest operons and define a new regulatory constant as a nonlinear combination of association and transcription initiation rate constants. This constant allows us to characterize activation and repression for more complex operons.

Math Seminars
Intro to Scientific Computing with Python
Adrian Soto & Jesse Berwald - Department of Mathematical Sciences, MSU
When: Monday, September 24, 2007 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Python is an open source, object-oriented, scripting language that is fun and efficient to use. We will provide an overview of Python. In addition, we'll discuss at least some of the following (time permitting and not necessarily in this order): { Libraries for numerical analysis { Libraries for graphing { CAS software for Python (a la Maple or Mathematica) { Topical software (dynamical systems, biology, etc.) { Matlab vs. Python

Math Seminars
The Branch Locus
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, September 21, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: The "branch locus" encodes the relative positions of asymptotic leaves in substitution tiling spaces. We'll review the results obtained with B. Diamond and R. Swanson for the branch locus in one dimension and talk about the higher dimensional situation.
Rheometry of Biofilms
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, September 20, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Biofilms are collections of microorganisms contained in self-secreted matrices of polymers and other substances. Rheometry is the measurement of material properties of a given material especially those characterizing the relation between stress and strain of that material. The biofilm matrix performs a number of tasks but perhaps the most important is a mechanical one, namely anchoring its population against external mechanical stresses. Hence measurement of biofilm mechanical properties is important. One method for performing the relevant measurements is by use of a parallel plate rheometer. In this talk I will discuss parallel plate rheometry applied to biofilms and compare to computational simulations. An alternative measurement method, microbead rheometry, will also be introduced.

Math Seminars
Waves Launched by Diffusion in a Model of Magnetic Reconnection
Dr. Dana Longcope - Department of Physics, MSU
When: Thursday, September 13, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: I present a set of coupled, linear PDEs, first studied by Craig and McClymont and by Hassam, describing the dynamics of a plasma near a null point in the magnetic field. In one limit the equations become telegraphers equations describing the propagation of disturbances toward or away from the null point. In a second limit they become a single diffusion equation. I use the full set of equations to model magnetic reconnection at a current sheet. The equations can be solved numerically on an exponentially refined grid with resolution spanning upwards of eleven orders of magnitude. In the resulting dynamics the diffusive solution (reconnection) couples to the hyperbolic solution (waves). The model demonstrates how localized processes, such as diffusion, can have global effects on very short time scales. This provides new insight into how solar flares can quickly release large amounts of energy which had been stored slowly over long times.

Math Seminars
Walking on a Picture
Adrian Soto - Department of Mathematical Sciences, MSU
When: Friday, August 17, 2007 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: There are certain drawings in the plane with funky properties. Since I twisted my ankle, I think it is appropriate to talk about walking. The talk will be pretty elementary.
Math Seminars
Positive Matrices and Higher Dimensional Continued Fractions
Dr. Bob Williams - Department of Mathematics, University of Texas
When: Monday, August 06, 2007 10:00AM to 11:00AM
Where: Hurst Conference Room

Math Seminars
Multivariate Classification of Vegetation Data
Ken Aho - Department of Mathematical Sciences, MSU
When: Monday, April 30, 2007 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Objective classifications provide unbiased standards for revegetation of drastically disturbed lands, and important tools for ecological analysis. I present here a summary of multivariate classification techniques and briefly explain several fundamental algorithms. In addition I discuss three items imperative for effective classification. These are: 1) an appropriate and effective dissimilarity/distance measure, 2) an effective classification methodology, and 3) an objective way to decide on an appropriate/optimum number of clusters. I address these considerations by testing distance measures, evaluating classification methods, and finding appropriate pruning levels for classifications of alpine and pre-mine steppe vegetation data from the Northern Rocky Mountain region.

Math Seminars
General Linear Group of a Tiling Space, Part III
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, April 27, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
An Introduction to the Math Multi-Media Classroom
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU
When: Thursday, April 26, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: The Math Multi-Media Classroom is nearing completion and will be in full form by Fall 2007. A brief description of the evolution of the room will be given followed by demonstrations of some of the features in its current state (Sun-Ray, lap top usage, workstations and the document camera). Its completed state will also be described as well as its most useful features and downfalls.
Math Seminars
CVs, Cover Letters and Other Fun Stuff
Dr. Lisa Davis - Department of Mathematical Sciences, MSU
When: Monday, April 23, 2007 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: I give a general timeline of events for the ACADEMIC JOB SEARCH. The bulk of the presentation gives an overview of the structure and content of the essential materials for the ACADEMIC JOB SEARCH. The Curriculum Vita, Research Statement, Teaching Statement and Generic Cover Letter are discussed. Humor will be interjected at both appropriate as well as inappropriate points during the talk. There will be some profanity, but I'll try to keep it to a minimum. If you are interested in participating in the ACADEMIC JOB SEARCH in the next year, ya might want to try to show up for this one.

Math Seminars
General Linear Group of a Tiling Space, Part II
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, April 20, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Why Does the Positive Regulation in Bacteriophage Lambda Affect Isomerization of the RNAP-DNA Complex?
Kate Patterson - Department of Mathematical Sciences, MSU
When: Thursday, April 19, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: Bacteriophage $\lambda$ is the best studied example of a gene regulation switch. The phage-infected cell can follow the lytic pathway which leads to production of new phages and lysis of the cell. Alternatively, the infected cell can follow the lysogenic pathway, in which the virus establishes stable association with the host. In the last 20 years a number of experiments elucidated gene regulation mechanisms that are behind the choice of alternative states and their maintenance. The transcription initiation involves two distinct steps; first RNA polymerase binds the promoter to form an unstable, closed complex (this reaction is described by an equilibrium constant $K_B$); second the closed complex isomerizes to an active, stable open complex (the reaction is described by a forward rate constant $k_f$). The cooperativity between CI protein and RNA polymerase is accomplished by DNA bound CI increasing the forward rate constant $k_f$ about 10-fold without having any significant effect on $K_B$. We use a model due to Santillian and Mackey, which is based on Ackers chemical equilibrium description of the promoter binding by the regulatory factors, to show that the stability of the lysogen will be severely compromised if CI had the $10$-fold effect on $K_B$ and no effect on $k_f$. We also discuss the underlying reasons for this highly non-linear and counterintuitive effect.
Math Seminars

**How to (Mathematically) Cook a Potato**
Jerome Trouba - Department of Mathematical Sciences, MSU
When: **Monday, April 16, 2007 04:10PM to 05:00PM**
Where: Wilson Hall 2-244
Details: The heat equation is a nifty PDE that can be used to model all types of heat flows. In this talk, I will use it to model the cooking of a potato in a pot of water. Pretty graphs will follow. No potatoes will be harmed in the derivation of the model.

Math Seminars

**General Linear Group of a Tiling Space**
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: **Friday, April 13, 2007 03:10PM to 04:00PM**
Where: Wilson Hall 1-139
Details: The group of all invertible linear transformations of a linear space has its analogue for an aperiodically tiled linear space. I will explain how this group enters considerations regarding rigidity of tiling spaces.

Math Seminars

**Phase-locking in Electrically Coupled Networks of Cortical Neurons**
Dr. Tim Lewis - Department of Mathematics, University of California, Davis
When: **Thursday, April 12, 2007 03:10PM to 04:00PM**
Where: Wilson Hall 1-139
Details: Electrical coupling between inhibitory interneurons appears to be ubiquitous in the brain. Because inhibitory interneurons are thought to play a fundamental role in generating cortical oscillations, phase-locking dynamics of electrically coupled interneurons has received considerable interest. In this talk, I will discuss collaborative work with the experimental lab Dr. Barry Connors at Brown University (Mancilla et al. 2007) in which we examine phase-locking in both real and model pairs of electrically cortical interneurons. By using the theory of weakly coupled oscillators and phase response curves (PRC), we identify some of the intrinsic properties of neurons that determine the stability of phase-locked states and describe the underlying dynamical mechanisms.

Math Seminars

**Connections between Bayesian Graphical Models and Models for Multivariate Spatial Data**
Kathryn Irvine - Oregon State University
When: **Tuesday, April 10, 2007 11:00AM to 11:50AM**
Where: Wilson Hall 1-144
Spatial regression models do not typically make assumptions about the distributions and/or correlation structures of predictors—a covariance component is only assumed for the residuals in these models, assuming fixed predictors. On the other hand, multivariate spatial models, such as the Linear Model of Coregionalization (LMC) and separable model (as in Banerjee et al. 2004), specify a covariance matrix for both a response and a predictor. We explore an alternative to these models for spatial data—an Isomorphic Chain Graph (ICG) (Gitelman and Herlihy 2005)—that allows for greater flexibility in modeling spatial correlation. The ICG model can be parameterized as an LMC or separable model, or to model the covariance of the predictor alone or the response alone. More importantly, we believe the ICG model to be more appealing intuitively because it represents complex multivariate systems visually, increasing interpretability. We examine three different ICG models: one (corrY) that assumes the residuals follow a gaussian spatial process, another (corrX) that assumes the predictor follows a gaussian spatial process, and a third (corrXY) which assumes both the response and predictor have spatial processes. We explore the interesting similarities and differences between these models and the existing models for multivariate spatial data. We use a real data example to motivate the need for a flexible modeling approach. Finally, we present simulation results concerning the consequences of specifying the wrong ICG model, in terms of estimating the effective range and regression coefficients.

Math Seminars
Constructing Regular Polygons
Andy Bouwman and Luke Shorty - Department of Mathematical Sciences, MSU
When: Monday, April 09, 2007 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Luke and I are going to try to throw together some regular polygon constructions for you. We'll do a pentagon and a heptadecagon (that's a 17-gon for those of you keeping score at home) and talk a little bit about which polygons are constructible, which ones aren't, and why. We may also end up accidentally throwing in some other fun tidbits.

Math Seminars
A Weakly Non-Autonomous Bursting Model for Neurons
Joe Latulippe - Department of Mathematical Sciences, MSU
When: Thursday, April 05, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-144
Details: THIS IS JOE'S THESIS DEFENCE. Certain mammalian visual neurons exhibit "On" and "Off" responses when given a light stimulus. In addition to these responses, Kuffler (1953) showed that for retinal ganglion cells, the neuron will also exhibit a "Mixed" response when given two simultaneous stimuli in different regions of the cell's receptive field. This "Mixed" response is a nonlinear combination of the "On" and "Off" responses. In this talk, a single cell model which can reproduce "On", "Off", and "Mixed"
responses is developed and examined using leading order analysis and averaging. This model is developed from a current balance equation which includes a non-autonomous input $I(t)$, and consists of three coupled, first-order nonlinear differential equations which describe the dynamics of the membrane potential of the cell. When $I(t)$ is assumed to be a constant current pulse, the "On" and "Off" responses can be reproduced but will depend on both the duration and the amplitude of the input. When $I(t)$ is assumed to be monotone slowly decreasing, the model can reproduce the nonlinear properties for two simultaneous stimuli. In this talk, conditions which will guarantee each type of response will be found using the different the sub-subsystem definitions of the model. NOTICE THE ROOM CHANGE FROM PREVIOUS ANNOUNCEMENT.

Math Seminars
Type Stability of Riemann Surfaces II
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Friday, March 30, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Joint work with Sergei Merenkov

Math Seminars
Sexual Health and Sexually Transmitted Infections in Montana
Dr. Dionne Gesink Law - Department of Microbiology, MSU
When: Thursday, March 29, 2007 03:30PM to 04:30PM
Where: Lewis 304
Details: I'll present the work we've been doing in Montana including describing the basic epidemiology of STIs for Montana using quantitative methods, qualitative results based on key informant interviews, and the capacity building we've been doing to take a community based participatory research approach to our work. NOTICE: Different time and room. This is a cross-listed Ecology Department seminar.

Math Seminars
The Proof
Tom Wells - Department of Mathematical Sciences, MSU
When: Monday, March 26, 2007 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Instead of a talk was a showing of the Nova special "The Proof" about Andrew Wiles' proof of Fermat's Last Theorem

Math Seminars
Type Stability of Riemann Surfaces
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Friday, March 23, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: An open and discrete continuous mapping $f$ from a topological plane $X$ to the Riemann sphere induces a unique Riemann surface structure on $X$. By the Uniformization Theorem, $X$ is conformally equivalent either to the unit disk (hyperbolic type) or to the complex plane (parabolic type). We say that $f$ is type-stable if the conformal type of $f$ does not change if we compose it with any self-homeomorphism of the sphere. I will show that mappings with uniformly separated singularities are type-stable, but that there are type-stable mappings which do not satisfy this criterion, both in the hyperbolic and parabolic case. This result answers a question of Sullivan. Joint work with Sergei Merenkov

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**Math Seminars**

**Determining Optimal Experiment Conditions - A Discrete Approach**
Greta Linse - Department of Mathematical Sciences, MSU
When: Monday, March 19, 2007 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: When formulating a mixture, experimentors have an infinite number of combinations to test to find the ideal combination of ingredients. This is not a feasible approach. What is needed is a space-filling design that identifies the minimal number of combinations to test that are all within a certain distance of each other in order to maximize success of a working combination while minimizing the cost and other constraints. This approach uses computer technology, a "triangular" mesh generating code and linear transformations. This talk will be a general overview of my progress so far to solving this problem.

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**Math Seminars**

**An Almost Minimal Non-uniquely Ergodic Golden Example on $T^2$**
Mark Mathison - Department of Mathematical Sciences, MSU
When: Friday, March 09, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: A transitive flow on a torus with one stopped point, in which all trajectories lift to parallel lines, can have either one or two ergodic measures. The time one map of this flow may have more. We give an example of a time one map on $T^2$ that has infinitely many ergodic measures yet all trajectories except for one are dense. The key step is solving the cohomological equation over irrational circle rotation with a suitably chosen singular data. The arguments hinge on the interplay of the asymptotics at the singularity and the continued fraction representation of the rotation number.

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**Math Seminars**

**Edge Detection**
Dr. Curt Vogel - Department of Mathematical Sciences, MSU
When: Thursday, March 08, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Here is what Wikipedia has to say about edge detection: The goal of edge detection is to mark the points in a digital image at which the luminous intensity changes sharply. Sharp changes in image properties usually reflect important events and changes in properties of the world. These include (i) discontinuities in depth, (ii) discontinuities in surface orientation, (iii) changes in material properties and (iv) variations in scene illumination. Edge detection is a research field within image processing and computer vision, in particular within the area of feature extraction. In this talk we will review the standard mathematical approaches to edge detection. We will also address somewhat nostandard approaches which are biologically motivated and which make use of edge orientation information.

Math Seminars
The Rauzy Fractal, The Ito Construction
Adrian Soto - Department of Mathematical Sciences, MSU
When: Monday, March 05, 2007 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Given a substitution like a->ac, b->ab, c->a, one can associate a pretty picture in IR^2 called "The Rauzy Fractal". There are various ways to produce this picture. I will present a construction by Ito. This construction leads into what is called "The dual tiling space". I hope you'll enjoy it.

Math Seminars
The Road to Mathematics Reform: One State's Perilous Journey
Dr. Mike Lundin - Department of Mathematics, Central Washington University
When: Thursday, March 01, 2007 03:30PM to 04:30PM
Where: Wilson Hall 1-133

Math Seminars
Modeling and Control of Biological Wastewater Treatment Processes
Prof. Rune Bakke - Telemark University College, Telemark, Norway
When: Thursday, March 01, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: I will present a discussion of: The standard models used to simulate biological processes, how they can be used in process design, operation and control.

Math Seminars
Preservice Elementary Teachers' Mathematical Content Knowledge of Prerequisite Algebra Concepts
Rachael Welder - Department of Mathematical Sciences, MSU
When: Monday, February 26, 2007 04:10PM to 05:00PM
Increasingly more district and state high school graduation requirements are including algebra, creating the need for all students, no longer just the college-bound, to be algebra proficient. Despite algebra's significance, the National Assessment of Educational Progress shows a deficiency in the algebra achievement of U.S. students. Research suggests that for students to succeed in Algebra I (or an equivalent first algebra course), it is vital they master prerequisite algebra concepts throughout their K-8 mathematics education: (1) numbers (and numerical operations), (2) ratios/proportions, (3) the order of operations, (4) equality, (5) patterning, (6) algebraic symbolism (including letter usage), (7) algebraic equations, (8) functions, and (9) graphing. Research illustrates that student achievement is effected by teachers' knowledge, requiring elementary and middle school (K-8) teachers to have satisfactory knowledge of prerequisite algebra concepts. The theoretical framework for the knowledge for teaching mathematics built for this study suggests that the mathematical content knowledge needed for teaching consists of specialized content knowledge in addition to common content knowledge. Specialized mathematical content knowledge extends beyond solving mathematical problems to encompass how and why mathematical procedures work and an awareness of structuring and representing mathematical content for learners. The effects of an undergraduate mathematics content course for elementary education students on preservice teachers' common and specialized content knowledge of prerequisite algebra concepts was investigated, using a pre-experimental one-group pretest-posttest design. A quantitative, 51-item, multiple choice instrument, developed specifically to measure both types of content knowledge with respect to prerequisite algebra concepts, was conscientiously constructed from the Learning Mathematics for Teaching Project's Content Knowledge for Teaching Mathematics Measures question bank. This instrument was administered to all students enrolled in Mathematics for Elementary Teachers I (n = 48), at Montana State University, during the first and last weeks of the fall 2006 semester. Matched pairs tests, comparing pretest and posttest scores within the single sample, show significant gains (p = .000) in both common and specialized content knowledge and in all tested aspects of prerequisite algebra knowledge (numbers and equations/functions). Results also suggest a significant correlation (r = .716, p = .000) between the common and specialized content knowledge of preservice teachers. Lastly, a one-parameter linear model was constructed to predict the number of participants to incorrectly answer each item on the instrument, based on item difficulty. Items missed by notably more or less students than predicted by the linear model were identified and analyzed. The one item students performed better than expected on addressed common content knowledge regarding a linear graph. The set of troublesome items addressed both common and specialized content knowledge of reading, writing, and representing functions in a variety of contexts and using ratios to write and solve proportions.

Math Seminars

Strengthening Strands, Professional Development for Middle School Mathematics Teachers
Math Seminars

Classical and New Problems in Numerical Relativity
Dr. Alexander Alekseenko - Department of Mathematics, Cal. State Univ. Northridge
When: Thursday, February 22, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-142
Details: The problem of simulating inspiral and merger of black hole binaries began to be elucidated after more than two decades of continuous effort by the scientists worldwide. Over these years, numerical general relativity became a source of challenging problems, some solved by classical methods (e.g., theory of PDEs, including nonlinear PDEs), while some were new and needed new theories to be developed (e.g., symmetric hyperbolic re-formulations of Einstein's equation and constraint-preserving boundary conditions). As a result, a significant heritage of analytic tools is now available for use in other disciplines. In this talk, we will consider several problems of numerical relativity, highlighting the mathematical methods used in their analysis. An emphasis will be given to problems that potentially can be applied to other disciplines and whose further understanding will help to advance knowledge in numerical relativity.

Math Seminars

Cohomology in One-Dimensional Substitution Tiling Spaces, Part II
Dr. Beverly Diamond - College of Charleston & MSU
When: Friday, February 16, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Joint work with Marcy Barge.

Math Seminars

Low Reynolds Number Flow in Microstructures: Applications to the Cricket Cercal System
Bree Cummins - Department of Mathematical Sciences and Center for Computational Biology, MSU
When: Thursday, February 15, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Fluid flow is described by the Navier-Stokes equations, which are a coupled set of partial differential equations that cannot be analytically solved except in very simplified cases. The Reynolds number (Re) is a non-dimensional group that arises from these equations and gives the ratio between inertial and viscous forces in the fluid.
If $Re << 1$, then the inertial terms in the Navier-Stokes equations may be ignored, yielding either the steady or unsteady Stokes equations, contingent on whether or not the fluid velocity has time dependence. Crickets have a near-field air velocity sensory system called the cercal system, which is composed of two prongs projecting from the back of the cricket covered with fine, thread-like hairs ranging from 50 to 2000 microns in length. These hairs are frequently subjected to velocities that are low enough to satisfy $Re << 1$, while still providing the cricket with critical information about its environment. The goal of my project is to fully characterize the hair-air interface at the cerci in hopes of understanding which components of the air signal are relevant to the cricket. I and my collaborators are currently using a simplified cercal geometry and the steady Stokes equations to model the behavior of a group of cercal hairs in an oscillating, axial air flow. This talk will address the major aspects of the model and show some preliminary results.

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**Math Seminars**

**Estimating the Association between All-Cause Mortality and Body Mass Index: A Bayesian Meta Analysis Approach**

Mahtab Marker - Florida State University, Department of Statistics

**When:** Thursday, February 15, 2007 10:00AM to 10:50AM  
**Where:** Wilson Hall 1-132

**Details:** Although there has been a continuing interest in the medical and public health areas in the relationship between mortality and body weight of individuals, no consensus has been reached on what the optimal weight for individuals is. Standards are usually specified in terms of body mass index (BMI = $wt(kg)/height(m)^2$ which is associated with body fat percentage. Many studies have shown that non-monotonic relationships (U-shaped or J-shaped) exist between mortality and body mass index with excess mortality associated with both very low and very high levels of BMI. To model this quadratic trend several investigators have simply included a suitably transformed second order term into a logistic or Cox proportional hazards model. Other studies in the literature have stated that there is a linear or even no relationship between BMI and mortality. Meta-analysis techniques, used to combine diverse results from similar studies to obtain a single estimate of the outcome measure will be discussed. Once a single relationship is estimated one can find the point of minimum mortality and establish reasonable ranges for optimal BMI. Meta-regression is then used to investigate possible reasons for the heterogeneity of results. A problem which we faced with the widely used iterative Generalized Least Squares method of estimation is that the between-study covariance matrix is not always positive definite. An alternative estimation via Bayesian Hierarchical models is proposed to overcome this problem. The Bayesian method allows us to put suitably chosen prior distribution with positive support on the between study covariance matrix ($D$). This yields a posterior with positive support and also takes into account the uncertainty associated with the estimation of $D$. 

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**Math Seminars**
Relatedness Inference in Structured Populations
Dr. Amy Anderson - University of Washington -- Department of Biostatistics
When: Monday, February 12, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-131
Details: Genetic data is used in a variety of fields to estimate the degree of relatedness between two individuals. For example, it would be reasonable to suspect that two individuals whose DNA is very similar might be closely related while individuals with dissimilar genetic material might be unrelated. A number of methods have been proposed to use the degree of genetic similarity between two individuals to make inferences about how closely those individuals might be related. One feature of these methods is that they tend to give high relatedness estimates for pairs of individuals that share rare genetic variants. Implicit in these methods is that the rarity of each genetic variant (allele) is assumed to be known. In practice, allele frequencies are often known for large, broad, populations (e.g. Northern European Humans), but the individuals being compared might be from a subpopulation (e.g. Irish) for which those frequencies don't precisely apply. In our work, we look at the effect of using allele frequencies from a broad population for estimating the degree of relatedness between individuals from a subpopulation. We demonstrate that a variety of commonly-used estimators that do not take this kind of model misspecification into account will systematically overestimate the degree of relatedness between two individuals from a subpopulation. We develop a maximum likelihood estimator that takes this type of population structure into account.

Math Seminars
Cohomology in One-Dimensional Substitution Tiling Spaces
Dr. Beverly Diamond - College of Charleston & MSU
When: Friday, February 09, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: One can often study the topology of a substitution tiling space by representing it as the inverse limit of an inflation and substitution map on a cellular Anderson-Putnam complex, in many cases on a set of `collared' tiles. For one-dimensional substitution tiling spaces, we describe a modification of the A-P complex that allows for simpler computation of the cohomology, and the identification of certain special features of the topology of the tiling space with particular components of the cohomology. Joint work with Marcy Barge.

Math Seminars
Applied Mathematics and the Measurement of Transport Dynamics by Magnetic Resonance: Hierarchy of displacement time and length scales
Dr. Joseph D. Seymour - Department of Chemical and Biological Engineering, MSU
When: Thursday, February 08, 2007 03:10PM to 04:00PM
**Where:** Wilson Hall 1-139  

**Math Seminars**

**Spatial Models for Ordered Categorical Data**  
**Megan Higgs - Colorado State University**

**When:** **Thursday, February 08, 2007 10:00AM to 11:00AM**  
**Where:** Wilson Hall 1-132  
**Details:** Ordered categorical data with spatial dependence may result from ecological and environmental research. A common and important problem arising from the collection of data over space is prediction at new spatial locations. Models and methods
for such prediction are widespread for continuous data, but sparse for categorical data. The scarcity of methods dealing with both the ordered categorical and spatial nature of such data motivates development of our model. Bayesian models and methods have been proposed for the analysis of independent ordered categorical data, relying on the techniques of data augmentation and Gibbs sampling, as well as other approaches to improve computational efficiency of the Gibbs algorithm (Albert and Chib, 1997). Spatial models for binary and count data have also been developed by embedding the Gaussian random field within the framework of generalized linear mixed models (Diggle, Tawn, and Moyeed, 1998). De Oliveira (2000) proposed the use of a clipped Gaussian random field for Bayesian prediction of a binary random field. We combine and extend these methods to provide a solution for analyzing spatial ordered categorical data. We investigate the problem by comparing two model formulations differing in how the spatial correlation is incorporated into the model. Both approaches rely on the use of an underlying latent Gaussian random field, and the concept of clipping a continuous variable to get at the categorical response. The models are fit in the Bayesian framework using Gibbs sampling and MCMC methods. We investigate and compare prediction at new locations and parameter estimation using simulated data sets. The methods are also applied to categorical data describing the number of fish species at a stream site.

Math Seminars
Holy Craps, It's Craps!
Robin Rumple - Department of Mathematical Sciences, MSU
When: Monday, February 05, 2007 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: I will be speaking at the first dynalite of spring 2007 ... baby. And it's all about CRAPS! Only the BEST casino game EVER! It will consist of a little of this ... and a little of that. The talk will have a little bit o' history ... a little on how the game is played ... a little strategy ... a little bit on odds (to keep it somewhat math-ie) ... and a LOT of rollin' action! And in case someone is not sure what craps is ... I like to call it "the casino oval dice game." That about covers it :)

Math Seminars
New Adaptive Finite Element Methods and Applications
Dr. Pengtao Sun - Department of Mathematics, Pennsylvania State University
When: Thursday, February 01, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-142
Details: This talk is focused on the construction of robust and accurate algorithms for mathematical models of physical phenomena that exhibit strong anisotropies, that is, when the quantities have very slow and smooth variations in some directions but have rapid variations in other directions. Our first result is on the mathematically characterization of optimal or nearly optimal meshes for a general function which could be either isotropic or anisotropic. We give an interpolation error estimate for the
continuous and piecewise linear nodal interpolation. Roughly speaking, a nearly optimal mesh is a quasi-uniform triangulation under some new metric defined by the Hessian matrix of the object function. We also prove the error estimate is optimal for strictly convex (or concave) functions. Based on the interpolation error estimates, we present practical algorithms to construct such nearly optimal meshes. By minimizing the interpolation error locally, we obtain several new mesh smoothing schemes. We then apply our mesh adaptation algorithms to the convection dominated convection-diffusion model problems, which present anisotropic singularities such as boundary or internal layers. We develop a robust and accurate adaptive finite element method for convection dominated problems by the homotopy of the diffusion parameter. We also apply our anisotropic AFEM to some realistic problems such as the 4th order thin film flow problem, black-hole binary system and fuel cell dynamics problem, all of which exhibit their own specific anisotropic singularities with practical physical significances. Adaptive FEM, in which quantitative control of errors is achieved automatically by anisotropic mesh adaptivity based on a posteriori error estimate, are a natural choice that has great potential for achieving the high level of adaptivity required in these simulations. In the second part of this talk, 21st century energy-conversion devices - fuel cell technology - will be discussed, some new numerical techniques for fuel cell modeling and simulation will be addressed as well. For those complicated fuel cell computations for which the commercial software package (StarCD, Fluent) can't get converge, our algorithms can obtain fast convergence. Fast solver for 3D complete fuel cell model is ongoing, and adaptive FEM will be explored for this full fuel cell model as well in the future.

Math Seminars
Spatial Dependence Estimation and Prediction for Max-stable Random Fields
Dr. Daniel Cooley - National Center for Atmospheric Research (NCAR) and Colorado State University
When: Thursday, February 01, 2007 02:10PM to 03:00PM
Where: Wilson Hall 1-132
Details: In meteorological or environmental studies, data are recorded at specific locations. With spatial data two immediate questions arise: how can the spatial dependence be measured, and how can spatial prediction be performed? If the data represents central tendencies of the process, the field of geostatistics answers these questions using the variogram and kriging. However, if the data are extreme observations, these questions are largely unanswered. To measure pairwise spatial dependence in max-stable random fields, we propose the madogram. The madogram is simply a first-order variogram and therefore has its roots in traditional geostatistics. However, the madogram also has a convenient relationship with multivariate extreme value distributions and the extremal coefficient, an existing measure of dependence for extremes. The madogram can be extended to provide an estimate of the complete bivariate dependence structure, and proposed madogram estimators are presented and compared to existing estimators. To perform spatial prediction, we propose estimating the conditional distribution of an unmonitored location given the
observed values at nearby locations. To estimate the conditional distribution, we utilize the spectral measure of the max-stable distribution. Our ongoing work is to find an appropriate parametric model for the spectral measure.

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**Math Seminars**

**Student Obstacles and Historical Obstacles to Foundational Concepts of Calculus**
Rob Ely - Department of Curriculum and Instruction, University of Wisconsin
**When:** Tuesday, January 30, 2007 03:30PM to 04:30PM  
**Where:** Wilson Hall 1-133

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**Math Seminars**

**An Anisotropic Sparse Grid Stochastic Collocation Method for Partial Differential Equations with Random Input Data**
Clayton Webster - Florida State University
**When:** Monday, January 29, 2007 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-141

**Details:** This work proposes and analyzes an anisotropic sparse grid stochastic collocation method for solving elliptic partial differential equations with random coefficients and forcing terms (input data of the model). The method consists of a Galerkin approximation in the space variables and a collocation, in probability space, on sparse tensor product grids utilizing either Clenshaw-Curtis or Gaussian knots. Even in the presence of nonlinearities, the collocation approach leads to the solution of uncoupled deterministic problems, just as in the Monte Carlo method. This work includes **a priori** and **a posteriori** procedures to adapt the anisotropy of the sparse grids to each given problem. These procedures seem to be very effective for the problems under study. The proposed method combines the advantages of isotropic sparse collocation with those of anisotropic full tensor product collocation: the first approach is effective for problems depending on random variables which weigh approximately equally in the solution, while the benefits of the latter approach become apparent when solving highly anisotropic problems depending on a relatively small number of random variables, as in the case where input random variables are Karhunen-Loève truncations of “smooth” random fields. This work also provides a rigorous convergence analysis of the fully discrete problem and demonstrates: (sub)exponential convergence in the asymptotic regime and algebraic convergence in the pre-asymptotic regime, with respect to the total number of collocation points. Numerical examples illustrate the theoretical results and are used to compare this approach with several others, including the standard Monte Carlo. In particular, for moderately large dimensional problems, the sparse grid approach with a properly chosen anisotropy seems to be very efficient and superior to all examined methods.
Rigidity in One-Dimensional Substitution Tiling Spaces
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, January 26, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Upper Bounds on the Coarsening Rates of Discrete Ill-Posed Nonlinear Diffusions
Dr. John Greer - Courant Institute, New York University
When: Thursday, January 25, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-142
Details: I will discuss a recent proof of a weak upper bound on the coarsening rate of the discrete-in-space version of an ill-posed, nonlinear diffusion equation. The continuum version of the equation violates parabolicity and lacks a complete wellposedness theory. In particular, numerical simulations indicate very sensitive dependence on initial data. Nevertheless, models based on its discrete-in-space version, which I will discuss, are widely used in a number of applications, including population dynamics (chemotactic movement of bacteria), granular flow (formation of shear bands), and computer vision (image denoising and segmentation). The bounds have implications for all three applications. This is joint work with Selim Esedoglu (U. of Michigan Mathematics).

Math Seminars
Pre-Algebra and the Chinese Remainder Theorem: Connections for Teachers and Students
Dr. Beth Burroughs - Department of Mathematics, Humboldt State University
When: Monday, January 22, 2007 03:10PM to 04:00PM
Where: Wilson Hall 1-133
Details: As part of a mathematics teacher preparation program, the study of number theory is generally required. NCTM's Principles and Standards for School Mathematics calls for instruction enabling students in grades 6-8 to ``use factors, multiples, prime factorization, and relatively prime numbers to solve problems,'' and for students in grades 9-12 to ``use number theory arguments to justify relationships involving whole numbers.'' This talk will look at a problem from pre-algebra that an undergraduate number theory student would recognize as a Chinese Remainder Theorem problem. The talk will analyze the connections between solution methods appropriate to middle schoolers and those appropriate to undergraduates.

Math Seminars
Three Semesters: Has it made a Difference?
Dr. Tod Shockey - Department of Mathematics and Statistics, University of Maine
Math Seminars
Computational Methods and Results for Structured Multiscale Models of Tumor Invasion
Dr. Bruce Ayati - Department of Mathematics, Southern Methodist University
When: Friday, January 12, 2007 02:10PM to 03:00PM
Where: Wilson Hall 1-139
Details: We present multiscale models of tumor invasion with components at the molecular, cellular, and tissue levels. We provide justifications for the model components, present computational results from the models, and discuss the scientific computing methodology used to solve the model equations. Because many of the features of the tumor invasion models, such as taxis, aging, and growth, are seen in other biological systems, the models and methods discussed also provide a template for handling a broader range of biological problems. Authors: Bruce P. Ayati, Glenn F. Webb, Alexander R. A. Anderson

Math Seminars
Network Structure
Jesse Berwald - Department of Mathematical Sciences, MSU
When: Monday, December 04, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Examples of networks abound in daily life. I will give an overview of the mathematical tools I have been using to investigate questions that arise with respect to clustering in networks as well as some preliminary results (time permitting). Networks come in many sizes. From the math department's server-workstation computer system to the decentralized power grid of the Western United States, all played an integral part in the ability to produce this simple abstract. I hope to develop efficient and robust algorithms to identify geometric structure in large scale networks. Recent work has focused on using these algorithms to search for dominant patterns in large data sets produced by neurological experiments.

Math Seminars
Torsion in Tilings
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, December 01, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: We will construct a tiling space with torsion in its 2-dimensional cohomology. We will also try to say what these words mean.
Agent (or Individual)-Based Models: Simulating the Glass-Ceiling in Corporations

Dr. Jim Robison-Cox - Department of Mathematical Sciences, MSU
When: Friday, December 01, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-122
Details: By creating an artificial society in the computer, we can investigate hypotheses which are not easy to test with available data. Such models are used in economics, political science, and ecology. Examples will be given, but most of the talk will focus on a simulation of the glass ceiling in corporations. We have postulated six possible contributing factors, but have found that one is by far the most influential (bias toward males in performance evaluations). From a statistical perspective, it is challenging to decide what data to analyze (one can become overwhelmed with data) and to examine the limits of inference when the simulation is a simplification of reality.

Math Seminars

Model Development and Control Design for High Performance Nonlinear Smart Material Systems

Dr. Ralph C. Smith - Department of Mathematics North Carolina State University
When: Thursday, November 30, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: High performance transducers utilizing piezoceramic, electrostrictive, magnetostrictive or shape memory elements offer novel control capabilities in applications ranging from civil applications to precision placement for nanoconstruction. To achieve the full potential of these materials, however, models, numerical methods and control designs which accommodate the constitutive nonlinearities and hysteresis inherent to the compounds must be employed. Furthermore, it is advantageous to consider material characterization, model development, numerical approximation, and control design in concert to fully exploit the novel sensor and actuator capabilities of these materials in coupled systems. In this presentation, the speaker will discuss recent
advances in the development of model-based control strategies for high performance smart material systems. The presentation will focus on the development of unified nonlinear hysteresis models, nonlinear distributed system models, reduced-order approximation techniques, and nonlinear control strategies for high precision or high drive regimes. Significant attention will be focused on the discussion of numerical techniques and control designs which facilitate real-time implementation of smart material actuators and sensors operating in highly nonlinear regimes. Examples will be drawn from problems arising in civil applications, tendon design to minimize earthquake damage, structural acoustics, high speed milling, deformable mirror design, artificial muscle development, and atomic force microscopy. The topics discussed in this presentation will be developed from first principles and hence will be accessible to a broad audience. Graduate students are encouraged to attend.

Math Seminars
A Talk on Computability Part III of III
Luke Shorty - Department of Mathematical Sciences, MSU
When: Monday, November 27, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Hi everyone it's me, Luke Shorty the "Robot Hunter" (aka the Steve Irwin of the Robot World). So we didn't quite get past Finite Automata in our last talk, today we'll look at Context Free Grammars, and Push Down Automata, than of course we'll hit Turing Machines. If we're lucky than we can get to everyone's favorite creature in the Robot Zoo: FLAMING ROBOTIC DANCING PANDAS!

Math Seminars
Intro to Computability Part II of III
Luke Shorty - Department of Mathematical Sciences, MSU
When: Monday, November 20, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Howdy exotic zooaphiles! Come join this week's Dynalite for an exciting tour thru the many different types of computing machines. There is the fairly domestic Deterministic Finite Automata and its wilier cousin Nondeterministic Finite Automata. We'll talk about Push Down Automata and Context Free Grammars, and finally we'll examine the most exotic of beastsies, the one, the only Turing Machines! There will be demonstrations, dancing, funny voices, some crowd participation, and maybe, just maybe a flaming giant robotic panda.

Math Seminars
Rotation Methods in Factor Analysis
Dr. Robert Boik - Department of Mathematical Sciences, MSU
When: Friday, November 17, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-122
Math Seminars
Mathematical Modeling of Hair Cell Sensors and Reduced Order Modeling for Flow Control Applications
Dr. John Singler - Department of Mechanical Engineering, Oregon State University
When: Thursday, November 16, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Autonomous micro air vehicle (MAV) flight faces inherent stability challenges. One challenge is controlling flow separation over the airfoil. An autonomous control system for MAV flight may be enhanced with closed loop separation control. In this talk, we focus on two modeling problems for flow control applications for MAVs. First, we develop a mathematical model for the output of biologically inspired hair cell sensors. Next, we combine proper orthogonal decomposition and the group finite element method to create reduced order models. Numerical results are presented for both topics.

Math Seminars
Inferring Protein-Protein Associations using a Likelihood Ratio Test and Empirical Bayes
Julia Sharp - Department of Mathematical Sciences, MSU
When: Monday, November 13, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: The field of proteomics is exploding with statistical problems waiting to be explored. In this talk, I will examine protein - protein interactions using `bait-prey' protein pull-down assays that use a protein affinity agent and an LC-MS (liquid chromatography-mass-spectrometry)-based protein identification method. A pull-down experiment generates a protein association matrix wherein each column represents a sample from one bait protein, each row represents one prey protein and each cell contains a presence/absence association indicator. This method evaluates the presence/absence pattern across a prey protein (row) with a Likelihood Ratio Test (LRT) and simulated Likelihood Ratio Test p-values. Based on the p-value, each prey protein is assigned a category (specific or non-specific) and appraised with respect to the pull-down experiment's goal and design. The Bayes' Odds is calculated for each prey-bait pair in the `Specific' category; this calculation is compared to an approach used by Gilchrist et al. to estimate the probability that two proteins occur together in the same complex. The method is illustrated using a pull-down experiment investigating the protein complexes of Shewanella oneidensis MR-1 at the Proteomics Facility of Pacific Northwest National Laboratory. The example analysis shows the results to be biologically sensible and more realistic than methods previously utilized to infer protein - protein associations.

Math Seminars
Sieves of Thunder - The Race for the Pseudosquares
Derrick Cerwinsky - Department of Mathematics, University of Wyoming
When: Thursday, November 09, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Given a large number we think may be prime, it is a difficult problem to prove the number is prime. A polynomial time deterministic algorithm exists for primality proving, but it is dependent on knowing the value of pseudosquares. In this talk we will look at the challenges faced in seeking the pseudosquares, as well as sieving techniques spanning from the times of the ancient Greeks to the state of the art; and one student's quest to understand them all. This talk assumes no background in number theory or algebra beyond modular arithmetic, so graduate students are strongly encouraged to attend.

Math Seminars
Infinite Secrets
Christine Latulippe - Department of Mathematical Sciences, MSU
When: Monday, November 06, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Christine Latulippe has agreed to host the November 6 Dynalite seminar. Due to the fact that she has completely overcommitted herself this semester, rather than a meticulously prepared power point regarding something brilliantly researched, she will be sharing with you her new interest in math history via a stunning NOVA documentary about Archimedes entitled "Infinite Secrets". There will be popcorn, and the comfy chairs are first-come, first-served. Please join us for an enjoyable and educational movie-going experience in the Hurst Conference Room. "In 1991, a small medieval prayer book was sold at auction. Miraculously, some original writings of Archimedes, the brilliant Greek mathematician, were discovered hidden beneath the religious text. Through scholarly detective work with the help of modern technology, this book now reveals Archimedes' stunningly original concepts, ideas, and theories revelations that, if known sooner, might have reshaped our world." ***For Mature Audiences Only, due to brief nudity.

Math Seminars
Some Aspects of the Penrose tiling
Dr. Edmund Harriss - School of Mathematical Sciences, Imperial College London
When: Friday, November 03, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: The Penrose tiling was discovered in the 1970s and is one of the simplest known sets of aperiodic tiles. These are sets of tiles which tile the plane only in a nonperiodic manner. It is also very beautiful as it has a five fold rotational symmetry. In this talk I will discuss the Penrose tiling and the links between two methods of
constructing it. The substitution method used by Penrose and the projection method discovered by De Bruijn.

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**Math Seminars**

**Turbulence Modeling and Simulation Using Stochastic PDEs**  
Dr. Curt Vogel - Department of Mathematical Sciences, MSU  
When: **Thursday, November 02, 2006 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139  
Details: We will present a stochastic PDE model for time-varying turbulence that can be viewed as a linearization of the Navier-Stokes equations, with deterministic advection and deterministic terms, plus a stochastic driving term. With an appropriate choice of the driving term, we obtain fixed-time realizations with the correct (Kolmogorov) statistics. We also obtain "boiling" behavior similar to what can be seen in temporally evolving turbulence. We also present simulation results in which we solve the stochastic PDE using a combination of Fourier transforms and Ito stochastic integration.

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**Math Seminars**

**A Bare Bones Introduction to the Limits of Computablity Part I of III**  
Luke Shorty - Department of Mathematical Sciences, MSU  
When: **Monday, October 30, 2006 04:10PM to 05:00PM**  
Where: Wilson Hall 2-244  
Details: I'll sum this talk up in a cute poem: Computers are neat and sometimes they're fun. Some people argue they can't be outdone! We use them for research, we use them for math. When people say they're limitless, I can't help but laugh. The key to their power is FUNCTION RECURSION. I'll tell you the tale in its simple version. It comes in two flavors, like Mulligan Stew. It comes as Recursive, as PRIMITIVE or MU. I'll teach you about Primitive in a way that is slick. By the end of the hour, we will have working ARITHMETIC. It'll be as tasty and good as a cold Black and Tan. I'll show you a MU recursion- a function called ACKERMANN. So show up or you'll be sorry...that's not part of the poem.

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**Math Seminars**

**Zeros of Harmonic Polynomials**  
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU  
When: **Friday, October 27, 2006 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139  
Details: m=deg g, then p has at most m(m-1)+3n-2 zeros, and he showed that this is the sharp bound in the case m=n-1. I will present a proof that this is also true for the case m=1. Both directions of the proof use techniques from complex dynamics. The general case of Wilmshurst's conjecture is still open. I will also explain what this problem has to do with Catalan numbers, real algebraic geometry, and gravitational lensing.'>Harmonic polynomials in the complex plane are of the form p(z)=f(z)+g(z).
where $f$ and $g$ are holomorphic and anti-holomorphic polynomials, respectively. A

generic harmonic polynomial of degree $n$ has finitely many zeros, and Bezout's theorem
implies that the number of zeros is at most $n^2$ in that case. Wilmshurst conjectured that
if $\deg f = n > m = \deg g$, then $p$ has at most $m(m-1)+3n-2$ zeros, and he showed that this is
the sharp bound in the case $m=n-1$. I will present a proof that this is also true for the
case $m=1$. Both directions of the proof use techniques from complex dynamics. The
general case of Wilmshurst's conjecture is still open. I will also explain what this
problem has to do with Catalan numbers, real algebraic geometry, and gravitational
lensing.

Math Seminars
The Spatial and Spatiotemporal Distribution of Sexually Transmitted Infections
Dr. Dionne Gesink Law - Department of Microbiology, MSU
When: Friday, October 27, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-122
Details: Local and national agencies spend millions of dollars on sexually transmitted infection (STI) interventions and prevention strategies including free access to STI health care, increased education, STI screening, and enhanced surveillance to identify outbreaks. We developed methods to describe the spatial and spatiotemporal distribution of STIs to optimize disease surveillance and decisions regarding resource allocation, prevention, and intervention. We applied these methods to investigate the spatial distribution of four reportable STIs in Wake County, North Carolina, and to investigate the spread of syphilis before, during and after an outbreak in Baltimore, Maryland. In North Carolina, we found that each reportable STI had a core area of infection that overlapped with other STIs. In Maryland, we found that the density of syphilis infection increased in two endemic core areas immediately preceding the outbreak, spread outward and initiated a third new core area of infection during the outbreak. As the outbreak waned, the density of infection receded back to the original two core areas, and the third new core area remained a distinct location of elevated infection. The results of our investigations have implications for targeting STI intervention and prevention strategies as well as for disease surveillance and outbreak investigation. Our next step is to build the capacity to investigate sexual health and STIs in northern frontier environments, focusing on Montana.

Math Seminars
Space-Filling Designs for High-Dimensional Mixture Experiments with Multiple Component Constraints
Dr. John Borkowski - Department of Mathematical Sciences, MSU
When: Thursday, October 26, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: The goal of a space-filling design is uniform scatter of the design points in the experimental region. For mixture designs, as the dimension of the experimental region increases, space-filling design criteria (such as maximin an minimax) place most, if not all, design points at or near the boundary of the constrained region. Four numbertheoretic (NT) methods for generating space-filling designs for highly-constrained mixture experiments will be implemented for an eight-component problem. The NT methods will include design generation involving lattice point sets, square root sequences, powers of the (s+1)st root, and H-sets. The uniform scatter of the points in these designs will be evaluated using distance-based criteria.

Math Seminars
Space-Filling Designs for High-Dimensional Mixture Experiments with Multiple Component Constraints
John Borkowski - Department of Mathematical Sciences, MSU
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Math Seminars
Surreal Numbers
Andy Bouwman - Department of Mathematical Sciences, MSU
When: Monday, October 23, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: The surreal numbers are a well-ordered superset of the real numbers, which even include so-called "infinite" and "infinitesimal" numbers. We'll construct them out of 2 very recursive axioms, and investigate various properties and structures they have.

Math Seminars
Topological Dynamics and Maximal Equicontinuous Factors
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, October 20, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
**Math Seminars**

**Molecular Design Using Chemical Fragments**  
Dr. Shawn Martin - Sandia National Laboratories  
**When:** Wednesday, October 18, 2006 02:10PM to 03:00PM  
**Where:** Wilson Hall 1-141  
**Details:** I will describe a mathematical framework developed for the design of molecular structures with desired properties. This method uses fragments of molecular graphs to predict chemical properties. Linear Diophantine equations with inequality constraints are then used to re-organize the fragments into novel molecular structures. The method has been previously applied to problems in drug and materials design, including LFA1/ICAM-1 inhibitory peptides, linear homopolymers, and hydrofluoroether foam blowing agents. I will provide a complete description of the method, including a new approach to overcome previous limitations due to combinatorial complexity. The new approach uses the Fincke-Pohst algorithm for lattice enumeration, implemented using the PARI/GP computer algebra library.

**Math Seminars**

**The RSA Ciphersystem**  
Corinne Casolara - Department of Mathematical Sciences, MSU  
**When:** Monday, October 16, 2006 04:10PM to 05:00PM  
**Where:** Wilson Hall 2-244  
**Details:** The financial world, government, and economy rely heavily on the security of transmitted information. This information can range from a bank account number to top secret government data to a consumer's debit card number being used to purchase merchandise online. Just as much of the world we are familiar with relies on and expects privacy of information, the security of the transmitted information relies on the strength of the cipher used to encrypt it. One very popular encryption cipher is the RSA ciphersystem. It is based on relatively simple mathematics, with its foundations in the Euclidean algorithm. The actual operations are quite easy to perform; RSA functions by using prime numbers, multiplication, and modular exponentiation. The security of such a simple system is reliant on the assumed difficulty of factoring very large prime numbers, not on the difficulty of the mathematical processes. No one has proved that factoring is difficult, but no one has derived an efficient and easy way to factor large numbers. Because the RSA system utilizes this assumption in conjunction with extremely large numbers, the system remains quite secure. The short story is that the math here can afford to be relatively simple because factoring is assumed to be very hard due to the stark lack of easy factoring methods. In fact, if a cryptanalyst attempted to crack the RSA cipher by factoring, the combined efforts of a hundred million personal computers would take more than one thousand years. While I won't attempt something of that magnitude, in the talk on Monday, I will explore the contributions that led to this system's creation and explain the mathematical concepts behind RSA.
An Alternate Version of the Conceptual Predictive Statistic
Dr. Joe Cavanaugh - Department of Biostatistics, University of Iowa
When: Friday, October 13, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-122
Details: The conceptual predictive statistic, Cp, is a widely used criterion for model selection in linear regression. Cp serves as an approximately unbiased estimator of a discrepancy, a measure that reflects the disparity between the generating model and a fitted candidate model. This discrepancy, based on scaled squared error loss, is asymmetric: an alternate measure is obtained by reversing the roles of the two models in the definition of the measure. We propose a variant of the Cp statistic based on estimating a symmetrized version of the discrepancy targeted by Cp. We claim that the resulting criterion provides better protection against overfitting than Cp, since the symmetric discrepancy is more sensitive to overspecification than its asymmetric counterpart. We illustrate our claim by presenting simulation results. Finally, we demonstrate the practical utility of the new criterion by discussing a modeling application based on data collected in a cardiac rehabilitation program at University of Iowa Hospitals and Clinics.

Spectral Approximation Algorithms: Clustering and Graph Partitioning.
Dr. David Tolliver - Google Fellow and Department of Computer Science, Carnegie Mellon University
When: Thursday, October 12, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: I'll provide an overview of recent advances in spectral clustering and partitioning technology. I'll briefly cover a fundamental result in clustering, and then delve into the basic spectral clustering algorithm. I'll walk through a few variations on the basic algorithm, highlighting the specific applications domains and drawbacks. Finally I'll cover our proof of an approximation bound for the Normalized Cut (an NP-hard objection function) for a simple spectral algorithm.

From Fetal to Newborn Circulation
Mark Campanelli - Department of Mathematical Sciences, MSU
When: Monday, October 09, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: The developing fetus has different circulation requirements than a newborn infant. The main difference arises from the placental source of oxygen (from the mother) instead of the fetal lungs (which are collapsed). In my talk, I will briefly discuss the postnatal heart and circulatory plan, and show how some very basic mathematics can shed light on nature's design of the pre-natal heart and circulatory plan. The fetal
circulatory system includes two physiological constructs to bypass blood flow to the lungs, even though, conceivably, one bypass should suffice. A very basic treatment of the circulatory system, using linear algebra and the circulatory equivalent of Kirchoff’s Laws, suggests why the multiple bypass system is preferable. It also sheds light on the mechanism that converts the pre-natal circulatory system into the post-natal circulatory system upon a newborn infant’s first breath and within the first hours after birth. This talk was adapted from a public lecture given by Charles S. Peskin at the Institute for Mathematics and Its Applications at the University of Minnesota in June, 2003.

Math Seminars
From Bernoulli Convolutions to Invariant Measures
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, October 06, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: I will present a construction that relates an (algebraic) Bernoulli convolution with a certain dynamically invariant measure for a suitable algebraic group automorphism.

Math Seminars
Multivalued Characteristics and Morse Decompositions
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, October 05, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: There are only a few analytical tools available to analyze dynamics of systems of nonlinear differential equations. Yet these tools are needed to understand complicated networks of reactions involved in gene regulation. The nonlinear systems arising in this situation are special; the reaction functions are often monotone in all their arguments. If the underlying structure of reactions is special, the monotonicity of reaction functions imply that the system is monotone. Monotone systems have simple dynamics - almost all solutions converge to a set of equilibria. An extension of monotone system theory to controlled monotone systems has been introduced several years ago by Sontag. The main player in the extension is so called input-output characteristic of the open loop system. If open loop system is monotone and if the characteristics is single valued function, one can conclude convergence to equilibria for closed loop system. We generalize this approach to multi-valued characteristics and weakened significantly the existing set of assumptions under which the Open loop -closed loop theorem is valid. (This is a joint work with Wendy Hines from Nebraska)

Math Seminars
Modeling Visual Neurons
Joe Latulippe - Department of Mathematical Sciences, MSU
Certain neurons exhibit responses which are stimulus dependent. In this talk we will explore how certain neurons behave when given a stimulus. To help determine how neuronal information is processed, mathematical models can be used to predict and explain the patterns that are recorded scientifically. First a simple synaptic model will be introduced and the numerical results of a phenomenological model will be given. We will also discuss some basic neuroscience, and show that the model can replicate certain behaviors found in visual neurons.

Math Seminars
Explaining Bacterial Persistence with Senescence
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, September 28, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: It has been known for many years that small fractions of persister cells resist killing in many bacterial colony-antimicrobial confrontations. These persisters are not believed to be mutants. Rather it has been hypothesized that they are phenotypic variants. Current models allow cells to switch in and out of the persister phenotype. In this talk a different explanation is suggested, namely senescence, for persister formation. Using a model including age structure, it is shown that senescence provides a natural explanation for persister-related phenomena including the observations that persister fraction depends on growth phase in batch culture and dilution rate in continuous culture.

Math Seminars
Half-Hex Tiling
Carl Olimb - Department of Mathematical Sciences, MSU
When: Monday, September 25, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Methods of determining periodicity of the half-hex tiling.

Math Seminars
The Puzzle of Bernoulli Convolutions
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, September 22, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: I will say a few words about an old problem regarding certain natural generalization of the ordinary Cantor set construction. Again this will be a very introductory talk (with no real content).
Math Seminars

Several Wrong Ways to Compute a Sensitivity With Respect to Actuator Location
Dr. Lisa Davis - Department of Mathematical Sciences, MSU
When: Thursday, September 21, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: This talk surveys several ways that sensitivity computations can fail if the smoothness of the sensitivity function is not taken into account. The results are motivated by actuator placement on an Euler-Bernoulli beam model. A steady state fourth order equation is examined, and several approaches to sensitivity computations are surveyed. A 'Discretize-Then-Differentiate' approach is considered along with a formal sensitivity equation. Each is shown to give erroneous results, some numerically interesting and qualitatively believable. A Petrov-Galerkin approach is then applied to a simple 1D elliptic interface problem to demonstrate how an appropriate variational formulation combined with a corresponding finite element method to produce convergent sensitivity calculations.

Math Seminars

Hyperspace of Arcs of a Dendroid
Adrian Soto - Department of Mathematical Sciences, MSU
When: Monday, September 18, 2006 04:10PM to 05:00PM
Where: Wilson Hall 2-244
Details: Imagine a tree, and suppose that you define a way to tell when two worms (arcs) are close together. In what way is that different from telling how far their extremes are? I will present some of the results my then advisor and I obtained when I was an undergrad. The talk will be based on drawings, and one example. The word "topology" will be mentioned.

Math Seminars

The Problem of Algebraic Realization of the Beta-Transformation
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, September 15, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars

Analysis of Biological Interaction Networks for Drug Discovery
Aditi Baker - Department of Mathematical Sciences, MSU
When: Wednesday, September 13, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-143
Details: NOTICE SPECIAL DAY AND SPECIAL ROOM!! Many physiological processes involve complex signal transduction cascades, in which large numbers of species
interact with each other. One of the critical steps in the drug development process is the identification of a target, a molecular species in the body whose functioning can potentially be altered by dosing with an external substance. The target is just one component of a huge signal transduction network, and it is critical to understand the potential impact of interventions at the target and any drug-induced changes on the overall network. One common approach to validating potential targets is to knock out or functionally remove the target from an animal model and then measure the resulting effects on the biology of interest. Usually the effects of the knockout are described in terms of concentration profiles or other physically measureable properties of biomarkers (other molecular species in the same cascade). These biomarkers will be hereafter referred to as responders. One way to identify a potential target is to knockout all the participating species in the signal transduction pathway, one at a time. The species whose knockout effects are similar to the desired output can be selected to be a potential target. However, this is always not experimentally feasible. Moreover, it would be an expensive project, given that cascades may contain as many as a thousand or more interacting species. Fortunately, with mathematical models of signal transduction networks, an in silico version of target validation can be conducted by computationally removing a species and predicting the effects on the system. The disruptiveness of a given knockout on the network then can be determined by examining how the knockout changes the behavior of other species (responders) in the network. In the computational version of the system, almost any molecule can be chosen as a responder. In some cases, it may be desirable to disrupt as much of the network as possible, while in other cases, only a specific region of the network is to be disrupted. As the models become large, analyzing complex signaling networks becomes increasingly difficult, so that development of general automatable analysis tools is critical. This project focuses on developing mathematical methods to: (1) quantify the effects of any single knockout on a responder; (2) quantify the disruptiveness of knockouts on the network; (3) devise a method to identify a target based on the previous measures; and (4) to apply the analysis techniques to a small model of signal transduction. We have used a simple model for MAPK signaling to validate approaches to the problem of automated quantification of deletions on network properties. MAPK signaling is important in cell differentiation and division responses to growth factor signaling. Aberrant signaling has been implicated in uncontrolled cell division responses, and in particular is associated with certain types of breast cancers. For the purpose of this project we identify ERK as the responder of the signal transduction pathway, and quantify differences in ERK behavior with and without single deletions of components of the signaling pathway. The project involves simulation of the responses in the presence and absence of deletions, establishing quantitative measures that capture various aspects of the changes in the response, and analysis of responses for different deletions to compare the effects of different deletions on the ERK response and the network-wide response.

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**Math Seminars**

**Tiling Spaces: A Picture Show**

**Veronica Baker - Department of Mathematical Sciences, MSU**
When: **Monday, September 11, 2006 04:10PM to 05:00PM**  
Where: Wilson Hall 2-244  
Details: A quick introduction to geometric tiling spaces and its link to quasicrystals. Very little prerequisite material is required.

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**Math Seminars**  
**Beta Transformation**  
Dr. Marcy Barge - Department of Mathematical Sciences, MSU  
When: **Friday, September 08, 2006 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139

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**Math Seminars**  
**Rational Functions and Subdivision Rules**  
Dr. Mario Bonk - Department of Mathematics, University of Michigan  
When: **Friday, July 21, 2006 03:10PM to 04:00PM**  
Where: Wilson Hall 1-141

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**Math Seminars**  
**Rigidity of Sierpinski Carpets**  
Dr. Sergiy Merenkov - Department of Mathematics, University of Illinois  
When: **Friday, July 21, 2006 02:10PM to 03:00PM**  
Where: Wilson Hall 1-141

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**Math Seminars**  
**Sampling Methods for Inverse Problems**  
Heikki Haario - Department of Mathematics and Statistics, University of Helsinki, Finland  
When: **Thursday, April 27, 2006 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139  
Details: The statistical approach, employing various Monte Carlo sampling methods, has become one of the basic methods to solve inverse problems. In this talk we will give a short overview of the basic algorithms, and point out situations where the standard versions will not work efficiently. As a remedy, we present adaptive methods and outline proofs that show under which conditions they will produce correct results. Examples include atmospheric gas profile inversion by satellite measurements, and models for algae bloomings in lakes.

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**Math Seminars**  
**Towards an Alternating-Direction Sinc-Galerkin Method for Elliptic Problems**
Nick Alonso - Department of Mathematical Sciences, MSU
When: Wednesday, April 19, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-117
Details: (NOTICE DIFFERENT DAY AND ROOM! The numerical solution of partial differential equations often requires an enormous amount of computation, especially as the number of dimensions increases. In this talk I will weave a path through problems and methods in an attempt to demonstrate the plausibility of constructing an AlternatingDirection Sinc-Galerkin scheme and thus combine the exponential convergence rate of a Sinc-Galerkin method with the savings in computation associated with AlternatingDirection schemes.

Math Seminars
Creating an Academic Portfolio: The CV, Teaching Statement, and Research Statement
Dr. Lisa Davis - Department of Mathematical Sciences, MSU
When: Monday, April 10, 2006 04:10PM to 05:00PM Where: Hurst Conference Room
Details: I will cover 4 of the main components of the academic job application packet. The Curriculum Vita (aka the resume) will be the first and most important topic that we discuss. I will also talk about the main themes or the major questions that should be addressed in the Research Statement and the Teaching Statement. I hope to at least mention a few words about writing good cover letters. This talk will be somewhat of an overview with a presentation of the basic ingredients one should always have in each of these documents. And I plan to have a few examples of these things as handouts for us to discuss and peruse. Questions and discussion during the talk will be welcome.

Math Seminars
Neurotransmitter Dynamics: Model meets Experiment
Dr. Emily Stone - Department of Mathematics, University of Montana
When: Thursday, April 06, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: In this talk I will describe progress toward modeling the dynamics of fast excitatory signaling in neurons in the central nervous system using a dynamical systems approach. The study of the dynamics of neurotransmitters in the synaptic cleft of such neurons is crucial to the understanding of brain function and neuronal organization, specifically memory and learning. On a molecular level synapses adapt to reflect the history of received action potentials, a phenomenon known as synaptic plasticity. Of recent interest in the study of synaptic plasticity is the question of `spill-over", can neurotransmitters released at one presynaptic terminal escape that cleft and eventually trigger a response in neighboring synapses? This phenomena would indicate the possibility of `cross-talk" between neurons, and which up until recently was not thought to exist via this mechanism. Dynamical systems modeling of paired pulse facilitation experiments involving the pharmaceutical blocking of neurotransmitter transporters and
receptors provides a unique method for probing signaling events taking place following neurotransmitter release in the synaptic cleft. This project is in collaboration with Professors Richard Bridges and Micheal Kavanaugh, Dept. of Biomedical and Pharmaceutical Sciences, UM, who study transport systems responsible for mediating the uptake and sequestration of the excitatory neurotransmitter glutamate.

Math Seminars
Introduction to Interval Exchange Transformations: Unique Ergodicity (II)
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Tuesday, April 04, 2006 03:30PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Life Experiences in the Mathematical Sciences: A Panel Discussion
Drs. Steve Cherry, Jack Dockery, Linda Simonsen, and Russ Walker - Department of Mathematical Sciences, MSU
When: Monday, April 03, 2006 04:10PM to 05:00PM
Where: Hurst Conference Room
Details: Did you know that Marcy Barge actually started out in Applied Math? Did you know that Steve Cherry has a MS in Ecology? Do you struggle with who to choose for your advisor or what topic or even trying to figure out which field is right for you? Then this panel discussion is for you! With representatives from each of the Mathematical Sciences in our department, we hope to learn more about their diverse mathematical and life experiences. The discussion will begin with the following three questions: How did you come to choose Math/Applied Math/Math Ed/Stat? (Did you always know you would be a ?) How did you choose your advisor and thesis topic? Where did you go after graduate school? There will be an opportunity to ask other questions of the panel members.

Math Seminars
Introduction to Interval Exchange Transformations: Unique Ergodicity
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Tuesday, March 28, 2006 03:30PM to 04:40PM
Where: Wilson Hall 1-139

Math Seminars
p-adic Numbers
Carl Olimb - Department of Mathematical Sciences, MSU
When: Monday, March 27, 2006 04:10PM to 05:00PM
Where: Hurst Conference Room
Details: Over the last century, p-adic numbers have come to play a central role in modern number theory. The analogy between the fields Qp and R is easily understood and provides helpful information when dealing with a variety of problems. In this talk I will investigate the construction of Qp by completing Q for all of its nontrivial absolute values. Also, the similarities between the two fields Qp and R will be discussed. In particular, work will be done with Hensels lemma and the local/global properties of Hasse-Minkowski Theorem for three indeterminates.

Math Seminars
Computational Homology in Nonlinear Dynamics
Dr. Konstantin Mischaikow - Department of Mathematics, Georgia Tech
When: Thursday, March 23, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Much of the fascination and challenge of studying infinite dimensional nonlinear dynamical systems arises from the complicated spatial and/or temporal behavior that they exhibit. On the mathematical side, this complicated behavior can occur on all scales both in phase space and parameter space. Somewhat paradoxically, from a scientific perspective this points to the need for a coherent set of mathematical techniques that is capable of extracting coarse but robust information about the structure of these systems. Furthermore, since most of our understanding of specific systems comes from experimental observation or numerical simulations, it is important that these techniques can be applied in a computationally efficient manner. Finally, it is important that the experimentally observed patterns be quantified in an efficient manner both for purposes of parameter identification and for modeling purposes. In this talk it will be argued that computational homology has an important role to play in these endeavors.

Math Seminars
Introduction to Interval Exchange Transformations: Minimality
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Tuesday, March 21, 2006 03:30PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Biofilm Modelling
Dr. Jack D. Dockery - Department of Mathematical Sciences, MSU
When: Thursday, March 09, 2006 04:10PM to 05:00PM
Where: Roberts Hall 101
Details: Notice a change in time and place.
A Cranky Calculator, a Loaf of Bread, a Jug of Wine, and the Dark of Night.
Tom Azeredo - Department of Mathematical Sciences, MSU
When: Monday, February 27, 2006 04:10PM to 05:00PM
Where: Hurst Conference Room
Details: In DynaHeavy, rich in serious and wise Humanity, things cosmological are too sacrosanct to even be uttered. We, however, the joblot souls of "DynaLite, being neither particularly serious nor wise, will chitchat in a light (even aberrant) vein over things universal. For those of you who are Monomatheists, and would prefer to get syzygy over your Prym varieties, remember that van der Waerden has asserted the origins of mathematical thought are hopelessly entwined with those of astronomy. Hopelessly. Think about it...

Math Seminars
Arnoux Rauzy Example
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Monday, February 27, 2006 03:30PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Using the Immersed Boundary Method to Simulate Biofilm
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, February 23, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: The immersed boundary (IB) method was a technique introduce by Peskin to compute the complex interaction between (elastic) heart muscle and (viscous) blood flow. It is well suited for use in situations with complicated moving interfaces, e.g. biofilm subject to shear flow. In this talk I will introduce the method in the context of biofilm - bulk flow interaction and describe some (very) preliminary results.

Math Seminars
Dynamics of a Simple Regulatory Switch
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, February 16, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: I will discuss dynamics of a regulatory switch, which occurs in multiple eukaryots. The main example we study is a switch for the NCR circuit in yeast. In addition to the earlier results presented in this seminar last spring, I will show that all solutions of the periodically forced delay equation model converge to unique periodic orbit with period equal to the period of the forcing.

Math Seminars
Math Seminars

Type Problem for Riemann Surfaces III
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Tuesday, February 14, 2006 03:30PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars

The Rauzy Fractal and Friends (in a full moon night).
Adrian Soto - Department of Mathematical Sciences, MSU
When: Monday, February 13, 2006 04:10PM to 05:00PM
Where: Hurst Conference Room

Details: People often wonder what dynamical systems are, and we answer back with pretty pictures like the Mandelbrot set or the Sierpiensky triangle. I will focus in some examples of fractals that arise in Substitutions. The talk will be rather simple and will require nothing more than a little bit of geometry. I hope to provide enough material so that the audience can play around with some ideas. There will be some overlap with the talk Mark Campanelli gave a while ago. For the Literate these are the key words: Tiling spaces, Rauzy Fractal, iterated function systems and of course, strands. By the way, this dinolite day will have a beautiful full Moon for your valentine...

Math Seminars

Convergence of Solutions for a Nonlocal Dispersal Model
Dr. Wendy Hines - Department of Mathematics, University of Nebraska
When: Thursday, February 09, 2006 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Details: We consider a model for dispersal from Hutson, Martinez, Mischaikow and Vickers

\[ u_t = \rho \left( \int \beta(x,y)u(y) \, dy \right) - u(x) + (a(x)-u)u \]

We would like to determine what sort of equilibria are possible and what the stability properties of the equilibria are. This is quite difficult in general and so we do it for the special case \( \beta \equiv 1 \). For that case, we describe the equilibria completely, prove that each solution converges to a single equilibria, and determine stability of the equilibria. We then discuss the difficulties in doing this for the general case.

Math Seminars

Type Problem for Riemann Surfaces II
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Tuesday, February 07, 2006 03:30PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars

The Borrowing Problem and its potential as a cryptography scheme
Luke Shorty - Department of Mathematical Sciences, MSU
When: Monday, February 06, 2006 04:10PM to 05:00PM  
Where: Hurst Conference Room  
Details: I’d like to share with you all a little problem I encountered three years ago. It involves simple arithmetic of whole numbers placed on the vertices of polygons. At least that's how it started. I'll give you a general example and explanation of the problem on an n-gon and then talk about the borrowing problem on n-dimensional simplex. If there is enough time remaining, we will touch on the potential use of this problem as a cryptography scheme. You’ll Laugh, You’ll Cry, It'll be better than Cats. PS We may solve world poverty as well if all goes right.

Math Seminars  
Transition to Turbulence, Small Disturbances, and Sensitivity Analysis  
Dr. John Singler - Postdoctoral Fellow, Mechanical Engineering, Oregon State University and Department of Mathematical Sciences, MSU  
When: Thursday, February 02, 2006 03:10PM to 04:00PM  
Where: Wilson Hall 1-139  
Details: Predicting transition to turbulence is one of the longstanding problems in fluid mechanics. Recently, new transition scenarios have been proposed that are based on the sensitivity of the linearized equations of motion with respect to small disturbances. These new "mostly linear" theories have increased our understanding of the transition process, but the role of nonlinearity has not been explored. In this talk, we analyze the impact of small disturbances on the transition process in nonlinear flow systems. We demonstrate using model problems that small forcing or small wall roughness can cause transition. Sensitivity analysis is used to predict the behavior of the disturbed problems. We also use sensitivity analysis on a general nonlinear flow system to show that small disturbances can trigger transition when the linearized operator is non-normal.

Math Seminars  
Type Problem for Riemann Surfaces I  
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU  
When: Tuesday, January 31, 2006 03:30PM to 05:00PM  
Where: Wilson Hall 1-139

Math Seminars  
Teaching College Math for Understanding: Without Sacrificing Procedural Skill  
Jon Hasenbank - Department of Mathematical Sciences, MSU  
When: Monday, January 30, 2006 04:10PM to 05:00PM  
Where: Hurst Conference Room  
Details: This talk will focus on the use of an instructional method that can help college algebra students (as well as more advanced students) develop an understanding of the
mathematics procedures they study. The teaching method is based on a framework of student-oriented questions designed to prompt students (and instructors) to consider the connectedness of mathematics topics as they learn (and teach). While my core results are still being triangulated with other data sources, the early evidence suggests that it is possible to teach in a way that promotes students understanding without hurting their performance on skills-oriented common hour exams.

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**Math Seminars**

**A Variational Approach to Video Segmentation for Biological Data**

Aaron Luttman - Department of Mathematical Sciences, University of Montana

**When:** Thursday, January 26, 2006 03:10PM to 04:00PM

**Where:** Wilson Hall 1-139

**Details:** In order to engage in photosynthesis, leaves use pores in their surface - called stomata - to take in CO2. The opening of these pores results in the evaporation of H2O, which is a detriment to photosynthesis. Thus a leaf is faced with the optimization problem of maximizing CO2 intake while simultaneously minimizing H2O loss across the entire leaf. In order to visualize CO2 intake, a dye is injected into a leaf so that it fluoresces when closing its stomata. Understanding how leaves locally solve the CO2gain/H2O-loss global optimization problem requires a thorough analysis of the fluorescence patterns seen in experimental videos. Using an a priori background model to drive video segmentation, we propose a method based on the "active contours without edges" approach of Chan and Vese for segmenting a video sequence in 3D into a multiply-connected region of active fluorescence and its complement. The associated partial differential equations are solved within a level-set framework using a three-dimensional semi-implicit numerical scheme.

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**Math Seminars**

**Professional Development: Interview Process, Starting a Job, Getting Tenure**

Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU

**When:** Monday, January 23, 2006 04:10PM to 05:00PM

**Where:** Hurst Conference Room

**Details:** I will walk you through the some issues related to transition from being a grad student to getting a job and then holding that job. I will talk about different expectations of various schools and expectations your future academic employer may have about your research, teaching and service. I will also, if time permits, talk about federal grants to support your research.

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**Math Seminars**

**Mathematical Epidemiology Models**

Jesse Berwald and Christina Hayes - Department of Mathematical Sciences, MSU

**When:** Thursday, January 19, 2006 03:10PM to 04:00PM
Details: We will provide a synopsis of four models used to analyze the spread of epidemics in populations. Approaches range from computer-intensive discrete graph theoretic models to more traditional probabilistic/DE models. This is an overview talk and is accessible to all students.

Math Seminars
Peano to Pi
Jesse Berwald - Department of Mathematical Sciences, MSU
When: Saturday, December 10, 2005 04:30PM to 05:10PM
Where: Hurst Conference Room
Details: A construction of the real numbers from Peano's Axioms. Because it's good for you.

Math Seminars
Rotation Sets for Skew Products (part II)
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, December 09, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
A Personal Approach to the Treatment of Disease
Nick Alonso - Department of Mathematical Sciences, MSU
When: Wednesday, December 07, 2005 04:30PM to 05:20PM
Where: Hurst Conference Room
Details: I will discuss the treatment of a variety of common illnesses such as colds, flus, digestive and urinary problems, and diabetes and cancer using herbs, vitamins and foods. I'll also consider the legend of Professor Li Chung Yun (1677-1933), ORAC values, and what might be tried when orthodox medicine fails.

Math Seminars
Rotation Sets for Skew Products
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, December 02, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Traveling Wave Phenomena in Pancreatic Islets
Heather Moreland - Department of Mathematical Sciences, MSU
When: Thursday, December 01, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: There is experimental evidence of wavefronts in the electric potential and calcium concentration in the Islets of Langerhans in the pancreas. One biophysical model for this behavior is quite complicated. We present a phenomenological model that exhibits the same bifurcation structure. For this model, numerical continuation methods support the existence of wavefronts for some sets of parameters (calcium concentration and wave speed). Subsequent numerical integration of the original PDE model suggests that some wavefronts are stable while others are unstable. These preliminary results and future directions will be discussed.

Math Seminars
Glacial Lake Missoula, a First Attack
Cody Custis - Department of Mathematical Sciences, MSU
When: Wednesday, November 30, 2005 04:30PM to 05:20PM
Where: Hurst Conference Room
Details: Cody will give a presentation about Glacial Lake Missoula, the topic of his writing project. Glacial Lake Missoula was a phenomenon that happened during the ice age, when ice dams on the Clark Fork River would cause the Missoula valley to fill with water. These ice dams would catastrophically fail, resulting in a torrent of water pouring over Eastern Washington. One important question is how many times Glacial Lake Missoula occurred. Guesses range from one into the seventies. The goal of the Glacial Lake Missoula project is to test the compatibility of different hypotheses with the available data on the process. However, due to the complexities of geology, finding a realistic estimate of the number of times Glacial Lake Missoula occurred is far more difficult than simply counting waterlines or layers of mud. This presentation will summarize the work done so far on the project, along with some of the goals, methods, and difficulties in estimating the number of occurrences of Glacial Lake Missoula. No statistical background beyond that found in a Liberal Arts math course is needed.

Math Seminars
Derivatives of Partial Correlation Coefficients
Ben Haaland - Department of Mathematical Sciences, MSU
When: Wednesday, November 30, 2005 03:10PM to 03:40PM
Where: Wilson Hall 1-143

Math Seminars
Introduction to Geometric Coincidence Conjecture (part III)
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, November 18, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Math Seminars
Implicit-Explicit Schemes for Large Eddy Simulation
Dr. Faranak Pahlevani - Department of Mathematical Sciences, MSU
When: Thursday, November 17, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: One of the most important aspects in approximating the solution of nonstationary PDEs is the type of applied time discretization scheme. In this presentation, we introduce a combination of implicit and explicit methods using one and two time steps for a subgrid eddy viscosity model and its sensitivity equation, obtained by differentiating the model with respect to the eddy viscosity parameter. The stability and convergence of the numerical scheme for the system of equations are proved using the finite element method. We also discuss the application of the sensitivity analysis in improving the flow functionals and provide numerical assessments to justify our theoretical results.

Math Seminars
Prerequisite knowledge for the learning of algebra
Rachael Welder - Department of Mathematical Sciences, MSU
When: Wednesday, November 16, 2005 04:30PM to 05:20PM
Where: Hurst Conference Room
Details: Researchers, teachers, and curriculum experts have noted content areas believed to contribute to students' abilities to succeed in algebra. Specifically, the Southern Regional Education Board (SREB) produced a list of 12 algebra-specific skills, Readiness Indicators, which classify the prior knowledge necessary for success in Algebra I (Bottoms, 2003). The list was developed by mathematics education experts, but not based upon research. Therefore, the current investigation explores similarities and differences between the relevant research and the Readiness Indicators. Research indicates that prior to learning algebra, students must have an understanding of numbers, ratios, proportions, the order of operations, equality, algebraic symbolism (including letter usage), algebraic equations and functions. These results partially, if not fully, support 8 of the 12 Readiness Indicators.

Math Seminars
Modeling Antibiotic Resistance in Biofilms
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, November 10, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: A Biofilm is a dense aggregation of microorganisms that are embedded in a hydrated polymer matrix. Biofilms often show antibiotic resistance. Four hypothetical resistance mechanisms will be incorporated into a model of biofilm formation and model behavior will be analyzed. The four mechanisms address retarded antibiotic penetration,
reduced metabolic activity or growth in parts of the biofilm due to local nutrient
depletion, stress response activation by some biofilm bacteria, and differentiation of
some biofilm cells into a dormant persister state analogous to spore formation.

Math Seminars
Cantor sets and Markov partitions
Adrian Soto - Department of Mathematical Sciences, MSU
When: Wednesday, November 09, 2005 04:30PM to 05:20PM
Where: Hurst Conference Room
Details: Can we make a path out of dust? Can we glue threads and make them solid?
Can we make the dust behave like the discrete waves in the ocean? Maybe. In this talk I
will introduce Cantor sets, which are like "compact dust", and the notion of "behave
like". I will show that anything "solid" can be made out of "compact dust". Given "an
ocean", we will explain that sometimes there is a way to break "The ocean" into pieces
the "Markov partition"- in such a way that we can teach our dust to "behave like" the
"discrete waves of the ocean". I will also try to understand with you why tilings spaces
have so much to do with this. For the literate, we will discuss: Cantor sets,
semiconjugacies, discrete dynamical systems, Markov partitions, Substitutions and tiling
spaces. We probably even toss some upper semi-continuous decompositions. It seems
I can't escape from the pretty pictures (I hope). I hope you'll like it. Peace. Adrian

Math Seminars
Introduction to Geometric Coincidence Conjecture (part II)
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, November 04, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Correspondence Maximization: Mathematics Behind the Magic of
Arathorn
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, November 03, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: I will review results related to mathematical understanding of the performance
of David Arathorn's algorithm. The algorithm was introduced in talk on October 20th, but
this talk will be independent and self-contained.

Math Seminars
An Introduction to Modelling Spread of Contagious Disease
Christina Hayes - Department of Mathematical Sciences, MSU
When: Wednesday, November 02, 2005 04:30PM to 05:20PM
**Details:** I will present some simple models used in mathematical epidemiology to study the spread of diseases such as smallpox, typhoid fever, and influenza. Assuming only basic understanding of what a derivative is, I will present a qualitative analysis of the SIR model. We will attempt to address such questions as: What is the final size of the epidemic? What proportion of the population escapes the epidemic? How long will the epidemic last? For the SIR model in particular, we will use parameter values associated with the Hong Kong flu outbreak which occurred in New York City -- in the late 1960s.

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**Math Seminars**

**Introduction to Geometric Coincidence Conjecture**

Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU  
*When:* Friday, October 28, 2005 03:10PM to 05:00PM  
*Where:* Wilson Hall 1-139

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**Math Seminars**

**A Covariance-Preconditioned Iterative Method for Nonnegatively Constrained Image Reconstruction**

Dr. John Bardsley - Department of Mathematics, University of Montana  
*When:* Thursday, October 20, 2005 03:10PM to 04:00PM  
*Where:* Wilson Hall 1-139  
**Details:** I will motivate from physical considerations a nonlinear iterative method for image restoration. Statistical considerations will lead to a connection between this method and the Richardson-Lucy iteration, which is often used in astronomical imaging. The importance of the incorporation of nonnegativity constraints and the corresponding effect on the conditioning of the underlying model will also be discussed.

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**Math Seminars**

**Graduate Teaching Assistants: Past, Present, and Future**

Christine Latulippe - Department of Mathematical Sciences, MSU  
*When:* Monday, October 17, 2005 05:00PM to 05:50PM  
*Where:* Hurst Conference Room  
**Details:** The university mission at many institutions involves providing quality undergraduate education. Given that graduate teaching assistants are responsible for a large portion of this mission, it is important to closely examine factors that seem to influence graduate teaching assistants' effectiveness in the classroom. For my dissertation, I am working to collect data from universities about teaching support structures in place for math TAs, and I am also collecting survey data from math TAs about their attitudes toward teaching and their perceptions of the support for teaching in their department. In my talk, I will be sharing a snapshot of who TAs are and what
research has been done on them in the past. I will also be talking about the fun and adventurous world of surveys!

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Math Seminars

5 Probabilistic Pieces: The Easy, The Queasy, The Sleazy
Tom Azeredo - Department of Mathematical Sciences, MSU
When: Monday, October 17, 2005 04:30PM to 05:20PM
Where: Hurst Conference Room
Details: Probability is a field where there aint no close link between how hard seems a problem and how hard it really is. Well discuss 5 problems which may be illustrative, even illuminating, or even, God forfend, interesting. (But not profitable. For that, try Lucky Lil.) Problems worthy of attack prove their worth by hitting back. -- Piet Hein

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Math Seminars

Map-seeking: From Cortical Theory to Inverse-Problem Method
David Arathorn - General Intelligence Corp. and Center for Computational Biology, MSU
When: Thursday, October 13, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: The map-seeking circuit (MSC), in both algorithmic and neuronal/analog circuit incarnations was devised to address the problem of transformation discovery inherent in machine and biological vision. During the last few years the general applicability of the method to various classes of inverse problems has become more apparent. Most recent focus has been on classes of problems which require concurrent solution in multiple domains or problem spaces, for which a minor variant of the original MSC provides an elegant solution. These include both "brain-instinctual" tasks and "brain-taxing" problems, and a preliminary insight into the difference will be discussed.

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Math Seminars

Model Development and Nonlinear Optimal Control Design for Nonlinear Smart Material Systems
Dr. Ralph C. Smith - Department of Mathematics, North Carolina State University
When: Thursday, October 06, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: High performance transducers utilizing piezoceramic, electrostrictive, magnetostrictive or shape memory elements offer novel control capabilities in applications ranging from flow control to precision placement for nanoconstruction. To achieve the full potential of these materials, however, models and control designs which accommodate the constitutive nonlinearities and hysteresis inherent to the compounds must be employed. In this presentation, the speaker will discuss recent advances in the development of nonlinear optimal control designs for high drive applications. Examples will be drawn from problems in high speed milling, deformable mirror design, artificial
muscle development, tendon design to minimize earthquake damage, and atomic force microscopy.

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**Math Seminars**

**Bimorph Deformable Mirrors for Correcting Aberrations of Human Eyes**  
Dr. Qiang Yang - Department of Mathematical Sciences, MSU  
**When:** Thursday, October 06, 2005 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-139  
**Details:** In this presentation a low-cost large-stroke small-aperture bimorph deformable mirror is introduced into the adaptive optics system for the correction of human-eye aberrations. Correction ability of the physical bimorph mirror is analyzed to match the requirements of eye aberrations. An optimized control scheme for the bimorph mirror is presented as a consequence of its limited correction ability. Simulation results are presented for the correction of eye aberrations based on a proposed physical bimorph deformable mirror.

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**Math Seminars**

**Topographic Prominence and Surface Networks**  
Andy Bouwman - Department of Mathematical Sciences, MSU  
**When:** Wednesday, October 05, 2005 04:30PM to 05:20PM  
**Where:** Hurst Conference Room  
**Details:** Topographic prominence is a relatively new way of thinking about the "importance" of mountains, rather than just using raw elevation. Calculating prominence became easier with the use of discrete elevation models, and the development of surface networks, which essentially boil topographies down to their basic components for analysis. In my talk I will define several relevant terms, introduce the components of surface networks, and discuss how math shows up even in such an outdoorsy activity as mountain climbing. There will even be some pretty pictures!

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**Math Seminars**

**A Novel Method for Characterization and Prediction of Nonlinear Systems**  
Dr. Graham Cummins - Center for Computational Biology, MSU  
**When:** Thursday, September 29, 2005 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-139  
**Details:** A common mathematical problem in engineering and the applied sciences is to create a simple model that duplicates or predicts the input/output relation of a physical system. This sort of model is phenomenological, not mechanistic, and is used to predict or control the system, or to simulate the contribution of that system to a more complex model, rather than to explain the function of the system. Robust and effective techniques for developing these models are available in electrical engineering and other disciplines. In the biological sciences, however, systems are often highly non-linear, noisy, have very inputs, are non-stationary, or are hard to measure for a long enough
period of time. Often, these complexities prevent classical system identification methods from yielding satisfactory results. I have developed a modeling method that performs better than existing methods of equivalent computational complexity on a class of event prediction tasks used in neuroscience. This technique uses principal component analysis to augment a pattern matching model. I present the technique, an example application of the technique (prediction of the response of a sensory neuron to white noise stimuli), and several possible refinements of the technique that I am currently testing in an attempt to make this approach effective for a wider variety of problems.

Math Seminars

What do I need to know about attending a conference?
Joe Latulippe - Department of Mathematical Sciences, MSU
When: Wednesday, September 28, 2005 04:30PM to 05:20PM
Where: Hurst Conference Room
Details: In this informative talk we will explore many aspects dealing with attending conferences. We will discuss some funding opportunities and the different roles that graduate students can play at conferences. We will also look into what grads can expect, and what they can prepare for while attending a conference. All claims will be in large supported by personal experience.

Math Seminars

Combining Sensitivities and Optimal Control for Design Techniques related to Micro Air-Vehicle (MAV) Applications Dr. Lisa Davis - Department of Mathematical Sciences, MSU
When: Thursday, September 22, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: In the context of modelling, analysis, design and control of physical systems, the behavior of state variables such as velocity, temperature, pressure, concentrations, etc are often influenced by parameters that appear in the mathematical models. Sensitivity analysis is a mathematical tool which seeks to answer the question of how small changes in parameter values might affect the behavior of the state variables. From the standpoint of numerical analysis, the sensitivity information can be used for a variety of tasks including gradient information for an optimization algorithm, design variable prioritization and model uncertainty analysis. During the course of this talk, I will give an overview of my research program which currently centers around the use of sensitivity information for the optimal placement of sensors and actuators for control systems. The ideas will be discussed in the context of a couple of examples including that of an Euler-Bernoulli beam, an LES model for approximation of Navier Stokes flows as well as the placement of cilia sensors on MAV wing.
Referential Sentences
Luke "Eats His Chia Pet" Shorty - Department of Mathematical Sciences, MSU
When: Wednesday, September 21, 2005 04:30PM to 05:20PM
Where: Hurst Conference Room
Details: In this informative talk we will explore many aspects dealing with attending conferences. We will discuss some funding opportunities and the different roles that graduate students can play at conferences. We will also look into what grads can expect, and what they can prepare for while attending a conference. All claims will be in large supported by personal experience.

Math Seminars
Smooth Siegel Disks (part II)
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Friday, September 16, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Smooth Siegel Disks
Dr. Lukas Geyer - Department of Mathematical Sciences, MSU
When: Friday, September 09, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Modelling, Simulation, and Control of MEMS Deformable Mirrors
Dr. Curt Vogel - Department of Mathematical Sciences, MSU
When: Thursday, September 08, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: MEMS stands for Micro Electo Mechanical Systems. We'll briefly discuss the application of MEMS devices for deformable mirrors in adaptive optics. Then we'll introduce a mathematical model, involving a coupled system of nonlinear 4th order PDEs, for a particular MEMS mirror. We'll go through the details of non-dimensionalization, model reduction, and numerical discretization that are required for realistic simulations. Finally, we'll present some simulation results and, if time allows, we'll talk about an interesting nonlinearly constrained quadratic optimization problem that arises in the control of these devices.

Math Seminars
A Comparison of Methods for Estimating the Causal Effect of a Treatment in Randomized Clinical Trials Subject to Noncompliance
Dr. Roderick Little - Department of Statistics, University of Michigan
When: Monday, August 29, 2005 04:10PM to 05:00PM
Where: Wilson Hall 1-142
Details: We consider the analysis of clinical trials that involve randomization to an active treatment (T = 1) or a control treatment (T = 0), when the active treatment is subject to all-or-nothing compliance. We compare three approaches to estimating the causal effect of the treatment in this situation: as-treated analysis, per-protocol analysis, and instrumental variable estimation (IV), where the treatment effect is estimated using the randomization indicator as an instrumental variable. Both model-based and method-of-moment based IV estimators are considered. The assumptions underlying these estimators are assessed, standard errors and mean squared errors of the three estimates are compared, and design implications of the three methods are examined. Extensions of the methods to include observe covariates are then discussed, emphasizing the contrasting role of covariates in these extensions.

Math Seminars
Regularized Stokeslets for Biological Flow Simulations
Dr. Ricardo Cortez - Mathematics Department, Tulane University
When: Tuesday, August 02, 2005 01:10PM to 02:00PM
Where: Wilson Hall 1-139
Details: The method of regularized Stokeslets gives a way to compute solutions to the Stokes equations of fluid motion without singularities. This give, for example, a bounded velocity for flows generated by a single force. The method can be used to model flows induced by external forces such as those exerted by flagella, cell bodies or other microorganisms. The method of images can also be applied for flows near a wall. In this informal talk, I will introduce the method and some of its properties, and I will show sample computations related to biology.

Math Seminars
Rigorous Pseudo-Arc-length Continuation for PDE
Jean-Philippe Lessard - Georgia Institute of Technology
When: Thursday, July 28, 2005 02:10PM to 03:00PM
Where: Hurst Conference room
Details: In this talk, I will introduce a rigorous numerical method to continue the equilibria of dissipative parameter dependent partial differential equations. This method is based on a standard finite dimensional path-following algorithm adapted to the infinite dimensional case. A theorem of existence and uniqueness for the equilibria branches of the original PDE will be presented as well as a discussion on the computational cost of the method.

Math Seminars
Adaptation of Biofilms in the Presence of Antimicrobials
Barbara Szomolay - Department of Mathematical Sciences, MSU
When: Thursday, April 28, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: There is mounting evidence that bacterial biofilms actively respond to antimicrobial challenges. This active response is a lot more effective than in the planktonic populations. Even cells in deeper regions of the biofilm are able to enter a resistant state if the time scale for adaptation is faster than that for disinfection. A mathematical model without growth terms will be presented and the qualitative properties of its solutions will be discussed. We will also introduce a more complicated model with added growth and detachment and will point to its possible applications in the control theory.

Math Seminars
A Brief Introduction to Kleinian Groups: Dynamics and Pretty Pictures
Ann Peterson - Department of Mathematical Sciences, MSU
When: Monday, April 25, 2005 05:10PM to 06:00PM
Where: Wilson Hall 2-244
Details: Kleinian Groups offer a beautiful introduction to studying symbolic dynamics, tiling spaces, fundamental regions of surfaces, and more. The limit sets of Kleinian groups are most often fractal - which means pretty pictures (the "Ooo Aww" factor). We'll look at a subset of such groups called quasi-Fuchsian groups: free groups on two generators whose limit sets form closed curves. Most of the basis for this expository presentation will be from the book, Indra's Pearls by David Wright, Caroline Series, and David Mumford. So we'll mix a little mysticism (why the name "Indra's Pearls"), artistic expression (bring your own crayons), and mathematics to wrap up the DynaLite season.

Math Seminars
Dualization of Multigrids According to de Bruijn
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, April 22, 2005 03:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Hyperbolic Fixed Points are Typical in the Space of Mixing Operators for the Infinite Population Genetic Algorithm
Christina Hayes - Department of Mathematical Sciences, MSU
When: Thursday, April 21, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: We study an infinite population model for genetic algorithm, where the iteration of the algorithm corresponds to an iteration of a map G. The map G is a composition of a selection operator and a mixing operator, where the latter models effects of both
mutation and crossover. We examine the hyperbolicity of fixed points of this model. We show that for a typical mixing operator all the fixed points are hyperbolic.

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**Math Seminars**

**What is the Statistical Meaning of the Geometrical Connection**

Thomas Azeredo - Department of Mathematical Sciences, MSU  
**When:** Tuesday, April 19, 2005 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-142  
**Details:** The "Connection" is a classical tool of geometry, a differential operator that allows us to relate a vector field on a manifold with its curvature. Starting from spaces where the Fisher Information is the Riemannian metric we will follow Amari's construction of a "natural" family of connections (the "alpha" connections). Once achieved, we have then available a complete definition of a "Statistical Manifold", as well as insight as to why its geometry is not Riemannian. Time permitting, and only if time permits, there will be discussion of the "duality" properties that flow from the alpha connection. These have fascinating links with "statistical divergences," which will be explored in a future talk.

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**Math Seminars**

**Construction and Operation of Magnetoplasma-dynamic Thrusters**

Nick Alonso - Department of Mathematical Sciences, MSU  
**When:** Monday, April 18, 2005 05:10PM to 06:00PM  
**Where:** Wilson Hall 2-244  
**Details:** Magnetoplasma-dynamic (MPD) thrusters have figured prominently in the conceptual design of several proposed space vehicles. An MPD thruster's ability to convert megawatts of electric power into directed thrust makes this technology a prime candidate for deep space robotic and piloted planetary exploration missions as well as for economic delivery of lunar and Mars cargo. As large amounts of power become available in space, MPD thrusters may become the technology that carries humans to other planets in our solar system and beyond. I will present a general overview of MPD thrusters, their construction and operation with a plethora of pleasing pictures and end with a look at a mathematical model of thruster plasma dynamics and some prospects for the future.

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**Math Seminars**

**Singular Perturbation Problems Done Right: Combination of Numerics and the Conley Index Theory**

Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU  
**When:** Thursday, April 14, 2005 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-139  
**Details:** I will first review some archetypical singular perturbation problems and explain why these problems are important and where the difficulties lie, when one wants to
prove the existence of particular solutions. I will then show how the use of numerical and Conley index techniques can make this process relatively painless. I will conclude with showing that the Garder-Smoller example, which models interaction between two species (with diffusion included) admits an uncountably many travelling waves that form a topological horseshoe. (This is joint work with H, Kokubu, H. Oka, K. Mischaikow, M. Gameiro and B. Kallies)

Math Seminars

Transitions to a New State
Cody Custis - Department of Mathematical Sciences, MSU
When: Monday, April 11, 2005 05:10PM to 06:00PM
Where: Wilson Hall 2-244
Details: This presentation will introduce the listener to basic Markov chains and transition matrices and their uses. It will also introduce some of the more interesting concepts such as absorbing states, periodicity, and equilibrium probability. Markov chains are a special type of stochastic process where the probabilities of future states depend only on the current state. The goal is not to present advanced topics in stochastic processes, but simply to familiarize the audience with transition matrices, their main properties, and give some examples of where they are useful. It also includes some famous examples, including the drunkard's walk, gambler's ruin and a surprising paradox in sequences of coin flips. Depending on time constraints, applications to game theory may appear. No specialized knowledge in probability and statistics is required, beyond that which would be taught in a finite mathematics course. However, familiarity with matrix operations is helpful and understanding of eigenvectors is necessary to understand the steady state solutions to a transition matrix.

Math Seminars

Individual Based Modelling of Multispecies Biofilms: Algorithms and Applications
Dr. J. B. Xavier - Visiting Postdoc at the Center for Biofilm Engineering, MSU
When: Thursday, April 07, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: In the present day, sophisticated 2D/3D biofilm models include first-principle based descriptions of several processes involved in biofilm formation: attachment of cells to a surface, growth, diffusion and reaction of solutes throughout the biofilm matrix, production of extracellular polymeric substances (EPS), biomass detachment resultant from shear stress, etc. The latest generation of multidimensional models allows the description of multispecies biofilms, at the same time including any number of solute species (e.g. carbon source, dissolved oxygen, soluble metabolites, etc.) reacting. In this talk, the newest advances on biofilm modelling carried out at Technical University of Delft will be presented, with emphasis on the individual based modelling of multispecies biofilms. Case studies will be shown, illustrating how modelling provides surprising insight into many aspects of biofilms, including: + The relationship between biofilm
structure and its activity + The occurrence of sloughing, i.e. losses of large amount of biomass from a biofilm + Reproducibility of the biofilm structure + Competition and cooperation between microbial species in multispecies biofilms + The role of the EPS matrix and of internal storage compounds See also our "BIOFILM MODELING AT THE TU DELFT" web page at: http://www.biofilms.bt.tudelft.nl/

Math Seminars
Combinatorial Generating Functions or How to Count Using Polynomials
Dr. John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, April 05, 2005 04:10PM to 05:00PM
Where: Wilson Hall 1-142
Details: The concept of a combinatorial generating function is introduced. These generating functions are useful (and actually quite simple tools) for handling constraints in combinatorial problems involving selection and arrangement, and can be applied to a wide variety of counting problems. Nine examples (if time permits) will be presented. For example, have you ever wondered or lost sleep trying to determine how many ways can you distribute \( R \) identical objects into five distinct boxes with an even number of objects not exceeding 6 in the first two boxes and between 3 and 5 in the other three boxes? If you have, you need to come to this seminar. Because these generating functions are based on products of polynomials, little mathematical background is required. It is the very simplicity of generating functions that make them so useful.

Math Seminars
Fermat: An Adequate and Refractory Mathematician
Tom Azeredo - Department of Mathematical Sciences, MSU
When: Monday, April 04, 2005 05:10PM to 06:00PM
Where: Wilson Hall 2-244
Details: Although Fermat is remembered today primarily for his number theory, in particular his "Last Theorem", his major work was in the development of a theory of maxima and minima and its uses in the questions on "tangents and quadratures". This was a substantially geometric form of "protocalculus", whose binding thread, in work spanning three decades, was the idea of Adequation. This idea originated with Diophantus, and in Fermat's hand evolved into an analytic process, bearing some analogy to the derivative, that permitted the achievement of many original results, including one akin to the Fundamental Theorem of Calculus. After sketching out a small and particular portion of the above, our focus in this talk will be on the difference between Fermat and Descartes as to the speed of light, on their clashing views as to the relation between mathematics and nature, and on their heated dispute as to Descartes' argument for Snell's "Law of Refraction". Before its resolution, or passing, this dispute was to see Fermat set out his Principle of Least Time as well as the first (and last) significant application of the Adequational Calculus to an important physical problem. Our goal will be to see what this meant. Finally, there will be consideration
given to the larger context of this dispute; for Fermat, for his contemporaries, and for the rise of a mathematical physics.

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**Math Seminars**

**Covering Torus Endomorphisms**

Dr. Marcy Barge - Department of Mathematical Sciences, MSU  
When: **Friday, April 01, 2005 03:10PM to 05:00PM**  
Where: Wilson Hall 1-139

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**Math Seminars**

**The Dirichlet Problem for Elliptic Equation with Drift Terms**

Dr. Martin Dindos - Brown University  
When: **Thursday, March 31, 2005 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139  
Details: Let $\Omega \subset \mathbb{R}^n$ be a "nice" domain. Assume that $(a_{ij}(x))$ is a positive definite (not necessary symmetric) matrix valued function and $(b_i(x))$ be a first order vector. We want to study Dirichlet problem $(D_p) \text{ in } L^p \text{ } Lu = \sum \partial_i(a_{ij}\partial_j u) + \sum b_i \partial u = 0 \text{ in } \Omega \text{ } u = f \text{ in } L^p \text{ on the boundary}$ It is a well known fact that the assumption that the coefficients $(a_{ij})$ are bounded is not sufficient for solvability of this equation for any $p < \infty$. On the other hand if both $a_{ij}$, $b_i$ are smooth, the solvability in any $p>1$ is easy. In the talk we will present "optimal" conditions on the matrix $a_{ij}$ and $b_i$ for the solvability. It turns out that these conditions are just barely better than $L^\infty$ (boundedness). Inside $\Omega$ they just mean that the coefficients are bounded, but near boundary they require a tiny bit more for the whole thing to work.

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**Math Seminars**

**Does it really matter what you do? Homework, Quizzes, and Student Motivation.**

Jon Hasenbank - Department of Mathematical Sciences, MSU  
When: **Monday, March 28, 2005 05:10PM to 06:00PM**  
Where: Wilson Hall 2-244  
Details: I will provide a brief overview of some of the literature pertaining to math students' motivation. Then I'll tell you what six of my students told me about their own motivation. Specifically, I'll tell you what I learned by interviewing six of my former Calc III students about the role that my homework and quiz policies played in motivating them to prepare for class. Not surprisingly, the students told me they appreciate the flexibility to select study habits that fit their own learning styles and goals. However, most felt it was important for their math instructors to provide them with some form of incentive to help them keep on track. I'll discuss how these students felt about regularly having their homework graded, and I'll share what they told me about the effects of having weekly quizzes based on the homework. I will also share some informal data
from a group of "Language of Math" students that suggest that motivational factors may vary with the mathematical ability level of the students. If time allows, I will also draw a pretty picture of the Markov partition Veronica talked about, and if I'm in the mood I might even tell you a stupid joke that I made up about Markov partitions.

**Math Seminars**

**Gradient Computations of Multilinear Functions Arising in Discrete Optimization Problems**  
Shaun Harker - Department of Mathematical Sciences, MSU  
When: **Thursday, March 24, 2005 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139  
Details: David Arathorn offered a technique for approaching certain types of discrete optimization problems he dubbed "Map seeking algorithm". We place this algorithm in the context of standard optimization techniques by showing that it is essentially a projected gradient method applied to a constrained multilinear objective function. Special structure of these problems allows for effective gradient computations. We apply these methods to solving of a Rubik's cube.

**Math Seminars**

**Substitutions and Pretty Stuff**  
Adrian Soto - Department of Mathematical Sciences, MSU  
When: **Monday, March 21, 2005 05:10PM to 06:00PM**  
Where: Wilson Hall 2-244  
Details: I will mention applications of substitutions to Dynamical Systems. I will talk about the Markov partition Veronica talked about, about graphs and how to find the composition of certain graphs via substitutions. All of the above in an understandable way. I will also give examples of substitutions for some tilings. If time allows I will mention intuitive ideas about inverse limits or conjugacy via Markov partitions. There will be a lot of drawings.

**Math Seminars**

**Fourier-domain Preconditioned Conjugate Gradient Method for Atmospheric Tomography**  
Dr. Qiang Yang - Department of Mathematical Sciences, MSU  
When: **Thursday, March 10, 2005 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139  
Details: Multiconjugate adaptive optics (MCAO) systems with $10^4 \sim 10^5$ degrees of freedom have been proposed for future giant telescopes. Using standard matrix methods to compute, optimize, and implement wavefront control algorithms for these systems is impractical, since the number of calculations required to compute and apply
the reconstruction matrix scales respectively with the cube and the square of the number of adaptive optics degrees of freedom. We introduce a new Fourier domain preconditioned conjugate gradient (FD-PCG) algorithm for atmospheric tomography, and we compare its performance against an existing multigrid preconditioned conjugate gradient (MG-PCG) approach. Numerical results indicate that FD-PCG is as accurate and robust as MG-PCG, but it is from one to two orders of magnitude faster for simulations of atmospheric tomography on thirty meter class telescopes.

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**Math Seminars**

**Employment Opportunities at Pacific Northwest National Labs**

Dr. Thomas Ferryman - Pacific Northwest National Labs, Richland WA  
When: **Tuesday, March 08, 2005 04:10PM to 05:00PM**  
Where: Wilson Hall 1-142

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**Math Seminars**

**The Evolution of Discrete Dynamical Systems**

Christina Hayes - Department of Mathematical Sciences, MSU  
When: **Monday, March 07, 2005 05:10PM to 06:00PM**  
Where: Wilson Hall 2-244  
Details: I will formally define a discrete dynamical system, orbit, fixed point (with classifications attracting, repelling, neutral), and hyperbolic and non-hyperbolic fixed point(s)/maps. We will examine orbits through means of phase portraits and web diagrams. Related to each concept I hope to give simple, yet beautifully illustrative examples that should leave one with a sense of meaning and oneness with the universe. Finally, I will give a real-life "application" by discussing the concepts introduced in the context of genetic algorithms. Disclaimer: This talk may or may not include discussion of the stable manifold theorem.

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**Math Seminars**

**Birkhoff Limits via Perron-Frobenius Operator, the Estimates**

Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU  
When: **Friday, March 04, 2005 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139

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**Math Seminars**

**Modeling On and OFF responses in visual neurons**

Joe Latulippe - Department of Mathematical Sciences, MSU  
When: **Thursday, March 03, 2005 03:10PM to 04:00PM**  
Where: Wilson Hall 1-139  
Details: Certain neurons exhibit an On and Off response when given a light stimulus.
Examples of each of these responses will be given. Using a current balance Hodgkin-Huxley type of equation, a phenomenological model which replicates the On and Off behaviors will be presented. We will investigate the behavior of the model for two different types of stimuli. Analysis and numerical results have already been accomplished in the case of a constant stimulus. We will introduce the effects of a nonconstant stimulus and discuss the direction for analysis and future work to be done. By introducing a non-constant stimulus we can numerically replicate the behavior of two simultaneous stimuli as found by S. Kuffler 1953.

Math Seminars

The Infamous Cat Map (Perhaps...)
Veronica Baker - Department of Mathematical Sciences, MSU
When: Monday, February 28, 2005 05:10PM to 06:00PM
Where: Wilson Hall 2-244
Details: I will do an in-depth study of the infamous cat map and how it pertains to several ideas including: flows on a circle, flows on a torus, Markov partitions, substitutions, mixing and Birkhoff Ergodic Theorem. It will be one continuous example with some vocabulary and ideas, but not a lot of theory. Disclaimer: some or all of these ideas might not be presented.

Math Seminars

Tracking Objects with Applications to Storm Data
Curtis Storlie - Department of Statistics, Colorado State University
When: Thursday, February 24, 2005 04:10PM to 05:00PM
Where: Wilson Hall 1-147
Details: A statistical approach to object tracking is presented which allows for birth, death, splitting and merging of objects. Objects are also allowed to go undetected for several frames. The splitting and merging of objects is a novel addition for a statistically based tracking algorithm. This addition is essential for storm tracking, which is the motivation for this work. The utility of this tracker extends well beyond the tracking of storms however. It can be valuable in other tracking applications that have splitting or merging, such as vortices, radar/sonar signals, or groups of people. The method assumes that the location of an object behaves like a Gaussian Process when it is observable. A Markov State Model decides when the birth, death, splitting, or merging of objects takes place. The tracking estimate is achieved by an algorithm that finds the paths that maximize the likelihood of the assumed model. Some theoretical properties of tracking estimates will also be developed such as sufficient conditions for consistency. The problem of how to quantify the confidence in a tracking estimate is addressed as well. The properties of the proposed method will be demonstrated on simulated data. Finally, the method is applied to the problem for which it was designed, tracking storms from radar reflectivity data.
Math Seminars

Functional Data Analysis for Valley Elevation Cross-Profiles
Dr. Mark Greenwood - Department of Mathematical Sciences, MSU
When: Thursday, February 17, 2005 04:10PM to 05:00PM
Where: Wilson Hall 1-147
Details: Functional data analysis methods including functional cluster analysis and functional linear modeling are discussed. The methods are used to describe the shape of elevation cross-profiles from U and V-shaped mountain valleys in the Himalayas. Typical methods for the analysis of these profiles are discussed in a nonlinear regression framework along with the use of two new model selection criteria. Functional cluster analysis is used to group profiles by shape, with the shape based on the estimated curvature of each profile. Finally, functional linear models are used to explain the variability in the observed shapes of the profiles.

Math Seminars

An Introduction to Discrete Dynamical Systems
Mark Campanelli - Department of Mathematical Sciences, MSU
When: Wednesday, February 16, 2005 01:10PM to 02:00PM
Where: Wilson Hall 2-244
Details: I will begin my talk with the basic ideas of discrete dynamical systems. After a description of what discrete systems are, I will develop a few examples that rely on the renowned Contraction Mapping Principle. This will include Newton's Method for the numerical calculation of roots of an equation, as well as the construction of self-similar (i.e. fractal) objects. The fixed point of a particular type of contractive discrete dynamical system, called an Iterated Function System (IFS), may exhibit fractal geometry. As examples of fractals generated by simple IFS's, I will discuss the infamous Cantor set in 1D, as well as the "Sierpinski gasket" and the beautiful "spleenwort fern" in 2D.

Math Seminars

Bayesian Spatial-Temporal Analysis of Colorectal Cancer Incidence
Song Zhang - Department of Statistics, University of Missouri at Columbia
When: Tuesday, February 15, 2005 01:10PM to 02:00PM
Where: Wilson Hall 1-147
Details: Bayesian semiparametric models are proposed to capture the demographic effects (including gender and anatomic site), spatial effects (county) and temporal effects of colorectal cancer incidence simultaneously. The dependence structure is modeled by the Kronecker product of three components. An intrinsic autoregression prior (IAR(2)), which corresponds to versions of smoothing spline, is implemented to estimate a smoothed nonlinear temporal trend. The gender-site precision matrix is modeled in term of standard deviations and the correlation matrix. Efficient sampling schemes are also discussed. The model is applied to the Iowa SEER colorectal cancer data. This method can be easily adapted to survey data in other areas.
**Math Seminars**

**Bayesian Hierarchical Models in Nest Survival Studies**  
Jing Cao - Department of Statistics, University of Missouri at Columbia  
**When:** Monday, February 14, 2005 03:10PM to 04:00PM  
**Where:** Wilson Hall 1-126  
**Details:** In a typical nest survival study, the data is left-truncated because nests that failed before they would be discovered are not included. Apparent nest survival, defined as the proportion of successful nests in a sample, is often positively biased because nest losses early in incubation are underrepresented. The first Bayesian model we proposed can estimate the age-specific nest survival rate by introducing latent variables to account for the truncation. The model works only for areal data. However, more and more current datasets include nest-specific biological measurements, such as distance to the nearest woody patch, and GPS measurements. We develop a new likelihood function for the point-referenced data and put a hierarchical prior on the multinomial logit transformation of the nest encounter and failure rates, satisfying the constraint that these two sets of rates sum up to one. This model can assess the importance of a wide range of biological covariates, and it provides a chance to study the spatial structure on the point location level. The model is applied to the Missouri Dickcissel Dataset.

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**Math Seminars**

**Forecasting and Updating Traffic Flow**  
Dr. Thomas Bengtsson - Department of Statistics, University of California, Berkeley  
**When:** Friday, February 11, 2005 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-131  
**Details:** The purpose of this project is to track vehicle flow using video recordings of freeway traffic. We currently use a simplified model of flow dynamics based on a cellular automaton model. Our approach is Bayesian and we have developed a sequential sampling algorithm for estimating the most current traffic state. The provided sampling scheme is exact and draws posterior states in real-time as new data arrive. We illustrate our method using the cellular automaton model of Nagel and Schrekenberg (1992). Data assimilation for systems with non-linear dynamics has received much attention in recent literature (e.g., Doucet et al. 2004). Because observations and forecast models are inexact (and because the evolution of the system state may depend sensitively on initial conditions), the true state can never be determined precisely. Our knowledge of the system state can be summarized by the probability density function (pdf) of the state conditional on the observations. In the setting of forecasting and updating traffic flow, representing the pdf present challenges similar to those encountered in atmospheric data assimilation: the state-vector is (extremely) high-dimensional and the system dynamics are patently nonlinear. In addition, the traffic-state is discrete. This talk will focus on the computationally intensive methods used to update (resample) the forecast pdf describing the current traffic flow.
Math Seminars

Multiscale Model Development for Ionic Polymers
Dr. Ralph C. Smith - Department of Mathematics North Carolina State University
When: Thursday, February 10, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: A multiscale modeling approach for predicting material properties of the ionic polymer Nafion will be presented. Following an overview of present and future applications utilizing ionic polymers, rotational isomeric state (RIS) theory will be applied in combination with Monte Carlo techniques to develop a nanoscale simulation model for predicting the conformation of Nafion polymer chains. Probability density functions quantifying chain properties are estimated and combined with energy principles from statistical mechanics to provide macroscale models which quantify ionic polymer behavior. Future research directions focused on extensions of the theory to topics including carbon-nanotube applications and regeneration of cartilage will be indicated. The topics discussed in this presentation will be developed from first principles and hence will be accessible to a broad audience. Graduate students are encouraged to attend.

Math Seminars

Adaptive Regression by Mixing: An Alternative to Model Selection
Demonstrated on a Capture-Recapture Data Set
Lihua Chen - Department of Statistics, Iowa State University
When: Monday, February 07, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-126
Details: Traditional data analysis techniques that depend on the selection of a model are vulnerable to model uncertainty. Model uncertainty arises when a small change in the problem makes a model selection criterion lead to selection of a different model. When the model choice is unstable, the results of the analysis may be unreliable. The present talk reports on an alternative to model selection, Adaptive Regression by Mixing (ARM), in the context of loglinear models. I present the information theoretic basis of ARM and characterize its theoretical risk bound. I demonstrate the advantage of ARM compared to commonly used model selection criteria, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and a popular model combining method, Bayesian Model Averaging (BMA). A data example is taken from the literature on capture-recapture studies where the object of interest is the hidden population size. In the context of loglinear models, this problem can be formulated as estimating a missing cell mean based on an incomplete contingency table. I show ARM leads to a better estimate than AIC and BIC as verified by a parametric bootstrap method.

Math Seminars

Flows of Dynamical Systems
Math Seminars
Punching Through a Periodic Garden of Integrable Peaks
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, February 04, 2005 03:10PM to 05:00PM
Where: Wilson Hall 1-139

Details: We present a new algorithm to discovering natural partitions of a set of samples based on their gene expression patterns found with microarray experiments. The algorithm uses a bi-criteria combinatorial optimization search to simultaneously identify an interesting set of genes and a partition of the array samples. Each gene in the gene set should respect the sample partition in the sense that if the gene's values are colored according to the partition class they come from, then the values, when sorted, should have a minimal number of color changes. We refer to this as the full color criterion. It measures how well a particular gene sorts the various partition classes. The other is the black and white criterion that measures how well a gene distinguishes one sample class from the remaining samples. Using a branch-and-bound algorithm we are able to find both the optimal gene set and the sample partitioning that minimizes the total color change. Additionally we can calculate a "p-value" to interpret the significance of the results. We have tested the algorithm on a 30 sample Cutaneous T-cell Lymphoma data set; it was able to almost perfectly discriminate short-term survivors from long-term survivors and normal controls.

Math Seminars
Linear Dynamical Systems and Their Applications
Joe Latulippe - Department of Mathematical Sciences, MSU
When: Monday, January 31, 2005 02:10PM to 03:00PM
Where: Wilson Hall 2-244
Details: I will be leading a discussion on linear systems and their importance in applications. In my talk we will examine a "dynamic" spring-mass problem, discuss the applications of linear systems in making fine beverages (unfortunately not in consuming them), and look into a Hodgkin-Huxley type of synaptic model (based on the "Giant Squid" Axon). We will break-down the sometimes cumbersome linear algebra into an easily accessible theory (i.e. 2x2 case). We will derive the infamous bifurcation diagram...
as found in many textbooks, and have a discussion about the effects of eigenvalues and eigenvectors on 2-d solution flow. This talk is designed to be accessible to all level graduate students (advance calculus a minimum requirement) in any field. Please join us in this refreshing mathematical learning environment.

Math Seminars
Rotation Sets: Examples from the Early Days, part III
Dr. Russ Walker - Department of Mathematical Sciences, MSU
When: Friday, January 28, 2005 03:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Oscillation in Multi-stable Monotone System with Slowly Varying
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, January 27, 2005 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: We consider a monotone system with positive feedback. We assume that the number of steady states in the closed loop system changes from one to three to one as the strength of the feedback increases. If the strength of the feedback is then allowed to vary slowly back and forth through this regime, we show that the system admits a periodic orbit. NOTE THE CHANGE IN TIME OF THE SEMINAR FOR THIS YEAR.

Math Seminars
Proximality and Tiling Spaces
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, January 21, 2005 03:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Combining Noninvasive Imaging Methods to Study the Living of the Human Brain
Dr. Armin Fuchs - Florida Atlantic University
When: Thursday, January 20, 2005 04:10PM to 05:00PM
Where: 108 Ag Bio Science Building
Details: Notice. Please, different place!!!

Math Seminars
Rotation Sets: Examples from the Early Days, part II
Dr. Russ Walker - Department of Mathematical Sciences, MSU
Math Seminars
Spatial Solitons in Quasi-Phase-Matched Quadratic Media: A Variational Approach
Ted Farnum - Department of Applied Mathematics, University of Washington
When: Monday, December 06, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: SPECIAL TIME!! In non-linear optics, there are two broad categories of materials, which typically exhibit entirely different phenomena. Quadratic materials are generally thought of as being used for frequency conversion. Cubic materials can be used to achieve an effect called self-focusing. Recently, there has been interest in trying to get "cubic-like" effects, like self-focusing, from quadratic materials. This is of practical interest since quadratic nonlinear effects become apparent at much lower energies, and for much shorter propagation distances. In this talk, I will give a short introduction to the physical set-up of the system and some of the theoretical predictions that have been made about it already. Then I will introduce an approach which combines a variational method with a multiple scales expansion in order to investigate the slow behavior of the system when initial conditions are perturbed from ideal launch conditions.

Math Seminars
Rotation Sets: Examples from the Early Days
Dr. Russ Walker - Department of Mathematical Sciences, MSU
When: Friday, December 03, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Symbolic-Numerical Framework for the Solution of PDEs in Mathematica
Dr. Rob Knapp - Department of Mathematical Sciences, MSU
When: Thursday, December 02, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: The numerical method of lines is a technique for solving PDEs that can posed with initial conditions. The PDE is semi-discretized into a system of ODEs or DAEs which are then handled by appropriate solvers. The symbolic capabilities of Mathematica enable an equation based interface for obtaining numerical solutions of PDEs. I will give an overview of how symbolic calculations can be used to discretize in a general way, form error estimates, solve linearized boundary conditions, and obtain the sparse structure for the Jacobian.

Math Seminars
Conclusion to Zeroth Talk on the Differential Geometry of a Statistical Manifold
Tom Azeredo - Department of Mathematical Sciences, MSU
When: Tuesday, November 30, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-141

Other

Cryptography and Schur
Dr. Michael Fried - MSU, Billings
When: Friday, November 19, 2004 03:10PM to 04:30PM
Where: TBA
Details: ABSTRACT (I will define capitalized words during the talk): In 1831, 19 year old Everiste Galois introduced FINITE FIELDS. The easiest are PRIME finite fields: Integers modulo a prime. You may know bankers who never heard of Galois, yet they know of cryptography and finite fields. Addition and multiplication on these keep financial data secure. Numbers in a finite field form an ABELIAN group. The nonzero numbers form a CYCLIC group. This allows encoding data using special polynomials: the easiest being odd degree CYCLIC polynomials x^3, x^5, ... In 1919, Group theorist Isaiah Schur guessed at a complete list of polynomials that could encode data in large prime finite fields. We explain why Schur's guess (solved in 1969, after hundreds of partial results) was correct. The main tools are NONABELIAN GALOIS THEORY, also introduced by Galois, and complex variables. Four recent large manuscripts have this at their center. We conclude with why it is timely to revisit this subject. Short Bio: Michael Fried has been a professor of mathematics at SUNY at Stony Brook (New York), University of California at Irvine, Hebrew University (Jerusalem) and University of Florida. He has received several well-known research fellowships including the Sloan Fellowship, the Alexander von Humboldt Senior Research Fellowship, and the Fullbright Fellowship. He is now Director of the "Office of Continuous Assessment" at MSU-B. His research work is in complex variables, algebraic geometry, algebraic number theory and what he likes to call applied group theory. He also finds it fascinating to consider how we all struggle with learning and what can help us with that struggle.

Math Seminars

Cartesian Mesh Electric Field Simulators for Plasma
Dr. Tao Lin - Department of Mathematics, Virginia Tech
When: Thursday, November 18, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: We consider Cartesian mesh finite element methods for a nonlinear boundary value problem appearing in modelling electric field of plasma propulsion engines. The basis functions in these methods are piece-wise linear polynomials satisfying the jump conditions approximately (or even exactly in many situations) across the interfaces of engine materials. The meshes used by these methods do not have to be aligned with
the interface; therefore, structured Cartesian meshes can be used to facilitate efficient particle tracing in plasma propulsion simulation. Finite element methods in both the Galerkin and Petrov-Galerkin formulations will be considered. We will show that these methods have the optimal orders of approximation capabilities in both the $L^2$ and $H^1$ norms. Representative numerical examples will be provided to illustrate features of these methods.

Math Seminars
Modeling On and Off Responses in the Visual System
Joe Latulippe - Department of Mathematical Sciences, MSU
When: Monday, November 15, 2004 04:10PM to 05:00PM
Where: Wilson Hall 2-244 (Hurst conference room)
Details: SPECIAL TIME AND SPECIAL PLACE! Certain neurons exhibit an On and Off response when given a light stimulus. Examples of each of these responses will be given. Using a current balance Hodgkin-Huxley type of equation, a phenomenological model which replicates the On and Off behaviors will be presented. This model will include two fast variables and one slow variable. The effects of a constant stimulus will be investigated and a comparison of the intensity of the stimulus and the duration that it is applied will be shown. In order to replicate the behavior of two simultaneous stimuli (Kuffler, 1953), an alteration to the model must be made. By adding a second slow variable, the two simultaneous stimuli behavior can be attained numerically. Future work will involve analysis on the two-fast, two-slow variables model, cell coupling behaviors, and layer-to-layer interactions.

Math Seminars
A Zeroth Talk on the Differential Geometry of a Statistical Manifold: How Gauss, Riemann, & Fisher Conspired to Say Something Negative about the Normal
Tom Azeredo - Department of Mathematical Sciences, MSU
When: Tuesday, November 09, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-141

Math Seminars
Halmos-von Neumann Theorem for Self-Similar Flows (part II)
Veronica Baker - Department of Mathematical Sciences, MSU
When: Friday, November 05, 2004 03:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Biofilm Modeling
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, November 04, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: A Biofilm is a dense aggregation of microorganisms that are embedded in a hydrated polymer matrix. Biofilms often show antibiotic resistance. Four hypothetical resistance mechanisms will be incorporated into a model of biofilm formation and model behavior will be analyzed. The four mechanisms address retarded antibiotic penetration, reduced metabolic activity or growth in parts of the biofilm due to local nutrient depletion, stress response activation by some biofilm bacteria, and differentiation of some biofilm cells into a dormant persister state analogous to spore formation. If time allows, the Klapper Cohesion model will also be discussed.

Math Seminars
Halmos-von Neumann Theorem for Self-Similar Flows
Veronica Baker - Department of Mathematical Sciences, MSU
When: Friday, October 29, 2004 03:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Computations Involving Materials with Highly Discontinuous Material Properties
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, October 28, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Subtitle: How I Learned to Love the Singular Perturbation Occasionally multiphase problems arise involving materials with differing material properties, e.g. interacting fluids with different viscosities or densities. In many cases, these material properties enter the modeling equations as coefficients in the leading order terms. Hence discontinuities, particularly large discontinuities, can be troublesome in performing computations. In this talk a method will be presented for handling large discontinuities of this sort by perturbing around the infinitely discontinuous case, a singular limit that turns out to have a significant simplifying effect.

Math Seminars
Beta-expansions and the Tree Wrapping Map (part II)
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, October 22, 2004 03:10PM to 05:00PM
Where: Wilson Hall 1-139
Tracking Eye Motion from Retinal Scan Data
Dr. Curt Vogel - Department of Mathematical Sciences, MSU
When: Thursday, October 21, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: The problem being addressed---tracking the motion of the retina of the eye---is important in understanding how the human visual system works. Our data comes from an adaptive optics scanning laser ophthalmoscope (AOSLO), a device which yields high resolution scans of the living retina. Difficulties arise when the eye moves as the scans are taken. Our problem becomes the following: Given a series of scans of roughly the same object, determine both the motion of the object and the optical properties of the object. To solve this problem, we apply a variant of David Arathorn’s map-seeking circuit (MSC) algorithm.

Math Seminars
Beta-expansions and the Tree Wrapping Map
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, October 15, 2004 03:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: I will go into some detail on the connections between the beta-expansions, beta-transformation, the tree wrapping map S we constructed last time, and the underlying toral automorphism f_A. Perhaps, I will have enough time to formulate the method for checking the conjecture about the isomorphism between S and f_A.

Math Seminars
Using Sensitivity Equations for Optimal Actuator Placement on an Euler-Bernoulli Beam
Dr. Lisa Stanley - Department of Mathematical Sciences, MSU
When: Thursday, October 14, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Recent results for using CSEMs for optimal placement of piezoceramic actuators on an Euler-Bernoulli beam are discussed. During this talk, a continuous sensitivity equation approach is used to solve the optimal control problem. When incorporating CSEMs into the optimal control problem, we have chosen to derive sensitivity equations based on the operator forms of the LQR problem rather than to differentiate at the discretization step. Although this requires a significant amount of mathematical analysis at the outset, many of the data structures required to solve the LQR problem can be re-used in order to solve the corresponding sensitivity equations. As an alternative, the LQR problem and the corresponding sensitivity system can be coupled together for an all-at-once approach that provides a state solve and a sensitivity at each step of the overall optimization problem.
Voting Without (Statistical) Controls  
Dr. Fritz Scheuren - National Opinion Research Center (NORC)  
When: Monday, October 11, 2004 04:10PM to 05:00PM  
Where: Wilson Hall 1-114  
Details: Dr. Scheuren will discuss the impact of errors in the voting system on our democracy. Does our election system have the accuracy to calculate a winner when vote totals are close? Could our election be too close to call? What can statisticians do to help professionally? Dr. Scheuren discusses how the steps for ensuring a Quality Process might be applied to the problem of increasing the accuracy of election outcomes - both by reducing the bias in election outcomes due to errors in the voting system and increasing precision. Bio: Dr. Fritz Scheuren is the President-Elect of the American Statistical Association and the theme he has chosen for his Presidential Year is "Using Our Discipline to Enhance Human Welfare." He has lead by example using his statistical skills in the area of human rights issues; for example, through the Human Rights Program of the AAAS, he was part of a team that gathered data on the Albanian border to estimate the number of political killings in Kosovo. Dr. Scheuren is currently Vice President for Statistics at NORC, a survey research arm of the University of Chicago. He works in sampling and estimation settings that involve the use of large organizational files. He also teaches survey sampling at the George Washington University.

Math Seminars  
Sensitivity Analysis of Eddy Viscosity Models  
Dr. Faranak Pahlevani - Department of Mathematical Sciences, MSU  
When: Thursday, October 07, 2004 04:10PM to 05:00PM  
Where: Wilson Hall 1-139  
Details: One of the promising methods for numerically approximating the behavior of turbulent flows is Large Eddy Simulation method (LES). LES models involve an eddy viscosity parameter whose changes causes different responses in the flow. Obviously, this affects the computational fluid dynamics predictions such as the force a fluid exerts upon an immersed body in lift and drag. Therefore, it is important to find ways to assess the uncertainty of LES models. One mathematical approach to investigate this problem is via sensitivities. In this talk we will discuss the numerical analysis of the sensitivity of flow variables (velocity and pressure) with respect to the variation of the eddy viscosity parameter based on deriving the sensitivity equation from the applied LES model. In addition, we will present the result of some numerical experiments of the LES model and its sensitivity using the 2-dimensional driven cavity problem and also the application of sensitivity in improving the lift and drag functional for a flow around a cylinder.

Math Seminars  
Uniform Designs for High-Dimensional Constrained Mixture Experiments  
Dr. John Borkowski - Department of Mathematical Sciences, MSU
Math Seminars
Generic Quadratic Gradients in the Plane
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, October 01, 2004 03:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Balanced Reduction Control Techniques for a Cantilevered Euler-Bernoulli Beam
Dr. Katie A. Evans - Department of Mechanical Engineering, Oregon State University
When: Thursday, September 30, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: In recent years, much research attention has focused on the development of implementable controllers for physical systems governed by partial differential equations (PDEs). In order to numerically implement a controller for a physical system we often first approximate the PDE and the PDE controller using some finite dimensional scheme. However, control design at this level will typically give rise to controllers that are inherently large-scale. This presents a challenge since we are interested in the design of robust, real-time controllers for physical systems. Therefore, a reduction in the size of the model and/or controller must take place at some point. In this presentation, I will discuss several different control designs we employ along with two different methods for obtaining low order controllers. As a means of numerical comparison, I present performance and robustness results of the low order controllers as applied to a cantilevered Euler-Bernoulli beam.

Math Seminars
Analysis of the Vegetation/Environment Relation: The Statistical Analysis of Maximal Cliques and Compact Sets
Dr. Dave Roberts - Department of Ecology, MSU
When: Tuesday, September 28, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
A Gradient-Descent Solution of the Monge-Kantorovich Problem
Rick Chartrand - Los Alamos National Labs
When: Friday, September 24, 2004 03:00PM to 04:00PM
Where: Wilson Hall 1-139
Math Seminars
Tomographic Methods for Limited View Angles and Sparse Data
Dr. Thomas J. Asaki - Los Alamos National Laboratory
When: Thursday, September 23, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: We consider methods for recovering information in tomography settings characterized by limited number of views and other sparse-data applications. In contrast to static-object medical and industrial imaging, which has the luxury of hundreds of radiographic views, our focus is on highly underdetermined systems of a few or single views. In particular, we consider Abel Inversion based tomography, single-view tomography of dynamic objects, and 3D object reconstruction from several views. Reconstruction tools include a variety of regularization techniques, Projection operator null-space enhancements, data submanifold learning, and dynamic constraints. We will show many pedagogical examples using synthetic data as well as real examples from proton and X-ray radiography experiments.

Math Seminars
Monotone Dynamical Systems
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Friday, September 17, 2004 03:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
COW: Computationally Optimal Wavefront Control for Adaptive Optics using the Portable Extensible Toolkit for Scientific Computing
Aron Ahmadia - Illinois Institute of Technology
When: Friday, September 17, 2004 02:10PM to 03:00PM
Where: Wilson Hall 1-126
Details: Motivation for the development of COW, including a brief introduction to adaptive optics control and the Linear Adaptive Optics Simulator (a Matlab code). This will be followed by an introduction to the techniques mathematicians can use to increase interactive mathematical software's (Matlab, Mathematica, Octave, etc...) speed, with some emphasis placed on solving large problems on supercomputers. A complete introduction to Petsc, describing the types of mathematical problems it is designed to handle, as well as the types of solvers it is equipped with and other software libraries built around it. Demonstration of COW's capabilities

Math Seminars
The Natural Extension of Renyi's Beta Transformation in Pisot Case
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
**Math Seminars**

**Structure Theorems and the Dynamics of Nitrogen Catabolite Repression in Yeast**
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: **Thursday, September 09, 2004 04:10PM to 05:00PM**
Where: Wilson Hall 1-139
Details: Using current biological understanding, a conceptually simple, but mathematically complex model is proposed for the dynamics of the gene circuit responsible for regulating nitrogen catabolite repression (NCR) in yeast. We apply monotone system theory to several sub-circuits of the full NCR-circuit, most importantly to the URE2-GLN3 sub-circuit that is independent of the other constituents but governs the switching behavior of the full NCR-circuit under changes in nitrogen source. Under hypotheses that are fully consistent with biological data it is proven that the dynamics of this sub-circuit is simple periodic behavior in synchrony with the cell cycle.

**Math Seminars**

**Heterogeneous Spiking Neurons Connected by Both Inhibitory and Electrical Coupling**
Dr. Sharon Crook - Department of Mathematical Sciences, University of Maine
When: **Friday, August 06, 2004 01:00PM to 02:00PM**
Where: Leon Johnson 346
Details: Fast-spiking interneurons in the cortex are connected by both inhibitory chemical synapses and gap junctions; however, it remains unclear how combinations of these two coupling modes affect the dynamics of networks of fast-spiking neurons. To address this issue, we examine synchronization patterns in model networks of oscillating cells. We study the influence of intrinsic cellular properties and coupling parameters, including the relative strengths of electrical and inhibitory coupling. We also investigate the effects of heterogeneity in the cells' intrinsic firing frequency on network synchronization patterns. This is joint work with Tim Lewis of the Center for Neural Science at New York University.

**Math Seminars**

**Recent Progress on the Poincare Conjecture**
Dr. Karen Uhlenbeck - Department of Mathematics, University of Texas, Austin
When: **Thursday, July 22, 2004 02:10PM to 03:00PM**
Math Seminars
Category Theory and Higher Dimensional Algebra as Potential Descriptive Tools in Biology
Dr. Ron Brown - School of Informatics, Mathematics Division, University of Wales, United Kingdom
When: Monday, June 14, 2004 02:10PM to 03:00PM
Where: Wilson Hall 1-139
Details: This is a presentation for a general audience aimed at showing how category theory is important for describing processes and structures, and higher dimensional algebra is a new tool for developing ideas of complex hierarchical interactions. The aim is to give the spirit and intuitions of these current research topics. Together they give new higher dimensional nonabelian tools for local-to-global problems. The talk will be illustrated with computer graphics, knots and string.

Math Seminars
Conformal Field Theory and Orbifold Models
Dr. Matthew Szczesny - Department of Mathematics, University of Pennsylvania
When: Friday, May 28, 2004 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Orbit Structure for Groups of Homeomorphisms
Norah Esty - Department of Mathematics, University of California, Berkeley
When: Friday, May 21, 2004 10:00AM to 11:00AM
Where: Wilson Hall 1-139

Math Seminars
The Stationary Navier-Stokes System in Nonsmooth Manifolds
Dr. Martin Dindos - Department of Mathematics, Cornell University and Brown University
When: Tuesday, May 11, 2004 02:10PM to 03:00PM
Where: Wilson Hall 1-139
Details: The Navier-Stokes equation is one of the most studied nonlinear equation. It models the flow of an incompressible viscous fluid. Due to nonlinear nature of these equations, one ingredient in their analysis is the study of stationary linearized systems. Traditionally, the linearized system known as the Stokes system is the primary object of such analysis. In our work we introduce and study whole family of such linearized systems among which the Stokes system is only one of many others. We find the solution to such linear system by the method of layer potentials. The whole approach
works in very general frame work of Lipschitz domains on Riemannian manifolds. We are particularly interested in what range of Sobolev-Besov spaces the solution exists. Our results show that the smoothness of the solution depends on the smoothness of the boundary that is for domains with $C^1$ boundary or boundary with small Lipschitz constant we get solvability in full range of spaces. In general Lipschitz domain this range becomes restricted. Next we apply the Schauder fixed point theorem, to obtain the existence result for stationary Navier-Stokes equation. Our result shows existence for arbitrary large data in up to four dimensions and small data in higher dimensions. We will also present several open problems as well as suggest possible ways to solve them.
Math Seminars
Modeling Biofilm Tolerance of Antimicrobial Agents: Successes and Failures
Dr. Phil Stewart - Center for Biofilm Engineering, MSU
When: Thursday, April 15, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: When microorganisms aggregate in biofilms, they become protected from killing by biocides and antibiotics. Mathematical and computer models of biofilm dynamics have proven to be useful tools in the investigation of this phenomenon. These modeling studies are as interesting for their failures to capture the full protection afforded to microbes in biofilm as they are for their occasional success. Models addressing two proposed mechanisms of biofilm protection from antimicrobial agents are discussed. The first mechanism is neutralization of the antimicrobial agent by reaction with biofilm constituents. The second mechanism is incomplete penetration of nutrients into the biofilm leading to regions of slow or no growth in which cells are less susceptible. Both phenomena are rooted in are action-diffusion interaction. Models of antimicrobial reaction and diffusion can describe retarded antimicrobial penetration, but fail to explain the continued survival of microorganisms once the antimicrobial agent has penetrated. Models of nutrient utilization and diffusion correct lypredict physiological gradients in biofilms, but also fail to capture the full degree of reduced susceptibility exhibited by biofilm microorganisms. These ideas will be illustrated with an eclectic mixture of experimental and theoretical results.

Math Seminars
Modeling a Spatio-Temporal Neural Map
Dr. Graham Cummins - Center for Computational Biology, MSU
When: Thursday, April 08, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Peripheral sensory systems often represent sensory information using neural maps. These are topological organizations in which neurons in particular regions of space carry information about sensory events of a particular type. Interneurons embedded in these maps receive different inputs depending on the spatial structure of their dendritic trees within the map. Anatomical and physiological data, in combination with statistical density estimation techniques, can provide a good representation of these spatial structure of these maps, and consequently can predict and explain some of the response properties of the interneurons. The interneuron response, however, depends not only on the shape of the map, but on the temporal patterns of activation of the cells making up the map. These patterns can be challenging to predict. I present a comparison of several reduced methods for predicting the temporal activity of a sensory
map in the cricketcercal sensory system. I compare these predictions to recorded activity from sensory cells in the map. Also, I use the map models to drive model interneurons, and compare the output characteristics of these with real interneurons. Models with a few linear and simple nonlinear components are sufficient to match the overall firing pattern of real cells to steady-state stimuli, but are unable to capture the fine temporal structure of activity, or the rapid adaptation to changes in stimulus level that are displayed by real cells.

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**Math Seminars**

**Coincidence Conjecture for Pseudo Anosovs**  
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU  
**When:** Friday, April 02, 2004 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-141

**Math Seminars**

**An Approximation Method for a Geometric Box Tiling Problem**  
Dr. Brendan Mumey - Department of Computer Science, MSU  
**When:** Thursday, April 01, 2004 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-139  
**Details:** I will present a new approximation algorithm for covering an $n \times n$ binary neuron image with minimum number of disjoint $h \times h$ boxes such that the total number of connected components within individual boxes is minimized. Time permitting I will discuss the proof that it is NP-complete to approximate the general problem within some fixed constant. This is a joint work with Minghui Jiang, Zhongping Qin, Andrew Tomascak and Binhai Zhu.

**Math Seminars**

**Katok's Example on the Torus**  
Mark Mathison - Department of Mathematical Sciences, MSU  
**When:** Thursday, March 25, 2004 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-141

**Math Seminars**

**Existence and Uniqueness of Weak Solutions to a Simplified DockeryKlapperModel**  
Niels Ch. Overgaard - Applied Mathematics Group, Malmo University, Sweden  
**When:** Thursday, March 25, 2004 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-139  
**Details:** Three years ago J. Dockery and I.Klapper, of Montana State University, proposed a model for the growth of a single species biofilm in which the biomass is considered as an incompressible viscous fluid obeying Darcy's law. Their model
assumes that there is one limiting substrate whose concentration is governed by an
equation of reaction-diffusion type. We consider a simplified version of this model in
which it is assumed that the substrate concentration is constant right up to the boundary
of the biofilm, and that the reaction term is linear. We show how the moving boundary
problem associated with this problem can be formulated as a variational inequality.
Existence and uniqueness then follows from a well known theorem of Stampacchia.

Math Seminars
From Fourier Optics to PSF Modelling and Image Reconstruction
Dr. John Bardsley - Department of Mathematics, University of Montana
When: Thursday, March 11, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: In imaging problems, the point spread function (PSF) characterizes the blurring
effects of the imaging system of interest. In ground-based astronomical imaging, the
blurring of images occurs due to both refraction and diffraction. A refractive blur is
incurred due to index of refraction variations in the atmosphere, while a diffractive blur
results from the finite aperture of the telescope. Depending upon the assumptions made
regarding the type of refractive blur that is incurred by a particular image, different
mathematical models result. The most standard approach taken is to assume that the
PSF is known and space-invariant. In recent literature, researchers have also
considered the image construction problem that results when the PSF known but
space-varying. Also, a technique known as phase-diversity has been used to solve the
problem of identifying the PSF and reconstructing the image when the blur is assumed
to be space-invariant but the PSF is unknown. In this talk I will propose a computational
approach for solving the image restoration/PSF identification problem that results when
the PSF is assumed to be both unknown and space-varying. In order to motivate the
approach taken, we will derive a general mathematical model for the PSF using
machinery from Fourier Optics.

Math Seminars
Augmented Dimension Group Invariants for Substitution Spaces
Megan Smith - Department of Mathematical Sciences, MSU
When: Thursday, March 11, 2004 03:10PM to 04:00PM
Where: Wilson Hall 1-141

Math Seminars
From Sequence to Structure: Finding the Shortcuts
Mensur Dlakic - Department of Microbiology, MSU
When: Thursday, March 04, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: The recent explosion in databases of biological sequences provides ample opportunity to infer evolutionary relationships by comparative genomics. Structural and functional relationships between proteins are often not obvious from the primary sequence due to evolutionary divergence. Presently, available protein databases are manually curated in an attempt to cover the protein space so that newly discovered proteins can be annotated automatically by sequence homology. This talk will explore how the sensitivity and speed of sequence searches can be improved to facilitate this goal.

Math Seminars
Linear Regression When Data Cannot be Collected as (x,y) Pairs
Dr. John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, March 02, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-138
Details: In simple linear regression it is assumed that a random sample of (x,y) pairs has been obtained. In some physical situations, it may not be possible to collect x and y as pairs. For example, fish biologists believe that there is a strong relationship between the strontium:calcium (Sr:Ca) ratio in the stream where a trout was raised and the Sr:Ca ratio found in the otoliths of individual fish. Thus, they collect independent stream samples and fish samples across multiple streams and record the Sr:Ca ratios for each water and fish sample. Thus, there is no pairing of individual water samples with individual fish from that stream. This seminar will be an informal discussion of potential data analysis methods that could be applied to this type of data.

Math Seminars
Bounding the Spectral Radius of a Directed Graph
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, February 27, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-141

Math Seminars
MOSES: The Instrument and the Math
Dr. Charles C. Kankelborg - Department of Physics, MSU
When: Thursday, February 26, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: A pioneering remote sensing experiment is being developed at MSU: the MultiOrder Solar Extreme Ultraviolet Spectrograph (MOSES). The MOSES rocket payload is scheduled for launch from White Sands Missile Range in August of this year. But the success of the mission hinges on what happens after the payload parachutes safely back to Earth: the mathematical and computational challenge of analyzing a new kind of data.
Math Seminars

The Logic of Simpson's Paradox
Dr. P.S. Bandyopadhyay - Department of History and Philosophy, MSU
When: Tuesday, February 24, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-138
Details: Simpson's paradox, which dates back to Lewis Carroll, is a subject of intense interest across many disciplines including philosophy, statistics, artificial intelligence, economics, biology, race and gender studies, and especially epidemiology. A variety of solutions to it have been offered. Most of them are statistical or probabilistic in character. One recent celebrated solution to the paradox is causal in nature. In our view, all of them fail. The correct solution is to be found in the logic of the argument which leads to the paradox.

Math Seminars

Model of Biofilm Mechanics: Version 1.0
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, February 19, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: A goal has been to construct a simple qualitative model of biofilm material properties and, in particular, biofilm response to mechanical stress including sloughing. In this talk I will present an attempt to include basic physics, chemistry, and biology in a model of biofilm mechanics and mechanical response. Parts of this model are still uncertain!

Math Seminars

The Relative Efficiency of Adaptive Cluster Sampling: Assessment via Response Surface Methodology and Simulation
Dr. Phil Turk - Department of Mathematical Sciences, MSU
When: Tuesday, February 17, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-138

Math Seminars

Pseudo-Anosovs Do Not Embed in Anosovs
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, February 13, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-141

Math Seminars

Modulation of Calcium Oscillations by Membrane Currents
Dr. James Sneyd - University of Auckland, New Zealand
When: **Tuesday, February 10, 2004 04:10PM to 05:00PM**
Where: Wilson Hall 1-132
Details: NOTE SPECIAL DAY AND SPECIAL ROOM, PLEASE.
Abstract: I'll begin with a brief discussion of the physiology of intracellular calcium signalling, and then present a model of calcium oscillations in secretory epithelial cells. I'll show how we used the model to address one particular controversy in the field, that of how calcium oscillations are affected by membrane calcium transport. I'll briefly describe how we used the model to make a number of predictions, and the experiments we did to test the predictions.

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**Math Seminars**

**Ergodic Decomposition**
Mark Mathison - Department of Mathematical Sciences, MSU
When: **Friday, February 06, 2004 04:10PM to 05:00PM**
Where: Wilson Hall 1-141

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**Math Seminars**

**Dewarping Scanning Retinal Images**
Mark Campanelli - Department of Mathematical Sciences, MSU
When: **Thursday, February 05, 2004 04:10PM to 05:00PM**
Where: Wilson Hall 1-139
Details: An Adaptive Optics Scanning Laser Ophthalmoscope (AOSLO) has been developed by Austin Roorda’s group at the University of Houston College of Optometry. The device employs a scanning laser with adaptive optics to resolve microscopic structures in the living human retina. The design of the system with a scanning laser allows 3D imaging of the various layers of the retina as well as dynamic imaging of blood flow in retinal capillaries. The potential applications of the device are numerous, including basic vision science research and the early diagnosis and improved treatment of retinal dysfunction. Scanning laser imaging presents some challenges when the object being scanned is in motion. This is the case with the human eye, even when the subject under test fixates his/her gaze. Eye-motion during scanning causes warping in the images which can distort the appearance of retinal structures and limit the usefulness of the device for precision imaging. In my talk, I will discuss the image warping problem and a couple of mathematical methods being investigated for dewarping images. The methods are cross-correlation and gradient-based optical flow, which are common in machine vision applications. Scanned imaging does not allow the standard application of either method. High frequency eye-motion limits the use of cross-correlation. In the case of gradient-based optical flow, the image gradients must be calculated in a novel manner. Also, the optical flow problem is ill-posed, so some regularization technique is required.
Math Seminars
On Embedding Pseudo-Anosovs into Anosovs - Part II
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, January 30, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-141

Math Seminars
An Introduction to Electrical Impedance Tomography and Modelling Nerve Detection
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU
When: Thursday, January 29, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Common medical imaging techniques such as CAT scans and MRIs do a poor job at imaging nerves in tissue. A local company is developing a nerve detection device using ideas similar to those in Electrical Impedance Tomography (EIT). In this talk, a forward model used in EIT and based on Maxwell's equations will be developed. Some numerical simulations related to the nerve detection problem will be presented and critiqued. Such models are inadequate for capturing time-dependent stimuli. However, standard RC and RLC circuit theory support potential modifications of the more standard EIT models. This work is preliminary and meant to be introductory.

Math Seminars
On Embedding Pseudo-Anosovs into Anosovs
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, January 23, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-141

Math Seminars
Second-Order Accurate Confidence Intervals in Regression and Multivariate Analysis on Nonnormal Data
Dr. Robert Boik - Department of Mathematical Sciences, MSU
When: Tuesday, January 20, 2004 04:10PM to 05:00PM
Where: Wilson Hall 1-138

Math Seminars
Cech Cohomology of a Compact Space Using an Inverse Limit Description - Part III
Megan Smith - Department of Mathematical Sciences, MSU
When: Friday, December 12, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Math Seminars
Cech Cohomology of a Compact Space Using an Inverse Limit Description - Part II
Megan Smith - Department of Mathematical Sciences, MSU
When: Friday, December 05, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Biofilm, Materials, and Numerics
Todd Shaw - Department of Mathematical Sciences, MSU
When: Thursday, December 04, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: In this talk I hope to do the following.

• First, I will give a brief introduction to biofilm, e.g., what it is, how it forms, why it is important, etc.
• Second, I will talk about materials and the fact that biofilm is a viscoelastic material.
• Third, I will mention our biofilm model.
• Lastly, I will present a method and some numerics that we plan to use to simulate the model. More specifically, I will address finding the solution of a multi-region elliptic problem with a strongly discontinuous coefficient across the interface.

The method, that Isaac Klapper has coined the large jump perturbation method (LJPM), reduces the problem to a small number of sub-problems, each with continuous coefficients.

Math Seminars
Cech Cohomology of a Compact Space Using an Inverse Limit Description
Megan Smith - Department of Mathematical Sciences, MSU
When: Friday, November 21, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
An Overview of the Continuous Sensitivity Equation Method and its Applications to Actuator Placement for a Control Problem
Dr. Lisa Stanley - Department of Mathematical Sciences, MSU
When: Thursday, November 20, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: The first portion of my talk will be devoted to the definition of a sensitivity and an overview of the Continuous Sensitivity Equation Method (CSEM) approach to calculating sensitivities. The ideas will be presented for a couple of simple examples, and I will survey some of the main issues that have been pointed out for CSEMs in the last few years. This portion of the talk is designed to be accessible to the graduate students in attendance. The remaining half of the talk will survey some of my current research in the development of CSEMs for use in optimal control problems. A simple actual or placement problem for an Euler-Bernoulli beam will be discussed. The CSEM approach is used, and some preliminary results will be shown.

Math Seminars
Map-Seeking Circuits: Convergence and the Ordering Property
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, November 13, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: I will briefly review main points of David Arathorn's talk from last week and then proceed to prove that map-seeking circuits always converge to either unique nonzero weight or to solution with all zero weights. I will also formulate the ordering property and show some combinatorial estimates of the relevant probabilities. The talk will be self-contained and those who missed the Nov 6th talk are most welcome.

Math Seminars
Recogizability for Primitive Aperiodic Substitutions
Veronica Baker - Department of Mathematical Sciences, MSU
When: Friday, November 07, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Map-Seeking Circuits: What do the Higher Visual Cortices Compute?
David Arathorn - Consultant, Center for Computational Biology, MSU
When: Thursday, November 06, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: The problem of recognition of objects under visual transformations has dogged computational vision for decades. Due to the size of the search space a straightforward approach problem appeared to be combinatorial intractable, thus driving research toward discovery of invariant transformations or identification of invariant features. This direction has had very limited success. Map-seeking circuits exploit an ordering property of super positions to reduce by many orders of magnitude the number of operations necessary to search the full space of transformations. The result is a computational mechanism which demonstrably solves the problem of recognition under transformation, and has an isomorphic, biologically plausible neuronal implementation. This is a first of two talks on this subject. David Arathorn will talk about the algorithmic version of the
Math Seminars
Galois Theory
Shaun Harker - Department of Mathematical Sciences, MSU
When: Friday, October 31, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Using the Immersed Boundary Method to Model Flagellar Motion and Eucaryotic Cell Growth
Dr. Robert Dillon - Department of Mathematics, Washington State University
When: Thursday, October 30, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: In this talk I will describe two models: one for ciliary and flagellar motion, the other for eucaryotic cell growth. These models are cast in the framework of Peskin's immersed boundary method. The model for ciliary and flagellar motion is developed for a single axoneme, or perhaps a small array of cilia. It is based on a fluid-mechanical model of an individual cilium or flagellum and incorporates discrete representations of the dynein arms, the passive elastic structure of the axoneme including the microtubules and nexin links. The model for cell growth is intended to model the growth processes of a collection of cells with applications in developmental biology and tumor growth.

Math Seminars
Discrete Spectrum for Pisot Tiling Flows (and its Elusive Purity)
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, October 24, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Return Map Characterizations of Singular Solutions for a Model of Bursting with Two Slow Variables
Dr. Roger Griffiths - Department of Mathematical Sciences, MSU
When: Thursday, October 23, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Various physiological systems display bursting electrical activity (BEA). There exist numerous three variable models to describe this behavior. However, four variables may be required to explain some qualitative features of the BEA.
In this talk a model with two slow and two fast variables is presented. For some parameter values the system has stable equilibria while for other values there exist bursting solutions. A singular construction of the latter solutions corresponds to the existence of a fixed point of a one dimensional map. The map is the composition of two maps derived from the slow-subsystem and the averaged fast-subsystem. In a degenerate case this fixed point is determined. For non-degenerate cases numerical methods for calculating these maps will be presented.

Math Seminars
Computationally Efficient Parallel Iterative Solving for Sparse Matrix Problems in Adaptive Optics
Aron Ahmadian - Illinois Institute of Technology
When: Thursday, October 16, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: A brief introduction to the current demand in adaptive optics for computationally efficient iterative algorithms for solving very large sparse matrices. The presentation will then focus on difficulties and solutions in developing a parallel approach. Some insights in developing a parallel computational model for a generic mathematical formula will be introduced, as well as the use of optimized parallel mathematics packages, specifically Petsc.

Math Seminars
Pisot Obstruction to Discrete Spectrum
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Thursday, October 16, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Large Solutions for Yamabe and Similar Problems on Domains in Riemannian Manifolds
Dr. Martin Dindos - Department of Mathematics, Cornell University
When: Friday, October 10, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Traveling Waves in a Pioneer-Climax Model
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, October 09, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Presented is a reaction-diffusion model for the interaction of a pioneer and climax species. We study the existence of traveling waves in the case of the climax
species diffuses at a slow rate. Singular perturbation analysis gives us information on
sign of the wavespeed. Numerical simulations of wave front propagation for the model
on two-dimensional domains are also given. This will be an introductory talk and all
graduate students are strongly encouraged to attend.

Math Seminars
Dynamical Approach to Pisot Theorem
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, October 03, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: To resolve the eigenvalues of the tiling flow one is faced with a question about
the equidistribution (or rather the lack there of) for the sequence lambda^n mod 1.
Thus, setting tiling spaces aside, I will give a proof of the classical result by Pisot to the
effect that, for an algebraic number, lambda^n converges to 0 mod 1 iff lambda is, you
guessed right, a Pisot number. The result is quite old but the new approach to the proof
demystifies what is going on and yields important new information.

Math Seminars
Modeling NCR Gene Regulatory Circuit in Yeast
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, October 02, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: I will discuss modeling of gene regulatory networks. This will be an introductory
talk, where I will concentrate on underlying biology, experiments as well as some simple
models of dynamics of a specific nitrogen catabolite repression (NCR) circuit in yeast. I
will show some numerical simulations and discuss plans for future research in this area.

Math Seminars
Mapping Tiling Spaces into Tori (Part II)
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, September 26, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: First, I will recast the mapping constructed last time as a sort of Iterated
Function System over a graph of the substitution. Second, I will show how one can
algorithmically resolve the problem of (almost everywhere) injectivity by constructing a
graph revealing what tilings get identified under the map.

Math Seminars
Coregistration and Color Balancing of Overlapping of Earth Imagery
for Automated Feature Extraction and Change Detection
Cody Benkelman - Co-founder/Principal Engineer at Positive Systems Inc., Whitefish, MT
When: Thursday, September 25, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Automatic extraction of features of interest and automatic change detection are ongoing challenges for commercial and military users of earth imagery (satellite imagery and film aerial photography). In the military world, example uses for these tools include identifying construction of new strategic sites, changes in activity levels at known strategic sites, automatic target recognition, and many others. Non-military applications include monitoring the health of agricultural crops, changes in total agricultural acreage, degradation or remediation of environmental quality, etc. In the commercial sector, earth imagery is used to create and update maps, select sites for new commercial development, etc. In this talk we will describe what is meant by automatic feature extraction and change detection for Positive Systems customers, and describe two related core technologies that are the focus of ongoing development: precise image-to-image co-registration and color balancing. We will then discuss some of the approaches that we are taking to solve these important problems. This is still very much work in progress, and we welcome input from the audience.

Math Seminars
Mapping Tiling Spaces into Tori
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, September 19, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Actuator-Sensor Geometries for Astronomical Adaptive Optics
Dr. Mike Flanagan - Department of Mathematical Sciences, MSU
When: Thursday, September 18, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: In adaptive optics (AO) for astronomical telescopes, we compensate for turbulence-induced wave front aberrations using deformable mirrors. These aberrations are detected using a wave front sensor. A standard configuration of sensors and deformable mirror actuators, known as Fried geometry, exhibits so-called "waffle mode". This is a checker board pattern on the mirror which can be induced by the actuators but cannot be detected by the sensors. Waffle mode can seriously degrade the performance of AO systems. In this talk, we introduce an alternate "diamond" geometry that avoids waffle mode. We also present simulation results comparing the performance of our diamond geometry with standard Fried geometry.

Math Seminars
Making a Surface from a Substitution
Math Seminars

Singularly Degenerate Cycle and Lorenz-like Attractors
Dr. Hiroshi Kokubu - Department of Mathematics, Kyoto University
When: Tuesday, May 13, 2003 02:10PM to 03:00PM
Where: Wilson Hall 1-132
Details: We show that the Lorenz system with appropriate choice of parameter values has a specific type of heteroclinic cycle, called singularly degenerate heteroclinic cycle, that consists of a line of equilibria together with a heteroclinic orbit connecting two of the equilibria. By an arbitrarily small but carefully chosen perturbation to the Lorenz system, we also show that the geometric model of Lorenz attractors formulated by Guckenheimer will bifurcate from it, among other things. Although not proven, one may also expect various other types of chaotic dynamics such as H' enon-like chaotic attractors, Lorenz attractors with hooks which were recently studied by S. Luzzatto and M. Viana, and what were observed in the original Lorenz system with large $r$ and small $b$ in the Sparrow's book on Lorenz Equations. The analysis is all done within a family of three dimensional ODEs that contains, as its subfamilies, the Lorenz system, the R"ossler's seconds ystem and the Shimizu-Moriokasystem, which are known to exhibit similar Lorenz-like chaotic dynamics.

Math Seminars

Phase-Locking in Integrate-and-Fire Neurons with Spike Dependent Threshold Modulation and Refractory Periods
Matt Holzer - Department of Mathematical Sciences, MSU
When: Thursday, April 24, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: It is known that phase locking can entrain frequency information for periodic inputs to the leaky integrate-and-fire (IF) model of a neuron. We show that this is still the case when the IF model is made more biologically realistic. We incorporate into our model spike dependent threshold modulation and refractory periods. Firing times from this model define a map on the annulus. We show that a unique rotation number still exists for this annulus map.

Math Seminars

Some Problems in Neuroscience and Mathematics
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, April 17, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: I decided to make an experiment and not to talk about a single subject and finish with a Theorem. Instead, I will review several topics which I find interesting, provide some introduction and then list problems I should be tackled within that area. The list includes mathematical problems related to neural coding, convergence in Map Seeking Circuits, Modeling receptive fields in V1, phase-locking in neuroscience vs. mathematics and Conley index application to singular perturbation problems. I hope to see a lot of graduate students in the audience.

Math Seminars
Rotation of Flows on Generalized Solenoids
Yuri Shvetsov - Department of Mathematical Sciences, MSU
When: Wednesday, April 16, 2003 03:10PM to 05:00PM
Where: Wilson Hall 1-143
Details: Ph.D. Dissertation Defense

Rotation sets have been defined and studied for maps and flows on various spaces, including the circle, an annulus, and a torus. They have been proven useful in the analysis of dynamics of such maps and flows. In this dissertation, we analyze ergodicity and rotation properties of flows on one-dimensional generalized solenoids, which include true solenoids and substitution tiling spaces. First, covering projections and lifts are constructed for homeomorphisms and flows on solenoids. We argue that only lifts homotopic to the identity should be considered, and show that a lift homotopic to the identity is unique. The concept of a rotation set is then defined for flows on solenoids. It is shown that a fixed-point free flow is uniquely ergodic, and that its rotation set contains exactly one point. It is also proved that a flow with fixed points is either uniquely ergodic or not, and as a consequence, the rotation set of such a flow is either a point or an interval. We give a criterion for distinguishing between these two cases. We also construct an example of two fixed-point free flows that have the same rotation set but are not topologically conjugate. Finally, all the above results are restated for flows on one-dimensional substitution tiling spaces.

Math Seminars
A Response Surface Approach to Assessing the Relative Efficiency of Adaptive Cluster Sampling
Phil Turk - Department of Mathematical Sciences, MSU
When: Tuesday, April 15, 2003 02:10PM to 04:00PM
Where: Hurst Conference Room Details: PhD Dissertation Defense

In this paper, we describe the motivation and provide the background behind adaptive cluster sampling (ACS). Several initial sampling designs are discussed with respect to theory and comparison to conventional sampling (Thompson 1990, 1991a,b). A review of the history and research for ACS is given for the years 1990 through 2002. Factors
and issues determining the relative efficiency of ACS are discussed. We also discuss further developments which include initial unequal probability sampling, other types of estimators, detectability, bootstrapping, and limiting sampling effort and cost. Using a designed experiment, multiple factors known to influence the efficiency of ACS were studied via response surface methodology where data were generated through computer simulation. This approach allowed us to characterize significant interaction effects as opposed to ignoring them as has been done in the literature. Using SRSWOR as a comparison, two responses were considered: the relative efficiency for the Horvitz-Thompson estimator of \( \text{RE}_{HT} \) and the relative efficiency for the Hansen-Hurwitz estimator of \( \text{RE}_{HH} \). Response surface plots at given conditions and grid searches were used to find factorial settings yielding variance-optimal relative efficiencies. Conditions that optimize \( \text{RE}_{HT} \) were harder to characterize than for \( \text{RE}_{HH} \). Different simulation approaches from the literature were compared with ours. A concern regarding any future investigation and the validity of conclusions regarding the factors that are important in terms of relative efficiency is the dependence on the simulation approach used to generate the study area population. The two estimation procedures were compared both through the response surfaces and through distributions of data gathered under varying population settings.

### Math Seminars

**Symmetry Breaking Bifurcation of the Information Distortion**  
Al Parker - Department of Mathematical Sciences, MSU  
**When:** Tuesday, April 08, 2003 10:00AM to 11:50AM  
**Where:** Hurst Conference Room  
**Details:** Ph.D. Dissertation Defense

**Spatially Periodic Modulation of Cortical Patterns and Waves**  
Dr. Paul Bressloff - Department of Mathematics, University of Utah  
**When:** Thursday, April 03, 2003 04:10PM to 05:00PM  
**Where:** Wilson Hall 1-139  
**Details:** One of the major simplifying assumptions in most large-scale models of cortical tissue is that the interactions between cell populations are homogeneous and isotropic, that is, that they are invariant under the action of the Euclidean group of rigid body motions in the plane. Euclidean symmetry plays a key role in determining the types of activity patterns that can be generated in these cortical networks. For example, it is well known that a homogeneous network can undergo a Turing-like instability due to competition between short-range excitation and longer range inhibition leading to the formation of spatially periodic patterns. When the degree of inhibition is reduced, traveling waves of activity can also be observed. However, the assumptions of homogeneity and isotropy are no longer valid when the detailed structure of long-range horizontal connections is taken into account.
In this talk we focus on the effects of spatially periodic inhomogeneities on cortical patterns and waves; these inhomogeneities reflect the underlying crystalline-like structure of cortex, as exemplified by the feature preference maps found in primary visual cortex. We begin by constructing a continuum model of cortex with long-range horizontal connections. We then use a mixture of Bloch wave theory and nonlinear analysis to show how spontaneous patterns can lock to the underlying cortical lattice, exhibiting a commensurate-incommensurate transition analogous to that found in convective fluid systems. Applications to visual hallucinations and cortical development are presented. Finally, we show how inhomogeneities can induce wave propagation failure in excitatory cortical networks, and identify a new form of instability leading to oscillatory waves.

Math Seminars
Comparison of Design Optimality Criteria of Reduced Models for Response Surface Designs in a Spherical Design Region
Boonorm Chomtee - Department of Mathematical Sciences, MSU
When: Tuesday, April 01, 2003 09:00AM to 10:50AM
Where: Hurst Conference Room
Details: PhD Dissertation Defense.

Math Seminars
An Overview of the Structure, Function and Modelling of the Visual Cortex
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU
When: Thursday, March 27, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: An overview of key anatomy of the visual system from the retina to the visual cortex is presented. Cell type and function will be described as well as certain well established (hard-wired) pathways. Electrical activity of cells are broadly categorized into functional groups: on/off center, simple and complex. Certain visual cues such as orientation are mapped from the visual field to the physical layers in the cortex. An overview of three different types of mathematical models for these layers will be presented.

Math Seminars
Solving Differential Inclusions
Dr. Bernd Kirchheim - Department of Mathematics, Trinity College, Oxford University, U.K.
When: Thursday, March 20, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: We consider the task to construct mappings between Euclidean spaces that use only a given class of gradients and want to understand to which extend these restrictions on the local behavior prescribe the global structure of the mapping. A
prototypical question seemingly elementary but still not completely understood asks which finite sets of matrices are the range of the gradient of a nontrivial (i.e. non affine) lipschitz mapping. We present recent progress on this problem and several applications, including questions from material sciences and regularity theory.

Math Seminars

Rotation of Flows on Generalized Solenoids
Yurii Shvetsov - Department of Mathematical Sciences, MSU
When: Tuesday, March 18, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars

Computational Topology and Analysis of Geometric Data Sets
Dr. Konstantin Mischaikow - Center for Dynamical Systems and Nonlinear Studies, Georgia Tech
When: Tuesday, March 11, 2003 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Come, this will be good.

Math Seminars

Some Recent Results on the Neural Coding Problem
Dr. Liam Paninski - Center for Neuroscience, New York University
When: Thursday, March 06, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: A central problem in neuroscience is to estimate the conditional probabilities P(response | stimulus) from neurophysiological data. Stated in this generality, this problem is unsolvable; we will never be able to record enough responses to specify these distributions for all possible stimuli. Thus, we have to try to solve some kind of easier version of this problem. As time permits, I'd like to talk about some recent results on three such approaches:

1. Instead of trying to estimate the full distribution, just estimate a few of the most important functionals of the distribution.
2. Fit some low-dimensional model to the distributions, instead of trying to estimate them by "brute force" (nonparametrically).
3. Design the experiments to be as efficient as possible, so we don't have to waste our time recording the responses to "uninformative" stimuli.

(These themes are not restricted to the neural context, of course.) The presentation will be fairly informal, and hopefully driven by the questions and interest of the audience.
**Math Seminars**

**Integrate-and-Fire Neural Networks and Forest Fires**
Dr. Jack Cowan - Department of Neurology and Dept of Mathematics, University of Chicago  
When: **Friday, February 28, 2003 12:00PM to 01:00PM**  
Where: Lewis Hall 11 (basement), next to CCB  
Details: There is a close correspondence between the dynamics and properties of large networks of spiking neurons and that of forest fires. Consider first a network of integrate-and-fire neurons. Each neuron is either hyperpolarized or refractory, depolarized or sensitive, or else activated. Now consider a forest fire comprising burned, green, or burning trees. Lattice models of such forest fires have recently been shown to exhibit a form of self-organized critical behavior. We show that integrate-and fire neural networks exhibit similar behavior and describe a number of new features associated with the dynamics of such networks.

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**Math Seminars**

**An Investigation of Prospective Secondary Mathematics Teachers**
Kate Riley - Department of Mathematical Sciences, MSU  
When: **Wednesday, February 26, 2003 01:10PM to 03:00PM**  
Where: Reid Hall 301  
Details: Ed.D. Dissertation Defense

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**Math Seminars**

**Adaptive Optics**
Dr. Curt Vogel - Department of Mathematical Sciences, MSU  
When: **Thursday, February 20, 2003 04:10PM to 05:00PM**  
Where: Wilson Hall 1-139  
Details: Adaptive optics, or AO, refers to the systems which adapt to compensate for optical effects introduced by the medium between the object (light source) and its image. In this talk we will give an overview of AO. We will present some recent mathematical results regarding AO system design and fast algorithms for AO simulation and control.

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**Math Seminars**

**Krige and Regress: Examining a Naive Estimator of Regression Parameters**
Lisa Madsen - Cornell University  
When: **Friday, February 14, 2003 12:00PM to 01:00PM**
Math Seminars
Traveling Waves in a Pioneer-Climax Model
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, February 13, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Presented is a reaction-diffusion model for the interaction of a pioneer and climax species. We study the existence of traveling waves in the case of the climax species diffuses at a slow rate. Singular perturbation analysis gives us information on sign of the wave speed. Numerical simulations of wave front propagation for the model on two-dimensional domains are also given.

Math Seminars
Density Estimation with Replicate Measurements
Julie McIntyre - North Carolina State University
When: Thursday, February 06, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-143

Math Seminars
Continuous Sensitivity Analysis for the Design of Control Systems
Dr. Jeff Borggaard - Department of Mathematics, Virginia Tech
When: Thursday, February 06, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: A common approach to designing controllers for distributed parameter systems is to discretize the problem and rely on finite dimensional control strategies. These finite dimensional methods require the solution of an nxn Riccati equation which becomes prohibitive with fine discretizations. For problems with a small number of inputs and outputs, Chandrasekhar equations provide an efficient tool for computing feedback laws. We’ll investigate this as well as the abstract form, Chandrasekhar PDEs, for computing functional gains. These gains provide a starting point for addressing sensor/actuator placement problems.

Math Seminars
The Sinc-Galerkin Method for Problems in Oceanography
Sanoe Koonprasert - Department of Mathematical Sciences, MSU
When: Tuesday, February 04, 2003 10:00AM to 11:50AM
Where: Hurst Conference Room
Details: Ph.D. Dissertation Defense

Math Seminars
P vs NP - Completeness: Overview and a Case Study
Dr. Brendan Mumey - Computer Science Department, Montana State University
When: Thursday, January 30, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Why certain problems seem to be harder to compute then the others? There is a belief that there is a class of hard computational problems, which are known as NP complete problems. I review this notion as well as related notions which characterize computational complexity. Then I illustrate techniques for proving NP-completeness on a concrete problem. I will show that optimal quantization using an information distortion function is an NP-complete problem. Brendan asked me to say that this will be informal talk. I encourage all grad students to come, as this will also be introductory talk, and, if you do not know, there is a million dollar prize for showing that P vs. NP problem.

Math Seminars
Spatial Models for Environmental Data
Dr. Jarrett Barber - Duke University
When: Thursday, January 30, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-143

Math Seminars
How do Learners Develop Meaningful Knowledge About Division of Fractions?
Dr. Janet Sharp - Iowa State University
When: Thursday, January 16, 2003 04:10PM to 05:00PM
Where: Wilson Hall 1-134
Details: Candidate for faculty position in Mathematics Education.

Math Seminars
Introduction to the Modeling and Numerics of Biofilm Flow
Todd Shaw - Department of Mathematical Sciences, MSU
When: Wednesday, December 11, 2002 03:30PM to 04:30PM
Where: Wilson Hall 1-131
Details: (This talk will also be part of Todd’s PH.D. oral exam. Students are especially encouraged to come.)
A PDE model for the ‘flow’ of a fluid and biofilm is presented. The model and flow is that of two immiscible fluids separated by an interface. The bulk fluid is assumed to be Newtonian and evolve according the Navier-Stokes equations. Experimental observations indicate that biofilm is most likely a viscoelastic fluid. Moreover, the polymer matrix (EPS) that microorganisms in a biofilm enclose themselves in is consistent with this idea. Viscoelastic fluids have more complex constitutive equations (stress and deformation relationships), and this complicates the computing. As a first step in simulating the two fluid model an algorithm is presented for the flow of two Newtonian fluids of different viscosities. The difficulty of the interface is handled using a
level set method. A movie will be shown, but refreshments will not be provided. (This talk will also be part of Todd's PH.D. oral exam. Students are especially encouraged to come.)

Math Seminars

Topological Neurology
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, December 06, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: The title is taken from two recent Russian publications, where p-adic dynamics is indispensable for anyone studying the human subconscious or human memory. Quote from a review in Math-Sci data base: "The encoding of ideas is via the coefficients of the p^n approximants .... Attractors of the dynamical system correspond to solutions to the problem posed by the conscious mind. "Are we back to the shame of Sputnik?" I will define p-adic integers and rationals, describe their topology and at least one p-adic dynamical system (the Newton map). This talk will be accessible to students in beginning topology whose ideas are p-adic approximants.

Math Seminars

Percolation Theory and Continuous Random Walks: Fractional Dynamics in Heterogeneous Porous Media Studied by Nuclear Magnetic Resonance
Dr. Joseph D. Seymour - Department of Chemical Engineering, MSU
When: Thursday, November 14, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: In this talk pulsed gradient spin echo NMR methods that directly measure the probability distribution of nuclei displacements, i.e. the van Hove self-correlation function or the propagator of motion, will be introduced. Some general ideas regarding transport in heterogeneous porous media such as fracture networks will be presented. Concepts from percolation theory will be introduced and applications to porous media discussed. Percolation theory predicts anomalous diffusion behavior, i.e. non-linear scaling of variance with time, for hydrodynamic dispersion in porous media. One means of generating anomalous diffusion is a continuous time random walk (CTRW) formulation that leads to fractional advection diffusion equations governing transport. CTRW's will be introduced and the behavior of fractional advection diffusion equations and the form of the van Hove self-correlation function presented. To conclude the predicted effect of these fractional dynamics on NMR measurements will be considered.

Math Seminars

Topological Optics (continued)
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
Math Seminars
A Sensitivity Equation Method for Elliptic Interface Problems
Dr. Lisa Stanley - Department of Mathematical Sciences, MSU
When: Thursday, November 07, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-136
Details: A Continuous Sensitivity Equation Methods is used to obtain sensitivity calculations for elliptic partial differential equations with discontinuous coefficients, or elliptic interface problems. The focus is on problems where the spatial location of the interface is parameter dependent. These PDEs have solutions which lack smoothness at the interface, and the corresponding sensitivity is discontinuous across the interface. The sensitivity equation is examined, and an iterative domain decomposition algorithm is used to numerically compute sensitivity approximations. This work is related to that of last week's speaker, Dr. Daoqi Yang. I am using his algorithm for the sensitivity computations. The algorithm is useful because it allows one to compute the state equation and the sensitivity equation using the same basic approach (and computer code). However, the parameter dependence of the subdomains affects the numerical algorithm through the use of relaxation parameters. In order to guarantee convergence, one must use values of these parameters which lie in certain intervals. Furthermore, to get fast convergence of the iterative algorithm, optimal values of the relaxation parameters can be computed or approximated numerically. These issues will be explored in more detail.

Math Seminars
Topological Optics
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, November 01, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Diffractive and dynamical spectra of quasi-crystals.

Math Seminars
Computational Algorithms for Interface Problems with Strongly Different Properties
Dr. Daoqi Yang - Department of Mathematical Sciences, Wayne State University
When: Thursday, October 31, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: An iterative finite element algorithm is proposed for numerically solving two phase steady-state generalized Stefan interface problems with discontinuous solutions, conormal derivatives, and coefficients. This algorithm employs finite element methods and iteratively solves smaller subregion problems for each phase with good accuracy,
and exchanges information at the interface to advance the iteration until convergence, following the idea of the Schwarz Alternating Method. The finite element grids in different phases do not have to match each other at the interface. Numerical experiments are performed to show the accuracy and efficiency of the algorithm for capturing discontinuities in the solutions and coefficients. One surprising property of the algorithm is that its accuracy does not deteriorate as the discontinuity in the coefficients becomes worse. That is, the accuracy remains the same for continuous problems and strongly discontinuous problems. Another surprising property is that its conditioning becomes better as the discontinuity gets worse. In other words, the stronger the discontinuity, the faster convergence. Numerical examples on matching and nonmatching grids are given with coefficient discontinuity jumps in the order of $10^3$, $10^5$, $10^{10}$, $10^{50}$, and $10^{100}$.

Math Seminars

The French Garden of Resonances
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, October 25, 2002 04:10PM to 05:00PM Where:
Details: How one can employ the algorithm introduced last time to detect resonances.

Math Seminars

Optimal Design of a Periodic Structure
Dr. Mike Flanagan - Department of Mathematical Sciences, MSU
When: Thursday, October 24, 2002 04:10PM to 05:00PM Where: Wilson Hall 1-139
Details: This is a type of inverse problem in diffractive optics. The idea is to create optical scattering sources on the order of the wavelength of light. Applications to this include photonic crystals, which is one of the latest-greatest research topics in "molding the flow of light".
I will present the problem formulation and the appropriate inverse problem. Time permitting, I will include a level-set method for solving this problem.

Math Seminars

On Some Nonlinear Wave Equations of Kirchhoff type
Barabara Szomolay - Department of Mathematical Sciences, MSU
When: Thursday, October 17, 2002 04:10PM to 05:00PM Where: Wilson Hall 1-139
Details: We discuss existence and non-uniqueness of weak solutions to a wave equation with a self-restoring term with Neumann boundary condition. Equations of this type have been mostly studied with Dirichlet boundary condition. We also investigate exponential decay and asymptotic behavior of solutions to some degenerate wave equations in terms of degenerate and nondegenerate cases of the Kirchhoff-operator. We extend these results to equations with bi-harmonic operator.
Math Seminars
Multidimensional Continued Fractions.
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, October 11, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Efficient approximation of a vector with real components by vectors with rational components is a basic applied problem. (For instance, it is critical for understanding the breakup of quasiperiodic motions under perturbations). In dimension one (that is for the real numbers), the Continued Fractions Algorithm is optimal for the task. In higher dimensions, finding an optimal algorithm is open. I will give an introduction to the continued fractions and propose their generalization to dimensions two and higher.

Math Seminars
Multiconjugate Adaptive Optics: 3-D Glasses for Large Telescopes
Dr. Curt Vogel - Department of Mathematical Sciences, MSU
When: Thursday, October 10, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: In this talk we will discuss the basic principles of multi-conjugate adaptive optics (MCAO), a proposed technology for correcting the blurring effects due to 3-dimensional variations in the index of refraction of the atmosphere. We will focus on the so-called wave front reconstruction problem, and we will present a computational algorithm to solve this problem.

Math Seminars
Investigating Neuronal Structure/Function Relationships using Genetic Optimization of Mathematical Models
Dr. Graham Cummins - Center for Computational Biology, MSU
When: Thursday, October 03, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: A central question in the study of neural computation is how the structural features of a neuron contribute to its computational function. This question is difficult to address experimentally, since it requires simultaneous measurement of many structural parameters, and, ideally, the ability to systematically alter them, and to observe the effect of these alterations on computational function. Mathematical models provide a system in which it is possible to perform this sort of systematic variation. Even in models, however, these experiments are difficult. Even a relatively simple aspect of function can depend on thousands of structural parameters, and, in general, these parameters interact strongly. As a result, exhaustive exploration of the parameter space is usually not possible. Optimization theory provides several algorithms for optimal searching of large parameter spaces. Several of these, notably genetic algorithms and
simulated annealing, have been used successfully with neural models. Usually these
techniques are used to find a point, or region, in parameter space at which the model
has some desired behavior (parameter fitting). It is also possible, however, to use these
techniques to study structure/function relationships. I have developed a method for
applying genetic algorithms to structure/function questions. This method makes it
possible to determine which parameters are most important to a given function in a
model, and, to a limited extent, to determine the mechanism of their effect. In addition to
describing the method, I will present the results of applying it to study sound localization
by an escape system neuron in fish.

Math Seminars
An Introduction to Combinatorics of Degree One Circle Maps (Part II).
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, September 27, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
An Introduction to Combinatorics of Degree One Circle Maps
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, September 20, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: This will be a very basic talk focusing on the number theory of circle rotations
and the associated combinatorial structure. I will also formulate a problem about
persistence of this structure for more general circle maps. The goal is to supply
students interested in pursuing research in dynamics with a warm up project.

Math Seminars
Continuation and Symmetry Breaking Bifurcation of the Distortion
Function
Al Parker - Department of Mathematical Sciences, MSU
When: Thursday, September 19, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: Using singularity and group theory, we determine the bifurcation structure of
the extrema for a class of cost functions which are used in Rate Distortion Theory
(Cover and Thomas1991, Gray 1990), Deterministic Annealing (Rose 1998),
Information Distortion (Dimitrov and Miller 2000, 2001) and the Information Bottleneck
Method (Tishby 2000). Knowledge of the bifurcation structure and numerical
continuation techniques yield an efficient optimization algorithm for this class of cost
functions.
Neural Coding: Mathematics Overview
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Thursday, September 12, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: I will review work which we have been doing in last couple of years on problem of Neural Coding in collaboration with Center for Computational Biology. I will concentrate on mathematical problems related to neural coding and indicate future directions and open problems.

Math Seminars
A Discrete Variable-Metric Theory of Spacetime
Nicomedes Alonso - Department of Mathematical Sciences, MSU
When: Thursday, May 02, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: The assumption that space time is a continuum has been questioned by many scholars, not because they doubt the validity and accuracy of results derived under that assumption but because it precludes lines of thought about the nature of physical reality that may lead to new insights. In this talk I will discuss some of the arguments against that assumption and introduce an unusual theory of space time first published by Herbert S. Ingham almost fifty years ago.

Math Seminars
Semiconjugacies to Toral Automorphisms.
Dr. Philip Boyland - University of Florida
When: Friday, April 26, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Topology and Fluid Mixing
Dr. Philip Boyland - University of Florida
When: Thursday, April 25, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: This is going to be a colloquium type talk so I encourage everybody to attend.

Math Seminars
Weighted Design Optimality Criteria
Dr. John Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, April 23, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-142
Math Seminars
High Speed Tour of Advanced Genetic Algorithm and Their Models (or lack thereof)
Neal Richter - Computer Science, MSU
When: Friday, April 19, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
On Labeling Points with Uniform Circles
Dr. Binhai Zhu - Department of Computer Science, MSU
When: Thursday, April 18, 2002 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: In this talk I will present the research development of the following NP-hard map labeling problem: Given \( n \) distinct points, label them with maximum circles such that all the circles have the same radius, no two circles overlap and no point is contained in any circle. In the past several years the approximation factor for the problem is reduced from roughly 29.86 (1997) to 19.85 (1999) and then to 3.6 (2000). I will also present a simple factor-3 approximation obtained very recently with Qin and Cimikowski. Some related open problems will be mentioned.
NOTICE CHANGE IN TIME. AT 4:00 WE HAVE AN AWARD CEREMONY FOR OUR UNDERGRADUATES, WHICH COULD SERVE AS A SEMINAR AFTER PARTY.

Math Seminars
Renormalization Group Analysis of Hamiltonian Flows
Dr. Hans Koch - Department of Mathematics, University of Texas
When: Friday, April 12, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139

Math Seminars
Attractor Reconstruction Through Spike Filters and Phase Locking
Matt Holzer - Department of Mathematical Sciences, MSU
When: Thursday, April 11, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: We investigate the problem of attractor reconstruction from inter-spike times produced by an integrate-and-fire model of neuronal activity. Suzuki et.al found that there construction of the R"{o}ssler attractor is incomplete if either cricket neural data or the integrate-and-fire model is used. To explain this failure, we define a discrete dynamical system on the R"{o}ssler attractor and show that if the attractor of the discrete system is a strict subset of the full attractor, the reconstruction of the R"{o}ssler attractor will be incomplete. For a wide range of parameters, numerical simulations demonstrate that the attractor of the discrete system is a subset of the R"{o}ssler
attractor. Moreover, the special structure of the incomplete reconstruction is explained by the existence of phase locking in a nearby periodically forced leaky integrate-and-fire model.

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**Math Seminars**

**The Simple Genetic Algorithm: A Dynamical Systems Model**
Christina Hayes - Department of Mathematical Sciences, MSU
When: Friday, April 05, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139

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**Math Seminars**

**Active Materials Technologies: Accomplishments and Challenges**
Dr. Aleksandra Vinogradov - Department of Mechanical and Industrial Engineering, MSU
When: Thursday, April 04, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139
Details: This presentation concerns an emerging and rapidly developing field of active or "smart" materials. A historical overview of the general subject area will be presented. Further, attention will be focused on the behavior, properties and applications of piezoelectric polymers. Research studies performed at Montana State University in the course of past several years will be summarized. A brief summary of the results, and new research directions will be discussed.

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**Math Seminars**

**Principal Component Models for Correlation Matrices**
Dr. Robert Boik - Department of Mathematical Sciences, MSU
When: Tuesday, March 26, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-142

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**Math Seminars**

**Proof of Birkhoff**
Kay Kirkpatrick - Department of Mathematical Sciences, MSU
When: Friday, March 22, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-139

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**Math Seminars**

**Traveling and Standing Patterns for a Pioneer-Climax Model**
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, March 21, 2002 04:10PM to 05:00PM
Where: Wilson Hall 1-132
**Math Seminars**

**Strong Coincidence Theorem**
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: **Friday, March 01, 2002 04:10PM to 05:00PM**
Where: Wilson Hall 1-139

**Math Seminars**

**Biofilms Are Fluids!**
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: **Thursday, February 28, 2002 04:10PM to 05:00PM**
Where: Wilson Hall 1-132
Details: In this brief seminar, concepts of viscoelasticity will be reviewed and evidence of fluid behavior in biofilms will be presented.

**Math Seminars**

**Geometric Realization and Coincidence.**
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: **Friday, February 15, 2002 04:10PM to 05:00PM**
Where: Wilson Hall 1-139

**Math Seminars**

**Neural Coding and Information Distortion**
Dr. Alexander Dimitrov - Center for Computational Biology, MSU
When: **Friday, February 08, 2002 04:10PM to 05:00PM**
Where: AgBioScience 108
Details: One of the steps toward understanding the neural basis of an animal's behavior is characterizing the code with which its nervous system represents information. We recently used tools from information theory to achieve two goals towards characterizing the neural coding scheme of a simple sensory system. We demonstrated that in the context of information theory, a coding scheme is an almost deterministic relation between clusters of stimulus/response pairs. We also developed a method to find high quality approximations of such a coding scheme. To do this, we quantized the neural responses to a small reproduction set and minimized an information-based distortion function to optimize the quantization. To use the method in cases involving complex, high dimensional input stimuli, we model the stimulus/response relation in a way that gives us an upper bound to the information distortion, used in the optimization problem. We use it to investigate coding properties of several identified neurons in the cricket cercal sensory system.
Math Seminars
Geometric Realization of Pisot Substitutions (part II)
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: **Friday, February 08, 2002 04:10PM to 05:00PM**
Where: Wilson Hall 1-139

Math Seminars
Singular Boundary Value Problems via the Conley Index
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: **Thursday, February 07, 2002 04:10PM to 05:00PM**
Where: Wilson Hall 1-139
Details: We use Conley index theory to solve a singular boundary value problem
\( \epsilon^2 u'' + f(u,x) = 0 \) on an interval \([-1,1]\) with separated boundary conditions. Our
assumptions are weaker than the standard set of assumptions since we use topological
methods. Conley index is used to track a certain cohomological information, which
guarantee existence of a solution to this boundary value problem.
This is a joint work with Konstantin Mischaikow (Georgia Tech) and Joerg Haerterich
(FreeUniversity Berlin). Joerg is supposed to supply some really cool example which
cannot be solved by traditional methods, but it has not happened yet.

Math Seminars
Geometric Realization of Pisot Substitutions (part I).
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: **Friday, February 01, 2002 04:10PM to 05:00PM**
Where: Wilson Hall 1-139
Details: First, I will finish recognizability. Second, for Pisot substitutions, I will factor the
translation flow of the tiling space onto an ergodictoral translation. I may have time to
mention how this relates to the open problem about the spectrum of the unitary group
generated by the flow (or the diffraction spectrum of the "quasi-crystal" represented by
the tiling).

Math Seminars
Approaches to Discovering Neural Coding Schemes
Albert Parker - Department of Mathematical Sciences, MSU
When: **Thursday, January 31, 2002 04:10PM to 05:00PM**
Where: Wilson Hall 1-139
Details: How does neural ensemble activity represent sensory stimuli?? In this talk, I
present historical approaches for characterizing neural coding schemes: rate coding,
Poisson and Gaussian modeling, Wiener series approximations, linear reconstruction
methods and a metric space approach. Appreciating these methods provides an
introduction to our approach for discovering neural coding schemes: we minimize an information-theoretic cost function. This talk will be repeated at CBS seminar on Feb. 1st and will be followed by a talk by Alex Dimitrov at the CBS seminar on Feb. 8, who will talk about our approach.

Math Seminars
Conjugacy of Solenoids (cont.).
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, December 14, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Conjugacy of Solenoids.
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Friday, December 07, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Return Map Characterizations of Singular Solutions to Bursting Systems with Two Slow Variables.
Roger Griffiths - Department of Mathematical Sciences, MSU
When: Tuesday, December 04, 2001 03:30PM to 04:30PM
Where: Wilson Hall 1-132
Details: Various physiological systems display bursting electrical activity (BEA). There exist numerous three variable models to describe this behavior. However, four variables may be required to explain some qualitative features of the BEA. A model with two slow and two fast variables is presented. For some parameter values the system has stable equilibria while for other values there exist bursting solutions. A singular construction of the latter solutions corresponds to the existence of a fixed point of a one dimensional map. The map is the composition of two maps derived from the slow subsystem and the averaged fast-subsystem. In a degenerate case this fixed point is determined. For nondegenerate cases numerical methods for calculating these maps will be presented. This is part of the oral PhD comprehensive exam.

Math Seminars
Neural Coding in Early Sensory Systems
Al Parker - Department of Mathematical Sciences, MSU
When: Thursday, November 29, 2001 03:30PM to 04:30PM
Where: Wilson Hall 1-132
Details: How does neural ensemble activity represent sensory stimuli?? In this talk, I present a new approach to characterizing neural coding schemes. This approach attempts to describe the specific stimulus parameters encoded in the neural ensemble activity and, at the same time, determines the nature of the neural symbols with which that information is encoded. An information-theoretic cost function (the information distortion) is minimized to produce a simple approximation of a coding scheme. This is the optimization problem I study. The admissible region for the problem is a direct product of simplices. It is shown that the optimal solution always occurs at a vertex of this admissible region. This allows are formulation of the problem as anew maximization problem on the set of vertices and the development of a new algorithm, which, under mild conditions, always finds a local extremum. The performance of the new algorithm to standard optimization schemes on synthetic cases and on physiological recordings from the cricket cercal sensory system are presented.

Math Seminars
Some Results and Open Problems in Quasi-Conformal Dynamics on Surfaces
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, November 16, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: After finishing the exposition on the extremal length, I will discuss how some natural results and open problems on topological entropy and rotation sets benefit from a quasi-conformal point of view.

Math Seminars
Lower Bound Constrained Optimization and an Application to Image Reconstruction
John Bardsley - Department of Mathematical Sciences, MSU
When: Thursday, November 15, 2001 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: As light propagates through the atmosphere, light rays are bent due to random variations in the index of refraction caused by atmospheric turbulence. This causes blurring of images of an astronomical object captured with a ground-based telescope. The inverse problem of interest is to reconstruct the object from these blurred images. Several features make this problem difficult to solve. First, the problem is ill-posed, so regularization is required. Also, due to the large number of pixels needed to obtain high resolution images, the problem has a large number of unknowns, and efficient numerical techniques are required. Lastly, we have a lower bound constraint resulting from the fact that any object reconstruction ought to have nonnegative light intensity at each pixel. A general theory for lower bound constrained minimization will be presented and several constrained minimization techniques will be discussed. We will finish with a
comparison of certain of these techniques applied to the image reconstruction inverse problem.

Math Seminars
The Use of Mahalanobis Distance in Wildlife Habitat Use Studies
Dr. Steve Cherry - Department of Mathematical Sciences, MSU
When: Tuesday, November 13, 2001 04:10PM to 05:00PM
Where: Wilson Hall 2-214

Math Seminars
Introduction to Quasi-Conformal Mappings and Extremal Length (continued)
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, November 09, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-139

Math Seminars
Long-Time Behavior of Magnetic Field in Two Dimensions
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, November 08, 2001 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: In this talk I will present some old work, recently cleaned up, on evolution of magnetic field in conducting flows over times long compared to all available physical time scales, a question relevant to astrophysical objects. In two dimensions under magnetohydrodynamic assumptions the possible behaviors can be largely catalogued. In three dimensions, however, the problem is (very) open.

Math Seminars
Introduction to Quasi-Conformal Mappings and Extremal Length
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, November 02, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: I will give prerequisites needed for some proofs in the theory of rotation sets that will be discussed in subsequent talks.

Math Seminars
A Multigrid Preconditioned Conjugate Gradient Method for Large Scale Wavefront Reconstruction
Dr. Luc Gilles - Department of Mathematical Sciences, MSU
When: Thursday, November 01, 2001 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: I will talk about the multi grid preconditioned conjugate gradient method to solve large linear systems occurring in the simulation and control of the adaptive optics of large telescopes. I will present numerical simulations results indicating the effectiveness of our approach for a wide range of wavefront slope measurement signal to-noise ratio.

Math Seminars
Long-Time Behavior of Magnetic Field in Two Dimensions
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, November 01, 2001 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: In this talk I will present some old work, recently cleaned up, on evolution of magnetic field in conducting flows over times long compared to all available physical time scales, a question relevant to astrophysical objects. In two dimensions under magnetohydrodynamic assumptions the possible behaviors can be largely catalogued. In three-dimensions, however, the problem is (very) open.

Math Seminars
Optimal Shape Design using Domain Transformations and Continuous Sensitivity Equation Methods
Dr. Lisa Stanley - Department of Mathematical Sciences, MSU
When: Thursday, October 25, 2001 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: The focus of the talk is an optimal design problem where the design parameter determines the shape of the domain of the constraint equation. The cost function is an integral expression describing the difference (in $L_2$) between some target function and the state variable. The state equation, or constraint equation, takes the form of an elliptic partial differential equation defined on the parameter dependent domain. I consider two approaches to approximating the solution to the optimal design problem. Both approaches use the method of mappings (a domain transformation technique) and Continuous Sensitivity Equation Methods (CSEMs) within the approximation scheme. The main difference between the techniques is the order in which the mappings and CSEMs are applied to the problem. One approach yields consistent gradients (with a sufficiently accurate quadrature rule applied) while the other approach yields asymptotically consistent gradients. The terms "consistent gradient" and "asymptotically consistent gradient" will be defined more specifically during the course of the talk. I will also give a sketch of some current ideas which are related to my talk. I am writing a proposal for a Humboldt fellowship with an optimization expert. If the proposal is funded, he and I plan to explore one of the techniques mentioned above in much greater detail.
**Math Seminars**

**Diffusion is the Great Leveler of Chemical Concentration, isn't it?**
Dr. Richard Field - Department of Chemistry, University of Montana

**When:** Friday, October 19, 2001 04:10PM to 05:00PM
**Where:** Ag Biosc. Room 108

**Details:** This should be a great overview of diffusion driven instabilities in Reaction Diffusion systems. Also, refreshments will be served!!

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**Math Seminars**

**Fast Wavefront Reconstructors for Adaptive Optics**
Dr. Curt Vogel - Department of Mathematical Sciences, MSU

**When:** Thursday, October 18, 2001 04:10PM to 05:00PM
**Where:** Wilson Hall 1-132

**Details:** As light propagates through the atmosphere, wave fronts are distorted by variations in the index of diffraction. Adaptive optics (AO) involves the use of deformable mirrors to correct for these distortions. A key component of an AO system is the wavefront reconstructor. This is a mapping that takes wavefront sensor measurements to mirror displacements. We will discuss algorithms for fast computation of wavefront reconstructors.

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**Math Seminars**

1. **An Inverse Problem in X-Ray Radiography 2. Modeling Control of HIV Infection through Structured Treatment Interruptions**
   1. John Bardsley 2. Al Parker - Department of Mathematical Sciences, MSU

   **When:** Thursday, October 11, 2001 04:10PM to 05:00PM
   **Where:** Wilson Hall 1-132

   **Details:** John and Al took part in 7th Industrial Mathematical Modeling Workshop this summer in North Carolina. Each will give a 1/2 hour overview of the work they did there. **THIS (as well as any other seminar) IS A MUST SEE FOR ALL GRADUATE STUDENTS.**

   Here are the abstracts:

   1. (John) Boeing Corporation is interested in improving its software for the inspection of high performance aircraft parts. X-Ray radiography is used in the inspection of these parts. One piece of the puzzle and the inverse problem of interest is following: Given a particular radiographic image of a fixed geometry (aircraft part), find the corresponding position of the X-Ray source and the detector array.

   2. (Al) Highly Active Anti-Retroviral Therapy (HAART) of HIV infection has significantly reduced morbidity and mortality in developed countries. However,
since these treatments can cause side effects and require strict adherence to treatment protocol, questions about whether or not treatment can be interrupted or discontinued with control of infection maintained by the host immune system remain to be answered. We present sensitivity analysis of a compartmental model for HIV infection that allows for treatment interruptions, including the sensitivity of the compartments themselves to our parameters as well as the sensitivity of the cost function used in parameter estimation. Recommendations are made about collecting data in order to best estimate the most sensitive parameters in the model. Furthermore, we solve the inverse problem to estimate the parameters using simulated data.
The general problem of the coronal magnetic field is to find an equilibrium satisfying boundary conditions on its normal component at the photospheric surface. The problem may be cast in variational terms as one of energy minimization subject to a number of possible constraints. I will present a new class of constraint whereby the amount of flux in each topologically distinct domain is held fixed. For $N_{\text{photospheric}}$ sources, connected via $N_{d}$ domains, the constraint can be applied using $N_{d}-N_{\text{photospheric}}+1$ different functionals. The resulting Euler-Lagrange equation has this number of free parameters (undetermined multipliers) and contains singularities (current sheets) along the same number of surfaces within the corona. I present a two-dimensional example where the equation can be solved analytically. This shows the nature of the current singularity and magnetic energy variation over the entire parameter space. I further discuss generalization to arbitrary two-dimensional equilibria.

**Math Seminars**

**Geometric Realization of Tiling Spaces**
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: **Friday, September 21, 2001 03:10PM to 04:00PM**
Where: Wilson Hall 1-139

**Math Seminars**

**A Protein Structure Alignment Problem: Antibody Epitope Mapping**
Dr. Brendan Mumey - Department of Computer Science, MSU
When: **Thursday, September 20, 2001 04:10PM to 05:00PM**
Where: Wilson Hall 1-132

Details: A recent idea for determining the three-dimensional structure of a protein involves mapping antibody epitope combining sites using random peptide libraries. Antibodies that bind to the surface of the protein, can be used as "witnesses" to report the structure of the protein as follows: The protein in question is composed of loops of linear polypeptide chain that must come together in a complex spatial folding pattern to create the binding sites for each antibody. Random peptide libraries can be used to select short amino acid {em probe} sequences that also bind to the active region of the antibody. These probe sequences are homologous to the surface of the protein and can be aligned to discontinuous regions of the one-dimensional {em target} sequence of the original protein. Such alignments indicate how pieces of the protein sequence must be folded together and provide valuable long-range constraints for solving the overall 3d structure. This approach has the advantage of requiring very small amounts of protein and is applicable to the large number of cases that are refractory to current approaches to structure determination. We formalize this alignment problem, prove that it is NPcomplete, and give some initial results using a branch-and-bound algorithm to solve some real-life cases.
Math Seminars
The Shilov Boundary of Operator Spaces and Applications to Dynamics
Kay Kirkpatrick - Department of Mathematical Sciences, MSU
When: Friday, September 14, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-139
Details: Abstract: The classical Shilov boundary is a very useful way of viewing Banach spaces as subspaces of function spaces. This notion has been extended nicely to the noncommutative world to similarly view operator spaces (which are noncommutative Banach spaces) as subspaces of C*-algebras (which are noncommutative function spaces). An interesting question to ask in this context is, "What operator spaces have C*-algebras for their Shilov boundary?" A partial answer to this question will be presented. In addition, the classical Shilov boundary provides a nice characterization of certain group actions on a topological space, and it is postulated that this characterization can be generalized to noncommutative topological spaces.

Math Seminars
Buffered Calcium Waves
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU
When: Tuesday, May 01, 2001 04:10PM to 05:00PM
Where: Wilson Hall 1-131
Details: Calcium is known to play an important role in intracellular and intercellular physiology. In some cells (liver, heart, epithelia, hippocampal, for instance), calcium waves have been measured by observing the intensity of light emanating from molecules to which the calcium binds (buffer). Some physiology and modelling efforts of such phenomena will be summarized. A model for calcium and buffer concentration will be developed and numerical and initial analytical efforts will be discussed.

Math Seminars
Derivation of Viscoelastic Fluid Equations for a Model Biofilm
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Tuesday, April 24, 2001 04:10PM to 05:00PM
Where: Wilson Hall 1-131
Details: Biofilms, collections of microorganisms bound together by a sticky polymer matrix, are common throughout nature. Control and removal of biofilms is an important objective in many circumstances, yet their mechanical properties are poorly understood. Experiments indicate that biofilms react to stress viscoelastically and are able to vary their mechanical properties in response to changes in those mechanical stresses. This talk will consist of a brief introduction to viscoelastic continuum mechanics followed by a derivation of a set of viscoelastic evolution equations for a simple biofilm model.
Mathematical Impressions from Tucson, Arizona
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, April 20, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-138

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**Math Seminars**

Optical Pulse Dynamics in Nonlinear Media (Part II)
Dr. Luc Gilles - Department of Mathematical Sciences, MSU
When: Friday, March 30, 2001 03:10PM to 04:00PM
Where: Math Conf. Room

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**Math Seminars**

Optical Pulse Dynamics in Nonlinear Media
Dr. Luc Gilles - Department of Mathematical Sciences, MSU
When: Friday, March 23, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-138

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**Math Seminars**

Phase Diversity Models and Algorithms for Atmospheric Image Reconstruction
Dr. Todd Torgersen - Department of Computer Science, Wake Forest University
When: Tuesday, February 27, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-131
Details: The approach taken here is based on a multiframe/multichannel formulation of the phase diversity method for image reconstruction. The emphasis is on extending previously presented models to new formulations which compensate for various undesirable effects present in real-world telescope data. These undesirable effects include: image mis-alignment of the diversity channels (tip/tilt), and image magnification changes between the diversity channels. The extended models and their associated (modified) objective functions lead to new non-linear optimization problems for phase diversity. Solution methods, software, and results from real telescope data are presented.

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**Math Seminars**

Polynomial Matrices and Positive K-Theory in Symbolic Dynamics
Dr. Mike Boyle - Department of Mathematics, University of Maryland
When: Thursday, February 22, 2001 04:10PM to 05:00PM
Where: Wilson Hall 1-142

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Math Seminars
Topological Entropy for Solenoidal Maps
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, February 09, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-148
Details: I will give an extension of the Bowen's formula for the entropy of a factor to the non-compact context relevent for solenoidal maps, i.e. the maps that permute leaves of some "irrational" lamination of a compact space. (For students: the solenoidal maps may offer a nice thesis topic.)

Math Seminars
Counting with the Euler Characteristic
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: Friday, February 02, 2001 03:10PM to 04:00PM
Where: Wilson Hall 1-148

Math Seminars
Weyl Geometry and Dynamics of Gaussian Thermostats (Part 2, Technical)
Dr. Maciej P. Wojtkowski - Mathematics Department, University of Arizona
When: Friday, December 01, 2000 03:10PM to 04:00PM
Where: Wilson Hall 1-148

Math Seminars
Weyl Geometry and Dynamics of Gaussian Thermostats
Dr. Maciej P. Wojtkowski - Mathematics Department, University of Arizona
When: Thursday, November 30, 2000 04:10PM to 05:00PM
Where: Wilson Hall 1-131

Math Seminars
Generalized Mixed Models Survival Data
Lewellyn Armstrong - Institute for Wetland and Waterfowl Research
When: Thursday, November 30, 2000 04:10PM to 05:00PM
Where: Wilson Hall 1-141

Math Seminars
The Temporal Correlation Hypothesis of Visual Feature Integration
Dr. Charles Gray - Department of Computational Biology, MSU
When: Tuesday, November 21, 2000 03:10PM to 04:00PM
Where: Wilson Hall 1-131
Math Seminars
The Young Person
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Friday, November 17, 2000 03:10PM to 04:00PM
Where: Wilson Hall 1-148

Math Seminars
Attractors Which Contain all Chainable Continua
Brian Martensen - Department of Mathematical Sciences, MSU
When: Friday, November 03, 2000 03:10PM to 03:40PM
Where: Wilson Hall 1-148

Math Seminars
Some Extensions of Common Principal Components
Dr. Robert J. Boik - Department of Mathematical Sciences, MSU
When: Tuesday, October 24, 2000 04:10PM to 05:00PM
Where: Wilson Hall 1-147
Details: This seminar will provide an introduction to principal components and to common principal components (CPC). Bernhard Flury's CPC model is useful when one is examining principal components in several distinct but related populations. For example, an investigator might be interested in the principal components of several measures of body size in different species of marmots. If the principal components in one species share characteristics with the principle components of other species, then the CPC model can be used to identify these characteristics. Several extensions to Flury's model are described.

Math Seminars
Intriguing Open Problems in Hamiltonian Dynamics
Dr. Oliver Knill - Department of Mathematics, Harvard University
When: Friday, October 20, 2000 03:10PM to 04:00PM
Where: Wilson Hall 1-148

Math Seminars
Optimal Control Problems in Food Sterilization
Dr. Ekkehard Sachs - Fachbereich IV-Mathematik, Universitat Trier and Math Dept, Virginia Tech
When: Friday, October 20, 2000 02:10PM to 03:00PM
Where: Wilson Hall 1-117
Details: We consider the mathematical modelling and numerical solution of sterilization processes by heating in the food industry. It leads to an optimal control problem with state and control constraints which is governed by a nonlinear heat equation. In its discretized form we use a SQP-method to solve the resulting largescale optimization problem. The computed control differs from the one typically used in industry in the case where the retention of vitamins is maximized during the sterilization.

Math Seminars
Estimation of Scaled Prediction Variances for Response Surface Designs (Or, Why Do I Get Different Results Depending on What Software I Use?)
Dr. John J. Borkowski - Department of Mathematical Sciences, MSU
When: Tuesday, October 17, 2000 04:10PM to 05:00PM
Where: Wilson Hall 1-147
Details: Among the numerous response surface design evaluation criteria is the IV criterion which is based on the average prediction variance. A comparison of the various ways that computing packages estimate the IV-criterion will be presented. A simple approach will then be given to provide the exact evaluation of the IV-criterion for response surface designs on the hypercube.

Math Seminars
Dynamics of Emerging Flux Tubes in the Sun
Tetsuya Magara - Department of Physics, MSU
When: Tuesday, October 17, 2000 03:10PM to 04:00PM
Where: Wilson Hall 1-131
Details: Space and ground base observations have discovered various kinds of activities on the sun. These activities are now widely believed to have a close connection with the magnetic field emerging to the solar atmosphere. It is therefore important to understand the physics of the emerging magnetic field in order to clarify the mechanism to cause such dynamical phenomena on the sun. The macroscopic behavior of magnetized fluid (or plasma) is described by the so-called MHD equations (MHD means Magneto Hydro Dynamics), which are usually time dependent, nonlinear hard-to-solve equations unless you assume some conditions, such as, time-independence, incompressibility, etc. However if you focus on the dynamical features of phenomena and try to reproduce them to make a direct comparison with observational results, numerical simulation is a good tool to make that research possible. In my talk, I will show the method of numerical simulation and discuss its strong points as well as weak points. Also, I will mention some techniques to reduce the numerical instabilities which affect the evolution of system. The subject which I talk about comes from my recent work. This work deals with the dynamics of a magnetic flux tube in stratified gas layers. A flux tube is considered to be a basic element for various magnetically
originated activities on the sun. I will show the behaviors of the flux tube in several evolutionary stages (rising in the convection zone, flattening at the photospheric-level, emerging to the solar atmosphere, and the strong expansion in the atmosphere), using numerical simulation results and discuss the features of each stage.

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**Math Seminars**

**Embedding Tiling Spaces into Surfaces**
Dr. Marcy Barge - Department of Mathematical Sciences, MSU
When: **Friday, October 13, 2000 03:10PM to 04:00PM**
Where: Wilson Hall 1-148

**Math Seminars**

**A Fresh Point of View on Kneading Sequences (Inspired by the Work of Scott Lewis)**
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: **Friday, October 06, 2000 03:10PM to 04:00PM**
Where: Wilson Hall 1-148

**Math Seminars**

**Optical Switching with a 1D Nonlinear Band Gap Structure: FDTD Results**
Dr. Luc Gilles - Department of Mathematical Sciences, MSU
When: **Tuesday, October 03, 2000 03:10PM to 04:00PM**
Where: Wilson Hall 1-131
Details: Using the Finite Difference Time Domain (FDTD) method of Computational Electromagnetics (CEM), I will discuss 1D nonlinear wave propagation through a quarter-wave reflector. An optical switch based on a strong pump beam sensing the embedded nonlinearities to control the switching of a weak probe (signal) beam will be presented. I will show that introducing a defect into such photonic crystals can improve their switching performance. Finally, I will consider the possibility to use chiral polymers as dopants to build a chiral switch where pump and probe can have the same frequency but different circular polarization.

**Math Seminars**

**Introduction to Dynamical Partitions of Tori**
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: **Friday, September 29, 2000 03:10PM to 04:00PM**

**Math Seminars**

**Detecting Fraud in Crop Insurance Payments**
Dr. Jim Robison-Cox - Department of Mathematical Sciences, MSU
**Math Seminars**

**Theoretic Estimation Bounds for Blind Inverse Problems with Application to Phase Diversity Imaging**

Brian Thelen - Veridian, ERIM -

When: **Friday, April 28, 2000 01:10PM to 02:00PM**
Where: Wilson Hall 2-274

**Details:** In a variety of inverse problems the forward operator is itself unknown, and the result is a "blind inverse problem" requiring the simultaneous estimation of the operator and the original function. In mathematical statistics, there have developed a variety of useful lower bounds on the expected estimation error which are valid for general classes of estimators. These theoretical lower bounds are particularly useful in the blind inverse problem as a design tool since typically there are a number of design parameters related to the forward operator and it is desirable to set these so as to have the optimal "amount of information" in the collected data. It can also provide a framework for developing an understanding of what really determines the information content. In this talk we present a general overview of the theory of statistical estimation bounds for blind inverse problems and then discuss specific applications for phase diversity. Phase diversity is a relatively recent development which provides the capability, with computer post-processing, for achieving fine-resolution imagery even in the case of significant (and unknown) turbulence-induced blur.

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**Math Seminars**

**Dynamics of a Simple Model of Gene Regulatory Networks**

Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU

When: **Tuesday, April 18, 2000 04:10PM to 05:00PM**
Where: Wilson Hall 1-130

**Details:** We consider a model of neural and gene networks where the nonlinearities in the system of differential equations are discontinuous and piecewise constant. We develop a framework for study of such systems. As a first step we associate to the system graph $G$ on a hypercube and show how the collection of strongly connected components of $G$ relates to the dynamics of the flow on the set of rays through the origin. In the second step we discuss the relationship between the invariant sets of the ray flow and the invariant sets of the original flow. We provide a sufficient condition for a one-to-one correspondence between these sets. We study the class of binary networks within this framework. Under certain conditions we can determine the structure of an invariant set corresponding to the lowest strongly connected component of the hypercube graph. In the second part of the talk we discuss possible invariant sets in the four dimensional systems for which lowest strongly connected component of the hypercube graph has form of figure 8.
Math Seminars
Sensitivity Equations and their Application to Complex Fluids
Dr. Jeff Borggaard - Virginia Polytechnic Institute and State University
**When:** Thursday, March 30, 2000 04:10PM to 05:00PM
**Where:** Wilson Hall 1-130
**Details:** In this talk, we present a continuous sensitivity equation method which handles a general class of flow problems. In particular, we introduce the equations for fluids with variable material properties. An example includes corn syrup, which becomes less viscous as it is heated. In addition, we discuss a number of applications for sensitivity equations including their role in shape optimization, nearby solutions, and assessing the accuracy of low calculations. Numerical studies (and several pretty pictures) will be included.

Math Seminars
Continuous Methods for Solving Nonlinear Ill-Posed Problems
Dr. Alexandra Smirnova - Department of Mathematics, Kansas State University
**When:** Friday, March 17, 2000 11:00PM to 12:00PM
**Where:** Hurst Conference Room
**Details:** The goal of the presentation is to discuss a general approach to solution of ill posed nonlinear problems in a Hilbert space based on continuous processes with a regularization procedure. To avoid the ill-posed inversion of the Fréchet derivative operator a regularizing one-parametric family of operators is introduced. Under certain assumptions on the regularizing family a general convergence theorem is proved. The proof is based on a lemma describing asymptotic behavior of solutions of a new nonlinear integral inequality. Then the applicability of the theorem to the continuous analogs of the Newton, Gauss-Newton and simple iteration methods is demonstrated.

Math Seminars
Evolution of Fingering Instabilities in a Biofilm Model
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
**When:** Tuesday, March 07, 2000 04:10PM to 05:00PM
**Where:** Wilson Hall 1-130
**Details:** A biofilm layer is modeled using a simple single substrate system. One dimensional moving front solutions are fully analyzed. These solutions are sometimes unstable to 2 and 3 dimensional interface perturbations. The evolution of these linear instabilities is followed numerically using a level set method.

Math Seminars
One Dimensional Biofilm Models
Lori Pritchett - Department of Mathematical Sciences, MSU
**When:** Tuesday, February 29, 2000 04:10PM to 05:00PM
Where: Wilson 1-130
Details: The term biofilm describes the collection of microorganisms that accumulate on surfaces in aqueous environments. Biofilms occur in a variety of places. Examples include: pipes in a water treatment plant, medical implants and rocks in a stream bed. The presence of such build-up poses health risks and can effect a system's operation. Since the mid-1980's, several models for biofilm growth have been proposed. Recent experiments suggest that the presence extracellular polymeric substances (EPS) have an effect on cell distribution in a biofilm. This talk will focus on the development of a single species one dimensional biofilm model that includes EPS production. A single species biofilm model will be presented and the existence of steady state solutions of this model will be proved. The model which does not include detachment suggests that a steady state solution is possible if the inactivation rate is zero. This model is adjusted to incorporate EPS production. In the new model, the production of a signaling chemical affects the cell's substrate utilization and EPS production. Numerical simulations indicate that the model tends to a steady state. In these steady state solutions, the cell density is high where the EPS concentration is low. When the chemical production rate is set to zero, the model tends to a steady state solution where the cell density is uniform and the EPS level is negligible.

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**Math Seminars**

**p-Adic Tiling Spaces**
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Thursday, February 24, 2000 03:10PM to 04:00PM
Where: Wilson Hall 1-141

**Math Seminars**

**Neural Maps and Information Processing in Sensory Systems**
Dr. Gwen Jacobs - Center for Computational Biology, MSU
When: Tuesday, February 22, 2000 04:10PM to 05:00PM
Where: Wilson 1-130
Details: This seminar will discuss recent work on the cricket cercal sensory system describing the cellular and computational mechanism involved in encoding stimulus direction and dynamics by an ensemble of sensory interneurons. These results will be discussed with respect to similar organizational principles found in other nervous systems.

**Math Seminars**

**A Sinc-Galerkin Method for Oceanography**
Dr. Ken Bowers - Department of Mathematical Sciences, MSU
When: Sunday, January 16, 2000 04:10PM to 05:00PM
Where: Wilson Hall 1-130
Details: The Sinc-Galerkin method is one that provides exponential convergence when numerically solving differential equations. This rapid convergence allows one to dramatically reduce the size of the resulting discrete system when compared to that of standard finite difference or finite element methods. An elementary introduction to Sinc-Galerkin methods will be given for those who are unfamiliar with this technique. An application in oceanography that of wind-driven ocean currents, will be used to illustrate the discrete formulation. Numerical results will be given to highlight the features of this method.

Math Seminars
Dynamic Patterns of Activation in a Neural Map in the Cricket Cercal Sensory System
Dr. Sharon Crook - Center for Computational Biology, MSU
When: Tuesday, December 07, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: Mechanosensory afferents in the cricket cercal system form a map of air current direction. Neural maps are thought to encode sensory stimuli in spatio-temporal patterns of activity. These activity patterns depend on both the anatomical relationships among the constituent neurons and also their physiological stimulus/response properties. We use experimental data to develop models that predict each afferent’s response to any given stimulus. We incorporate these predictions into a probabilistic atlas that describes the anatomy of the map. An analysis of the dynamic patterns of activity in the atlas yields insight into how sensory stimuli are represented in spatio-temporal patterns of activity by this ensemble of neurons.

Math Seminars
Chaos in General Relativity
Dr. Neil Cornish - Department of Physics, MSU
When: Monday, December 06, 1999 04:10PM to 05:00PM
Where: Math Conference Room

Math Seminars
Chaos in the Cosmos
Dr. Neil Cornish - Department of Physics, MSU
When: Tuesday, November 30, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: It has long been known that the gravitational N-body problem is only integrable for fewer than three bodies. Consequently, many astrophysical systems exhibit chaotic behavior. To understand the structure of the Kuiper belt or the tumbling of Saturn’s moon Hyperion, one needs to understand deterministic chaos. The situation is further complicated in Einstein’s theory of gravity since the non-linearities are more pronounced than in Newton’s theory. Motion about black holes and the evolution of the universe
itself can exhibit chaotic behavior. The talk will give an overview of chaos theory applied to cosmology and astrophysics.

Math Seminars
Hydrodynamics - Biofilm Interactions: A Continuing Challenge to Mathematical Modelers
Dr. Paul Stoodley - Dept. of Civil Engineering, Center for Biofilm Engineering, MSU
When: Tuesday, November 23, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: Biofilms are composed of bacteria and other microorganisms embedded in an extracellular polymeric slime matrix which are attached to a surface (usually solid). Biofilms generally form on any wetted surface and are consequently found in many environmental, industrial, and medical systems. The hydrodynamics of an aqueous environment has a significant influence on biofilm development and activity and is, in turn, influenced by the biofilm. In a conduit, such as a heat exchanger or water distribution pipe, biofilm accumulation can influence the hydrodynamics with important implications for heat, mass, and momentum transfer. Biofilms growing in pipelines can result in significant increases in pressure drop. Such pressure drops are much greater than those caused by rigid rough surfaces. As yet the influence of biofilm formation on pressure drop cannot be predicted. Recently biofilm researchers have found that biofilms systems are much more complex than previously thought. Biofilms are often heterogeneous and consist of clusters of cells separated by interstitial channels. These channels allow fluid flow within the biofilm. Another complicating factor is the small scale of biofilm thickness (10 to 100's of m). This thickness is comparable in scale to that of the viscous boundary layer and consequently biofilms reside within a velocity gradient. Biofilms can be viscoelastic and begin to flow when the fluid shear stress is elevated beyond the yield point. In turbulent flow biofilm filaments oscillate with high frequency. Both these processes presumably influence drag and mass transfer in the region near the wall but it is not known to what extent. Our understanding of many of the physical processes (i.e. mass transfer, drag and shear) which influence biofilm growth and detachment can only be fully understood when we can mathematically describe the interactions between a moving fluid and a biofilm. Experimental research continues to reveal levels of complexities

Math Seminars
Huygens' Clocks
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Monday, November 22, 1999 03:10PM to 04:00PM
Where: Wilson Hall 1-139
A Semi-Implicit Time Scheme for the Bidomain Model in Cardiac Tissue
Dr. Kristina Bogar - Department of Mathematical Sciences, MSU
When: Tuesday, November 16, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: A numerical scheme to study the propagation of action potentials in cardiac tissue using the bidomain model will be presented. This model assumes that cardiac tissue is a two-phase medium, consisting of intracellular and extracellular spaces. The governing equations keep track of the currents in and between each of these spaces, as well as the potentials that drive these currents. The bidomain equations consist of a nonlinear parabolic equation coupled with an elliptic equation and several ordinary differential equations. Previous methods have used explicit or implicit time stepping schemes. Explicit methods are easily implemented, but have severe time step restrictions. With implicit methods, there are no time step restrictions; however, a nonlinear system of equations must be solved at each time step. The decrease in cPu time, resulting from a larger time step, may not compensate for the extra work required to solve this nonlinear system. Due to these concerns a hybrid method, referred to as a semi-implicit time step scheme, is proposed. This scheme eliminates the severe time step restriction and requires only linear systems be solved at each time step. These linear systems are solved using a multigrid method. Results for the two dimensional Fitzhugh Nagumo and Beeler Reuter ionic models will be discussed.

Math Seminars
Simple Models for Quorum Sensing in Bacteria
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Tuesday, November 09, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: We discuss simple models for cell to cell signaling in bacteria populations of Pseudomonas aeruginosa.

Math Seminars
Numerical Methods for Interface Problems and Applications
Dr. Zhilin Li - Department of Mathematics, North Carolina State University
When: Friday, October 29, 1999 03:10PM to 04:00PM
Where: Wilson Hall 1-130
Details: Many physical problems involve interfaces. Examples include phase transition problems where the interface separates the solid and liquid regions, bubble simulation, Hele-Shaw flow, composite materials, and many other important physical phenomena. Mathematically, interface problems usually lead to differential equations whose input data and solutions have discontinuities or non-smoothness across interfaces. As a result, many standard numerical schemes do not work or work poorly for interface problems. In this talk, I will introduce the immersed interface method. Through some simple examples, I will try to explain the problems of our interest and related
background information. Then I will present our method for some typical model problems in two dimensions. Our method can handle both discontinuous coefficients and singular sources. The main idea is to incorporate the known jumps in the solution and its derivatives into the finite difference scheme, obtaining a modified scheme on the uniform grid for quite arbitrary interfaces. The second part of the talk will focus on applications of the methods combined with the level set method for moving interface problems: including the Stokes flow with different surface tension, the simulation of Hele-Shaw flow, and computation of crystal growth if time permits.

Math Seminars
Chaotic Solutions in Slowly Varying Perturbations of Hamiltonian Systems with Applications to Shallow Water Sloshing
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Tuesday, October 19, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: We study a slowly varying planar Hamiltonian system modeling shallow water sloshing. Using the Conley index theory for fast-slow systems of ODEs, we prove the existence of complicated dynamics in the system which is described in terms of symbolic sequences of integers. This includes the solutions proven by Hastings and McLeod as well as those conjectured by them.

Math Seminars
Algorithms for Non-negatively Constrained Image Deblurring
Dr. Curt Vogel - Department of Mathematical Sciences, MSU
When: Tuesday, October 12, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: Incorporating non negativity constraints can sometimes dramatically improve the quality of images obtained from deblurring, or deconvolution. We will present a class of rapidly convergent Newton-type schemes to incorporate these non-negativity constraints. These schemes generate a sequence of linear, unconstrained sub-problems to which we apply conjugate gradient iteration. The resulting algorithm is compared to the standard EMalgorithm for a deblurring problem arising in atmospheric optics.

Math Seminars
An Approximation Algorithm for the Fixed Linear Crossing Number Problem
Dr. Brendan Mumey - Department of Computer Science, MSU
When: Tuesday, October 05, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-132
We (joint work with Bob Cimikowski) present a randomized approximation algorithm for the fixed linear crossing number problem (FLCNP). The problem is similar to the book crossing number problem in which the vertices of a graph are optimally placed on a horizontal "node line" in the plane, each edge is drawn as a semicircle in one of $k$ half-planes (pages), and the objective is to minimize the number of edge crossings. In this restricted version of the problem, the vertex locations along the node line are pre-determined and fixed. Initially, we transform the problem to the maximum $k$-cut problem. Following the approach pioneered by Goemans and Williamson, the algorithm randomly rounds the optimal solution of a semi definite program. Previously no performance bounds were known for this problem. For the special case $k=2$, our analysis leads to a randomized $0.878 + \frac{0.122}{r}$ approximation algorithm, where $r$ is the ratio of the crossing number to the number of conflicting pairs (pairs of edges that potentially could cross). We analyze the performance for the family of random graphs $\{\mathcal{G}_{n,1/2}\}$, where each edge of $\mathcal{K}_n$ occurs with probability $1/2$. We show that $\frac{1}{r} \geq \frac{2}{4r^*-1} + \Omega(\lambda/n)$ with probability $4e^{-\lambda^2}$, where $r^*$ is the ratio of the crossing number to the number of conflicting pairs for $\mathcal{K}_n$. A widely-held conjecture implies that $r^* = \frac{3}{8} + \Omega(1/n)$. This would imply an asymptotic expected performance ratio bound of $1.366$ for $\mathcal{G}_{n,1/2}$. The algorithm is compared with two other heuristics on a set of test graphs. The results indicate that the randomized algorithm yields near-optimal solutions and outperforms the other heuristics overall.

Math Seminars
Proper Orthogonal Decomposition for Low Order Feedback Controllers
Dr. Belinda B. King - Interdisciplinary Center for Applied Mathematics, Virginia Tech
When: Friday, October 01, 1999 03:10PM to 04:00PM
Where: Wilson Hall 1-130
Details: In order to design practical, implementable (in real time) feedback controllers for many problems described by partial differential equations, it is essential to have low order controllers. We discuss a framework for reduced order compensator-based controllers which involves a special form of the feedback control law from LQG or Minmax design. In particular, we use the proper orthogonal decomposition (POD) to obtain a reduced basis for approximation of the compensator-based control law. In this talk, we provide examples of how POD can be used to obtain low order controllers for the heat equation. We show that one approach which has been successfully used for simulations may be ill-suited for feedback control. We discuss an alternative approach which may be widely applicable for designing controllers for PDE systems.

Math Seminars
Sensitivity Equation Methods for Elliptic Boundary Value Problems
Dr. Lisa Stanley - Department of Mathematical Sciences, MSU
When: **Tuesday, September 21, 1999 04:10PM to 05:00PM**  
**Where:** Wilson Hall 1-132  
**Details:** With the significant advances in computer technology over the last twenty five years, industries which design and manufacture high performance products are increasingly interested in exploiting the advantages of computer-aided design, numerical analysis and optimal design methods. For example, a detailed analysis of aerodynamic systems, automated manufacturing processes and casting or molding processes can be performed using a software package prior to any time-consuming, expensive and labor-intensive physical experiments. The physical performance of the design is modelled by a system of mathematical equations, usually partial differential equations. Generally, there are a number of physical parameters (or design variables) that a designer can adjust (either manually or within a computer simulation) in order to change (and hopefully improve) the performance of the design. Consequently, designers become very interested in how sensitive the state variables are to small changes in the design variables. For example, when analyzing a composite material, one may be interested in the sensitivity of the heat flow through the material to small changes in the thickness of the respective component materials. Sensitivity analysis is a mathematical tool which provides a methodology for investigating such questions. There are various methods available for computing sensitivities. This talk will focus on Sensitivity Equation Methods (SEMs). We will give an overview of some of the mathematical framework which can be used to mathematically justify the derivation of sensitivity equations for a class of elliptic boundary value problems. The framework makes use of elliptic PDE theory, the method of mappings and the Implicit Function Theorem. Within the category of SEMs, there are various approaches to obtaining a sensitivity equation. We will discuss two of these methods in the context of a specific 1D example. Numerical results will be given to

Math Seminars  
**Stability, and Instability, of Spiral Waves**  
**Professor Björn Sandstede - Ohio State University**  
When: **Tuesday, August 24, 1999 10:00AM to 10:50AM**  
**Where:** Wilson Hall 1-143  
**Details:** Spiral waves are very interesting patterns that arise in many chemical and biological systems. One particularly interesting property of spirals is the irrobustness with respect to perturbations of the domain boundary. In addition, spirals can destabilize in various different ways: They can experience core and far-field instabilities or begin to meander. I will begin by discussing similar instability mechanisms for fronts and pulses in one space dimension. Afterwards, I would like to show how these "one-dimensional" ideas can be used to, at least partially, understand the aforementioned stability and instability mechanisms of spiral waves. This is joint work with Arnd Scheel (FU Berlin).  

Other  
**Dynamics of Rotations and Rotations of Dynamics**
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU
When: Wednesday, August 18, 1999 02:00PM to 03:00PM
Where: Wilson Hall 1-143

Other
Computational Methods for Sensitivity Analysis with Applications to Elliptic Boundary Value Problems
Dr. Lisa Stanley - Department of Mathematical Sciences, MSU
When: Wednesday, August 18, 1999 10:00AM to 11:00AM
Where: Wilson Hall 1-143

Other
What is (and Why) Numerical Integration?
Dr. John Lund - Department of Mathematical Sciences, MSU
When: Tuesday, August 17, 1999 02:00PM to 03:00PM
Where: Wilson Hall 1-143

Other
Reaction Diffusion Models on Jack's Desk
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Tuesday, August 17, 1999 10:00AM to 11:00AM
Where: Wilson Hall 1-143

Other
Number Theory and Dynamical Systems
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Monday, August 16, 1999 02:00PM to 03:00PM
Where: Wilson Hall 1-143

Other
Oceanography in the Middle of the Mountains
Dr. Ken Bowers - Department of Mathematical Sciences, MSU
When: Monday, August 16, 1999 10:00AM to 11:00AM
Where: Wilson Hall 1-143

Other
A 3-Dimensional Rotation Set for a Flow on T3
Doreen Dumonceaux - Department of Mathematical Sciences, MSU
When: **Thursday, August 12, 1999 02:00PM to 03:00PM**  
Where: Wilson Hall 1-143  

**Other**  
**Topology of Laminations**  
Luther Johnson - Department of Mathematical Sciences, MSU  
When: **Thursday, August 12, 1999 09:00AM to 10:00AM**  
Where: Wilson Hall 1-143  

**Other**  
**Computational Mathematics and Image Reconstruction** Dr. Curt Vogel - Department of Mathematical Sciences, MSU  
When: **Wednesday, August 11, 1999 10:00AM to 11:00AM**  
Where: Wilson Hall 1-143  

**Other**  
**Some Simple Models of Neural Networks**  
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU  
When: **Tuesday, August 10, 1999 02:00PM to 03:00PM**  
Where: Wilson Hall 1-143  

**Other**  
**1-D Biofilm Models**  
Lori Pritchett - Department of Mathematical Sciences, MSU  
When: **Tuesday, August 10, 1999 10:00AM to 11:00AM**  
Where: Wilson Hall 1-143  

**Other**  
**The Topological Dynamics of Picnics**  
Dr. Marcy Barge - Department of Mathematical Sciences, MSU  
When: **Monday, August 09, 1999 02:00PM to 03:00PM**  
Where: Wilson Hall 1-143  

**Other**  
**Analysis of Excitable Cell Models**  
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU  
When: **Monday, August 09, 1999 09:30AM to 10:30AM**  
Where: Wilson Hall 1-143
**Math Seminars**

**Continuation of Invariant Tori in a System with Rapid Periodic Forcing**
Dr. Carmen Chicone - Department of Mathematics, University of Missouri

When: **Friday, August 06, 1999 10:00AM to 10:50AM**  
Where: Wilson Hall 1-141

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**Math Seminars**

**Two-Level Preconditioners for Regularized Ill-Posed Problems**
Kyle Riley - Department of Mathematical Sciences, MSU

When: **Tuesday, July 13, 1999 03:10PM to 04:00PM**  
Where: Hurst Conference Room  
Details: This is the Ph.D. dissertation defense for Kyle Riley.

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**Math Seminars**

**Controllability of Excitable Cells**
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU

When: **Monday, April 19, 1999 04:10PM to 05:00PM**  
Where: Wilson Hall 1-142  
Details: Mathematical models of cell electrical activity typically consist of a current balance equation, channel activation (or inactivation) variables and concentrations of regulatory agents. These models can be thought of as nonlinear filters whose input is some applied current I (possibly zero) and output is a membrane potential V. A natural question to ask is if the applied current I can be deduced from the potential V. For a surprisingly large class of models the answer to this question is yes. To show this, first we show that many models can be imbedded into higher dimensional quasilinear systems. For quasilinear models, a procedure for determining the inverse of the nonlinear filter is then described and demonstrated on two models: 1) the FitzHugh-Nagumo model and 2) The SRK model of bursting activity in pancreatic beta-cells. For the latter example, the inverse problem is then used to deduce model parameters using real experimental data. The main advantage of this correlation technique is that only derivative information of the measured electrical potential is needed to find parameter estimates.

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**Math Seminars**

**Using Mathematics to Help Computers Pretend That They Can See, Hear, and Talk**
Dr. Daniel Maki - Department of Mathematics, Indiana University

When: **Thursday, April 08, 1999 04:10PM to 05:00PM**  
Where: Wilson Hall 1-142
Details: Computer vision, speech recognition by computer, and speech synthesis by computer involve engineering, computer science, linguistics, and mathematics. These areas of computer-human interaction have advanced rapidly in the last five years and several mathematical models have played an important role in this advance. In this talk, we first discuss several of the models which have been historically used in these areas, and we introduce some of the new models which are currently being used and investigated. In particular we consider the use of Hidden Markov Models, which are used in the best speech recognizers, and Neural Networks, which have become very popular for many types of pattern recognition problems. Most of the examples in the talk involve speech recognition by computers. We include a survey of the evolution of speech recognizers, and an audio tape is used to illustrate the training of a neural network.

Math Seminars
Dynamics of Flapping Flight
Dr. Steve Childress - Courant Institute of Mathematical Sciences
When: Friday, March 26, 1999 01:10PM to 02:00PM
Where: Wilson Hall 1-132
Details: Flapping flight involves significant vortex shedding and interaction with shed vortices. We summarize some of the features of two-dimensional theories of flapping flight, and describe some new simulations of forward flight and hovering. We then discuss the mechanisms of optimal flapping, and the role of paired vortices in hovering.

Math Seminars
Existence of Symbolic Dynamics
Dr. Konstantin Mischaikow - Georgia Institute of Technology
When: Tuesday, March 09, 1999 10:00AM to 10:50AM
Where: Wilson Hall 1-143

Math Seminars
Spike Dynamics for a Reaction-Diffusion System
Dr. Michael Ward - Department of Mathematics, University of British Columbia
When: Monday, March 08, 1999 04:10PM to 05:00PM
Where: Wilson Hall 1-142
Details: Many classes of singularly perturbed reaction-diffusion systems possess localized solutions where the gradient of the solution is very large only in the vicinity of certain points in the domain. An example of such a problem where spikes occur is the Geirer-Meinhardt (GM) activator-inhibitor model of morphogenesis. Of interest is to characterize the equilibria, the stability, and the dynamics of spike-layer patterns. Results of this nature are given for the GM model for the case of an infinite inhibitor diffusivity and for a finite inhibitor diffusivity. For the case of an infinite inhibitor diffusivity, the GM model reduces to a non-local problem for the activator concentration.
By studying the spectrum of the linearization it is shown that the non-local term leads to the existence of metastable behavior for a one-spike solution in a multi-dimensional domain. An explicit characterization of the metastable dynamics is given and is confirmed in the case of one-spatial dimension by numerical computations. The dynamics of a spike attached to the boundary of a multi-dimensional domain are also described. The case of a finite inhibitor diffusivity is studied in a one-dimensional domain. It is shown that there are a sequence of critical values $D_n$ of the inhibitor diffusivity $D$ for which an $n$-spike equilibrium solution is stable if $DD_n$. An explicit formula for $D_n$ is given. The dynamics of an $n$-spike solution are then described. Finally, we show that many of the results given here for the GM model also hold for other reaction-diffusion equations including the non-local Allen-Cahn equation from materials science, a problem in microwave heating etc.

**Math Seminars**

**Pattern Formation and Hamiltonian Saddle-Foci**
Dr. Jaroslaw Kwapisz - Department of Mathematical Sciences, MSU
When: **Monday, March 01, 1999 04:10PM to 05:00PM**
Where: Wilson Hall 1-142
Details: Upon cooling, many crystals (liquid crystals) sacrifice some of their symmetry in order to lower the energy and they bifurcate into a number of less symmetrical phases. The boundaries (or defects) between the new phases may form various patterns. After giving an informal introduction to Landau's theory of phase transitions, I will discuss a particular (1-d) model in which stable chaotic patterns emerge (at the so called Lifshitz point). A mathematical proof of their existence is variational and depends on an observation that, for Hamiltonian systems with two degrees of freedom, saddle-focus equilibria restrict the homotopy types of the minimizers viewed in the configuration space.

**Math Seminars**

**Existence of Stable Subharmonic Solutions for Time-Periodic Reaction-Diffusion Equations**
Dr. Peter Polacik - Department of Mathematical Sciences, Georgia Tech
When: **Thursday, February 18, 1999 11:00AM to 11:50AM**
Where: Wilson Hall 1-132
Details: Stable periodic solutions run the dynamics of time-periodic reaction diffusion equations in the sense that most bounded trajectories converge to such a solution. For a class of homogeneous reaction-diffusion equations, we discuss the problem whether the attracting periodic solutions can have minimal period larger than the period of the equation (so that they are subharmonic solutions). The answer can be both positive and negative, depending on the spatial domain.

**Math Seminars**
Fine-Resolution Imaging of Solar Features (and Other Things)
Rick Paxman - ERIM International
When: **Friday, February 12, 1999 11:00AM to 11:50AM**
Where: Wilson Hall 1-148
**Details:** Phase-Diverse Speckle (PDS) is a data-collection and processing technique that blends phase-diversity and speckle-imaging concepts. PDS has been successfully used to overcome blurring induced by atmospheric turbulence and thereby achieve near diffraction-limited resolution in ground-based imaging of solar phenomena. Variants of PDS that involve narrow-band spectroscopic, and polarimetric data provide more informative observations. PDS can also be used in ground-based imaging of satellites and in horizontal-path geometries.

Math Seminars
Some Thoughts about Neural Coding Problems
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: **Monday, February 01, 1999 04:10PM to 05:00PM**
Where: Wilson Hall 1-142
**Details:** I will present some thoughts about how one may be able to extract/discover the neural code from the given set of measurements. I will think about the coding process as a randomly perturbed deterministic map from input to output. I will use the language of stochastic transition functions and some ideas from the theory (or rather, practice) of attractor or reconstruction from the time series. Based on the data one can define a multivalued map which is an approximation of the underlying stochastic transition function. Some limitation of the method will be discussed.

Math Seminars
Why do Sunspots Float? Using Simple Physics to Unlock Mysteries of the Sun’s Interior.
Dr. Dana Longcope - Department of Physics, MSU
When: **Monday, November 30, 1998 04:10PM to 05:00PM**
Where: Wilson Hall 1-131
**Details:** Sunspots occur where fragments of the Sun’s magnetic field float to the visible surface. Since the field is compressed into slender "tubes" it forms the isolated spots we see. A model for a rising tube of magnetic flux involves simple ingredients such as buoyancy, tension and aerodynamic drag (ingredients also found in a physical systems ranging from bars of soap to sport utility vehicles). During the past decade such models have been compared, with great success, to eighty years of accumulated observational data. In a classic example of applied astrophysical modeling this comparison can be used to infer properties of the magnetic field deep inside the Sun. These models provide our only information about the depth of field generation (200,000 km beneath the solar surface) and magnetic field strength at that point (50,000 Gauss).
Math Seminars
Two Computational Problems in DNA Physical Mapping
Brendan Mumey - Department of Computer Science, MSU
When: Monday, November 23, 1998 04:10PM to 05:00PM
Where: Wilson Hall 1-131
Details: A physical genomic map specifies information about the order and physical separation of landmarks along the genome. Physical maps are useful for guiding the search for genes and ultimate genome sequencing. This talk addresses computational problems arising from two separate approaches to creating physical maps. The first approach is called restriction fragment mapping. Restriction fragment maps are made using a set of clones called a clone library and a set of restriction enzymes. The clone library consists of overlapping fragments of the genome. A central problem is to infer the underlying ordering and overlap relationship for a set of clones based on restriction fragment fingerprints of each clone. We propose a maximum-likelihood based algorithm for this problem that works quite well in practice. A second, completely different strategy for physical mapping involves mapping probes to locations along the genome given noisy pairwise distance data as input. The model used is quite general: The input consists of a collection of probe pairs and a distance interval for the genomic distance separating each pair. We call this the probe-location problem. Because the distance intervals are only known with some confidence level, some may be erroneous and must be identified and removed in order to find a consistent map. This is cast as the suspect-identification problem, a generalization of classical group testing. A randomized heuristic algorithm is proposed. The algorithms were implemented and experimental results were collected for synthetic data sets (with and without errors) and real data from a region of human chromosome 4.

Math Seminars
Bursting: An overview
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU
When: Monday, November 16, 1998 04:10PM to 05:00PM
Where: Wilson Hall 1-131
Details: Bursting in the pancreatic beta-cell is an electrical oscillation induced by glucose which has been correlated with insulin release. As a mathematical phenomenon, bursting is an oscillation whose fast subsystem exhibits bistability between equilibria and stable periodic solutions. In this talk I will summarize some progress made analyzing models of electrical activity and glucose diffusion/transport in beta-cell ensembles. Unresolved modelling and mathematical issues will be discussed. Time permitting, current work on parameter estimation techniques using experimental data will be described.

Math Seminars
Computational Issues Arising in Atmospheric Optics
Dr. Curt Vogel - Department of Mathematical Sciences, MSU  
When: Monday, November 09, 1998 04:10PM to 05:00PM  
Where: Wilson Hall 1-131  
Details: We will address the problem of simultaneously estimating the phase $\phi$ and the object $f$ from incoherent image data $d = s[\phi] \ast f + \eta$, where $\eta$ represents noise, $\ast$ denotes two-dimensional convolution, and the dependence of the point spread function $s$ on phase is given by $s[\phi] = |F^{-1}(Ae^{i\phi})|^2$, with $F$ representing the two-dimensional Fourier transform. Our primary interest is in the identification of space objects from images obtained from ground-based optical telescopes, although similar problems arise in biomedical imaging. This talk will focus on  
- Sufficiency of data to determine both $\phi$ and $f$.  
- Numerical optimization methods for (nonlinear) estimation.  
- Numerical linear algebraic sub-problems which arise in the implementation of these optimization methods.

Math Seminars  
Mathematics of Perception  
Dr. Jan Holly - Center for Computational Biology, MSU  
When: Monday, November 02, 1998 04:10PM to 05:00PM  
Where: Wilson Hall 1-131  
Details: Many different types of mathematics are used in neuroscience and psychology to analyze how we detect and perceive aspects of the world around us. This talk will highlight just a few of the mathematical methods, used to help understand the sense of touch and the sense of self-motion. We'll also see what this has to do with John Glenn.

Math Seminars  
2D Instabilities of 1D Biofilms  
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU  
When: Monday, October 19, 1998 04:10PM to 05:00PM  
Where: Wilson Hall 1-131  
Details: A simple 2D model of a biofilm will be presented. It will be shown that under the conditions of the model a flat 1D biofilm is generally linearly unstable to 2D fingering.

Math Seminars  
Stability in a Semilinear Boundary value Problem via Invariant Cone fields  
Dr. Jarek Kwapisz - Department of Mathematical Sciences, MSU  
When: Monday, October 12, 1998 04:10PM to 05:00PM  
Where: Wilson Hall 1-131  
Details: We will give a geometric proof of stability of spatially nonhomogeneous equilibria in a popular simple model of a one-dimensional bistable distributed system. The method depends on an observation that applies to many equations of the form $u_t = \epsilon u_{xx} + g(u) - c(x)h(u)$.
Math Seminars
Steady State Solutions to Biofilm Models
Lori Pritchett - Department of Mathematical Sciences, MSU
When: Monday, October 05, 1998 04:10PM to 05:00PM
Where: Wilson Hall 1-131
Details: A simple 1-D biofilm model will presented and the existence of steady state solutions of this model will be discussed. Followed by a brief discussion of other biofilms models and the possibility of steady state solutions in these models.

Math Seminars
Instability in Slowly Evolving Flat Biofilms
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Monday, September 28, 1998 04:10PM to 05:00PM
Where: Wilson Hall 1-131
Details: Using a simple model of a quasi-static growing biofilm, a tendency for flat biofilms to be unstable to finger formation will be discussed.

Math Seminars
Optimal Information Processing in Biological Sensory Systems
Alex Dimitrov - Center for Computational Biology
When: Monday, September 21, 1998 04:10PM to 05:00PM
Where: Wilson Hall 1-131
Details: The brain is a specialized computer which is optimally adapted to its environment. In particular, in higher animals parts of the brain have developed structures which perform general signal processing on sensory inputs. The structure of the early sensory pathways in most animals is determined in part by the statistical structure of signals they perceive from the surrounding environment. Because of evolutionary pressure, their sensory systems have developed to optimally process the incoming sensory data stream in a way that can be described by certain information theoretic measures. I will review the biological structures in question and present the quantities from information theory pertinent to the brain. I will then discuss several cases where information theory was successfully applied to understanding the functionality of various biological structures, including my own work on information processing in visual area one of the mammalian visual cortex.

Math Seminars
Reconstruction of an Unknown Inclusion Using Electrical Impedance Tomography
Dr. Martin Hanke - Universitat Karlsruhe
When: Tuesday, July 14, 1998 10:00AM to 10:50AM
Where: Wilson Hall 1-138
In electrical impedance tomography currents are applied to a two-dimensional body and the resulting voltages are measured on the boundary. The goal is to use these (overdetermined) boundary data to reconstruct information about the distributed conductivity coefficient $\sigma$ within the body. It is known that these boundary data (i.e., the Neumann-to-Dirichlet operator) uniquely define the conductivity coefficient provided that $\sigma$ is, for example, piecewise analytic. This may correspond to the practical situation that the body consists of a number of inhomogeneities (organs) in a homogeneous background medium. We present a theoretical characterization of the domain of these inclusions (yet, under some restrictions on $\sigma$) which is easily translated into a very cheap numerical algorithm for the reconstruction of their domain. Preliminary numerical results will be presented. This is ongoing work with M.~Br"uhl, A.~Kirsch, and M.~Pidcock.

Math Seminars

Splitting Methods as Preconditioners for the Preconditioned Conjugate Gradient Method
Kyle Riley - Department of Mathematical Sciences, MSU
When: Friday, April 24, 1998 02:10PM to 03:00PM
Where: Wilson Hall 1-125
Details: Abstract: The problem of Atmospheric imaging results in an ill-posed deconvolution problem. Regularization is used to create a well posed problem that can be solved. The system sizes are generally quite large, thus the method of Preconditioned Conjugate Gradient is used to approximate the solution. In this talk splitting methods like Jacobi and Symmetric Gauss Seidel will be used to form the preconditioners. I will give a brief description of the development of the preconditioners and present some preliminary results to a 2-D imaging problem.

Math Seminars

Phase Resetting Functions
Dr. Tomas Gedeon - Department of Mathematical Sciences, MSU
When: Friday, April 17, 1998 02:10PM to 03:00PM
Where: Wilson Hall 1-125
Details: Abstract: I will attempt to review the results and ideas connected to phase resetting in biological oscillators. Main applications come from the fibrillations in the heart. I will mention also joined work with Leon Glass on continuity of phase resetting functions in infinite dimensional dynamical systems. Disclaimer: This is more applied than mathematical talk and there will be no surprising, new mathematics. On the other hand, if you want to see who, apart from mathematicians, care about maps of the circle to itself, come and see.

Math Seminars

Integrable Systems Methods in Curve Evolution
Dr. Annalisa Calini - Department of Mathematics, College of Charleston
When: Friday, April 03, 1998 02:10PM to 03:00PM
Where: Wilson Hall 1-125
Details: Several interesting models of curve dynamics are described by soliton equations whose rich structure has some remarkable consequences on the geometry and topology of the solution curves, I will discuss the construction of large families of explicit solutions and results on their symmetries. I will also describe how techniques of integrable systems can be used to determine topological properties of closed curves and to obtain canonical representatives for many classes of knots. This seminar will be followed by donuts and coffee with the speaker.

Math Seminars
Stochastic Systems Analysis as a Tool in Computational Neuroscience Research
Dr. Sharon Crook - Center for Computational Biology
When: Friday, March 27, 1998 02:10PM to 03:00PM
Where: Wilson Hall 1-125
Details: The computations underlying an animal's behavioral decisions are carried out within the context of the code with which information is represented in neural activity patterns. In order to determine the neural code, one must understand what an organism can infer from its own neural signals and how this information can be extracted from the neural responses. Stochastic systems analysis provides one approach for characterizing the deterministic aspects of the relationship between a sensory stimulus and the neural response. I will discuss results from using these techniques to study the cercal sensory system of the cricket. This system mediates the detection and analysis of low-velocity air currents in the animal's immediate environment.

Math Seminars
Spontaneous Symmetry-Breaking and Superlattice Wave Patterns
Dr. Mary Silber - Department of Applied Mathematics, Northwestern University
When: Friday, March 06, 1998 02:10PM to 03:00PM
Where: Wilson Hall 1-125
Details: I will describe how spontaneous symmetry-breaking leads to the formation of some beautiful spatial patterns in certain hydrodynamic systems. Classic results of equivariant bifurcation theory will be reviewed and applied in a case study spatially periodic patterns. These results are then specialized and extended to help us understand some recent laboratory results on "superlattice" wave patterns.

Math Seminars
A Mathematical Caricature of Multiple Slow Calcium Processes in a Model Exhibiting Bursting
Dr. Mark Pernarowski - Department of Mathematical Sciences, MSU
When: Friday, February 27, 1998 02:10PM to 03:00PM
Where: Wilson Hall 1-125
Details: The model of bursting electrical activity in the pancreatic beta cell due to Bertram et al (Biophys J. 1995, Vol 68) incorporates several channel types including a voltage rectified potassium current, a slowly inactivated transmembrane calcium current and a CRAC current which activates with increased intra-ER calcium stores. Imbedded in this model is a reduced model (which does not include the CRAC current or intra-ER calcium concentration) which has two fast variables and two slow variables. In the talk preliminary numerical simulations of the reduced model indicate a potential asymptotic construction for the 4-dimensional bursting cycle. The leading silent phase dynamics can be described explicitly if posed as a second order system involving one fast and one slow variable. Fixed points of this system are unstable for parameters in the bursting regime. However, the fixed point of this system can be stabilized by changing the value of glucose dependent parameter. Though this implies the existence of a stable equilibrium of the full 4-dimensional system, it does not preclude the possible coexistence of stable equilibria and bursting solutions. Resolution of this issue may come from an examination of the return map describing the bursting cycle.

Math Seminars

Homoclinic Tangles for Noninvertible Maps
Dr. Evelyn Sander - Department of Mathematics, Georgia Tech
When: Monday, February 09, 1998 04:10PM to 05:00PM
Where: Wilson Hall 1-142
Details: One of the cornerstones of dynamical systems theory is the Smale-Birkhoff Theorem. This theorem gives criteria for the existence of complicated behavior under iteration by a diffeomorphism. This talk will discuss the necessity of the hypothesis of invertibility in the Smale-Birkhoff Theorem. It contains an example of a noninvertible map which has a transverse homoclinic point and yet has no horseshoes. I will show that this behavior arises through a codimension two bifurcation.

Math Seminars

The Hilbert Class Library: Linking Large-Scale Optimization with Complex Simulations
Dr. Mark Gockenbach - Department of Mathematics, University of Michigan
When: Friday, February 06, 1998 02:10PM to 03:00PM
Where: Wilson Hall 1-126
Details: Numerical optimization has been studied for many years, with a number of high quality software packages implementing the best known algorithms. However, due to the restriction placed on the programs and their interfaces by procedural languages such as Fortran, scientists often find it difficult or impossible to take advantage of these sophisticated algorithms. Indeed, many scientists find themselves coding optimization
algorithms themselves, rather than utilizing "off-the-shelf" software. Using the object-oriented programming paradigm, it is possible to design optimization code that can be used with applications of arbitrary complexity. I will describe the Hilbert Class Library (HCL), a collection of C++ classes designed with two goals in mind:
1) Algorithms can be coded in a natural style (no contortions such as reverse communication); 2) the algorithms can be used to solve complex, simulation based problems employing arbitrary data structures. An important question that arises with the use of C++ is whether the code can be competitive in efficiency with Fortran code. I will show examples comparing the execution time of HCL with two well regarded Fortran packages: Nocedal's LBFGS code (unconstrained minimization) and Sorensen's ARPACK (eigenvalue problems). This is joint work with Bill Symes of Rice University, and was motivated by our experience solving seismic velocity inversion problems.

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**Math Seminars**

**Special Holiday Applied Math Seminar. What's a Derivative Really Worth: Option Pricing and the Black-Scholes Formula**
*Dr. Isaac Klapper - Department of Mathematical Sciences, MSU*
*When: Thursday, December 11, 1997 04:10PM to 05:00PM*
*Where: Wilson 1-132*
*Details:* The lucrative problem of pricing options and futures will be presented, including the principle of no arbitrage and the Black-Scholes formula.

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**Math Seminars**

**Magnetic Fields on the Sun: Kinky Business**
*Dr. Richard Canfield - Department of Physics, MSU*
*When: Thursday, November 20, 1997 04:10PM to 05:00PM*
*Where: Wilson 1-132*
*Details:* I will review how physicists measure magnetic fields on the Sun, and how those measurements lead us to be interested in topology. I will define magnetic helicity and summarize the formalism for thin magnetic flux tubes. Finally, I will review several recent discoveries about magnetic fields on the Sun, and relate them to twist, writhe and chirality.

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**Math Seminars**

**Phase Diversity-Based Deconvolution and Phase Retrieval**
*Dr. Curt Vogel - Department of Mathematical Sciences, MSU*
*When: Thursday, November 13, 1997 04:10PM to 05:00PM*
*Where: Wilson 1-132*
*Details:* The phase diversity problem in atmospheric optics can be formulated as follows:
One is given image data \[ d_k = s(\phi + \eta_k) \ast u + \eta_k, \quad k=1,...,K, \] where the \( \eta_k \) represent noise, \( u \) is the desired image (called the "object"), \( s(\cdot) \) is the point spread function, and \( \ast \) indicates convolution product. \( \phi \) is called the phase function and models effects of turbulence on light propagating through the atmosphere. The \( \eta_k \) are called phase diversity functions and represent additional modifications to the light before the images \( d_k \) are recorded. For instance, one might place a beam splitter in the light path and record 2 separate images---the first with no modification, in which case \( \eta_1 = 0 \), and the second taken out of focus, in which case \( \eta_2 \) is a known quadratic function. From \( d_k \) and \( \eta_k \) for \( k=1,\ldots,K \), one wishes to estimate both the phase function \( \phi \) and the object \( u \). In this talk we will discuss recently developed regularized least squares optimization techniques to solve this estimation problem. We will also discuss the numerical implementation of these techniques.

**Math Seminars**

**S-shaped Bifurcation of a Singularly Perturbed Boundary Value Problem**  
Dr. Pavol Brunovsky - Comenius University, Bratislava, Slovakia  
**When:** Monday, November 03, 1997 04:10PM to 05:00PM  
**Where:** Wilson 1-132  
**Details:** Abstract: A simple one-parameter nonlinear second order boundary value problem will be discussed. Applying well known tools of geometric singular perturbation theory (normal hyperbolicity, transversality, exchange lemma) as well as some newly developed ones, it will be shown that solutions of the problem are represented by a curve with two generic fold bifurcations.

**Math Seminars**

**Detecting Periodicity**  
Dr. William R. Derrick - Department of Mathematics, University of Montana  
**When:** Thursday, October 23, 1997 04:10PM to 05:00PM  
**Where:** Wilson 1-132  
**Details:** It is very well-known that Hopf bifurcations frequently lead to the creation or destruction of periodic oscillations. These oscillations are characterized by being of small amplitude for parameter values close to the bifurcation value. A less known mechanism for the creation or destruction of periodic oscillations arises through the formation of homoclinic orbits and heteroclinic connections. Here the amplitude of the oscillation is generally large for parameter values near the homoclinic orbit. This talk will present four elementary models that exhibit such behavior: one in epidemic theory, another in the cell division cycle (M-phase promoting factor), the third in a type of Lotka-Volterra competition model, and finally in the Bray-Liebhafsky reaction that converts aqueous iodate to elemental iodine. In all three cases we show that periodic oscillations occur in a narrow window of one of the parameters. Thus, the phenomenon is probably ubiquitous, but may be difficult to observe in experiments, and when observed the experiments may often be hard to reproduce.
Math Seminars

Homeomorphisms of One-Dimensional Hyperbolic Attractors
James Jacklitch - Department of Mathematical Sciences, MSU
When: Monday, October 20, 1997 03:10PM to 04:00PM
Where: Wilson Hall 1-131
Details: Given two diffeomorphisms on manifolds with one-dimensional connected hyperbolic attractors. We show that if the attractors are homeomorphic and the topological entropies of the diffeomorphisms restricted to their attractors are \( \log(a) \) and \( \log(b) \) then the algebraic fields \( \mathbb{Q}(a) \) and \( \mathbb{Q}(b) \) are identical.

Math Seminars

Current Singularities in 2D Ideal MHD
Dr. Isaac Klapper - Department of Mathematical Sciences, MSU
When: Thursday, October 16, 1997 04:10PM to 05:00PM
Where: Wilson 1-132
Details: Singularity formation in solutions to the ideal magnetohydrodynamics (mhd) equations has important implications for fluid turbulence, mhd turbulence, as well as solar mhd. In 2D, theory and computation have concentrated on the possibility of singularity formation at magnetic null points. In this talk I will show that this commonly considered scenario cannot occur. In addition I will present preliminary ideas concerning the general 2D ideal mhd singularity problem.

Math Seminars

Summary of the 1997 Industrial Mathematics Modeling Workshop
Lori Pritchett - Department of Mathematical Sciences, MSU
When: Thursday, October 09, 1997 04:10PM to 05:00PM
Where: Wilson 1-132
Details: I will give a brief overview of the workshop and some of the problems that were presented. I will also discuss my group's problem: Given a long thin hallow tube of known geometry with one end open and the other end closed. If the pressure time history is known at the closed end, what are the time histories for the flow rate and pressure at the open end of the tube, and the different approaches that we looked at to solve it.

Math Seminars

Kneading Theory for the Lozi Mappings II
Chris Cleveland - Department of Mathematical Sciences, MSU
When: Monday, October 06, 1997 03:10PM to 04:00PM
Where: Wilson Hall 1-131
Math Seminars

Efficient Algorithms for Least-squares Type Problems
Dr. Gene Golub - Stanford University
When: Friday, October 03, 1997 03:10PM to 04:00PM
Where: Wilson 1-131
Details: The standard least-squares problem is to minimize \( \min_{x \in \mathbb{R}^n} ||Ax-b|| \) where \( A \) is an \( mxn \) matrix, with \( m > n \), \( b \) is an \( m \)-dimensional vector, and \( ||\cdot|| \) indicates the Euclidean norm of the vector. Frequently in practice, the data \( A \) and \( b \) are not known exactly. The TLS algorithm and regularization-based methods are popular schemes for handling such uncertainties. We propose several new formulations of least squares type problems which explicitly include bounds on the uncertainties and which regularize the solution. We also provide efficient algorithms for their solution. This talk represents joint work with S. Chandrasekaran, M. Gu, A. H. Sayed and U. von Matt.

Math Seminars

Kneading Theory for the Lozi Mappings
Chris Cleveland - Department of Mathematical Sciences, MSU
When: Monday, September 29, 1997 03:10PM to 04:00PM
Where: Wilson Hall 1-131
Details: Kneading theory has proven to be an extremely powerful tool in the analysis of dynamics for unimodal (and multi-modal) maps of the interval. In recent work of Yutaka Ishii, Duncan Sands, Andre' de Carvalho, Marcy Barge, Beverly Diamond and others, kneading theory techniques have been applied to 2 dimensional dynamical systems. We will look at some recent work of Ishii and Ishii/Sands. Ishii has developed quite a nice kneading theory for the 2 parameter Lozi family of homeomorphisms of the plane. We will introduce the concept of the pruning front as a way to set an admissibility criteria for symbol sequences. Topological and combinatorial results will follow.

Math Seminars

The Evolution of Slow Dispersal Rates: A Reaction Diffusion System
Dr. Jack Dockery - Department of Mathematical Sciences, MSU
When: Thursday, September 25, 1997 04:10PM to 05:00PM
Where: Wilson Hall 1-132
Details: We consider \( n \) phenotypes of a species in continuous but heterogeneous environment. It is assumed that the phenotypes differ only in their diffusion rates. Assuming haploid genetics and a small rate of mutation it is shown that the only nontrivial equilibrium is a population dominated by the slowest diffusing phenotype. We also prove that if there are only two possible phenotypes then this equilibrium is a global attractor and conjecture that this is true in general. Numerical simulations supporting this conjecture and suggesting this is a robust phenomenon are also discussed.
Math Seminars

New Invariants for Weak Equivalence of Nonnegative Matrices
Dr. Richard Swanson - Department of Mathematical Sciences, MSU
When: Monday, September 22, 1997 03:10PM to 04:00PM
Where: Wilson Hall 1-131
Details: In recent work, Barge and Diamond proved that weak equivalence of nonnegative (primitive) transition matrices is necessary for two inverse limits of Markov tent maps to be homeomorphic. In this talk we will:

• define weak equivalence of integral matrices
• establish the "ideal class" invariant for weak equivalence
• show that the discriminant and reduced discriminant are invariants in the "unimodular" case
• for the tent family, prove that inverse limits in the "cyclic" periodic orbit case and the "last psuedo-Anosov" case are never homeomorphic

Math Seminars

Using AI Methods for Intelligent Robot Design
Lyudmila Litvintseva - The University of Electro-Communications
When: Friday, August 01, 1997 03:10PM to 04:00PM
Where: Wilson 1-144