DC Math Graduate Student Meeting: Schedule and Abstracts

April 25-26, 2009
Media and Public Affairs, room 309

Session 1 (Saturday, 9:00am - 11:00am)

9:00 - 9:20 | Ryan Hoban, University of Maryland

Spherical and hyperbolic shadows

Abstract: Problems involving projections of shadows are often used to teach students about geometry, trigonometry and calculus. Our motivating example will be the following elementary problem from freshman calculus:

A street light is mounted at the top of a 15-ft tall pole. A man 6 feet tall walks away from the pole with a speed of 5 ft/sec along a straight path. How fast is the tip of his shadow moving when he is 40 ft from the pole?
Calculus students typically solve this problem in the Euclidean plane, despite the fact that nothing in the problem explicitly says that the man is walking in flat Euclidean space (curvature=0). Solving this same problem in Spherical geometry (curvature=+1) and Hyperbolic geometry (curvature=-1) illustrates some of the key similarities and differences between the geometries. Despite some drastically differing behavior of the shadow, we will see that the solutions in all three cases are in fact intimately related and emphasize the duality between Spherical and Hyperbolic geometry.

9:30 - 9:50 | Michael Coleson, George Mason University

Easy examples of weakly n-dimensional spaces

Abstract: The first examples of weakly n-dimensional spaces for $n = 2, 3, ...$ were first given by Mazurkiewicz in 1929. His construction of such spaces is cumbersome. In 1991, Van Mill and Pol came up with easier examples of weakly n-dimensional spaces constructed using an ambient spaces which is an $(n+1)$-dimensional compactum. Not only are these spaces weakly n-dimensional, but they are G_δ subsets of the ambient space, which means they are completely metrizable. Taking $I^{(n+1)}$, where $I = [0, 1]$, as the ambient space gives the easiest known examples of weakly n-dimensional spaces.

10:00 - 10:20 | Chatchawan Panraksa, University of Maryland

The three-segment unit arc with maximum width

Abstract: We will describe the unique three-segment unit arc in the plane whose minimal width is as large as possible (the "Trine"). Moreover, we will investigate the algebraic properties and dynamical systems of this figure. (This reports and extends joint work with John E. Wetzel and Wacharin Wichiramala. The authors acknowledge significant contributions by Gregory Stanton, Tirasan Khandhawit and Sira Sriswasdi.)

10:30 - 10:50 | Cindy Merrick, George Mason University

Characterizing Choquet simplices in $\mathbb{R}^n$

Abstract: I will introduce the notion of a Choquet Simplex, with its special homothety property, and then show that this definition is equivalent to the usual notion of a simplex. I will discuss my current work regarding more general convex bodies having a slightly more relaxed homothety condition.

Keynote Address (Saturday, 11:30am - 12:30pm)

Jane Gilman
Rutgers University-Newark and the National Science Foundation

Continued fractions and the geometry of hyperbolic 3-manifolds

Abstract: It is well-known that all negatively curved Riemann surfaces are quotients of the upper half plane by Fuchsian groups (discrete subgroups of $PSL(2;\mathbb{R})$), and likewise that factoring upper half space by Kleinian groups (discrete subgroups of $PSL(2;\mathbb{C})$) yields hyperbolic 3-manifolds. Over the last several years many investigators have discovered certain families of words in the generators of these groups with important properties. For example there are the *good words* of Gehring and Martin, and the *killer words* of Gabai, Meyerhoff and N-Thurston. We survey these families of words and discuss in detail the relation between palindromes, continued fractions and geometry.

Jane Gilman is Professor of Mathematics at Rutgers University in Newark and is currently serving as a Program Officer in the Division of Mathematical Sciences at the National Science Foundation. Dr. Gilman received her Ph.D. from Columbia University and an SB from the University of Chicago. She has held visiting positions at Princeton University, Yale University, the Institute for Advanced Study, the Mathematical Sciences Research Institute, the Mittag-Leffler Institute and the Institut-des-Hautes-Études Scientifique. Dr. Gilman's research centers on Teichmüller theory and Kleinian groups, an area which uses techniques from algebra, hyperbolic geometry and complex analysis.

Session 2 (Saturday, 1:30pm - 4:00pm)

1:30 - 1:50 | Stefan Mendez-Diez, University of Maryland

***D*-Branes**

Abstract: String theory is a physical field theory in which point particles are replaced by strings (1-manifolds) propagating in time. The 2-manifold representing the time evolution of a string is called the string worldsheet. Strings can be either closed (meaning that their worldsheets are closed surfaces) or open (meaning that their worldsheets have boundary). D-branes are submanifolds of the space time manifold defined by the boundary conditions of open strings. In this talk we will define what a D-brane is and discuss their importance in string theory.

2:00 - 2:20 | Cecilia Gonzalez Tokman, University of Maryland

Scaling laws for bubbling bifurcations

Abstract: We present scaling laws for the average bursting time for a type of bifurcation of an attractor in an invariant manifold, assuming the dynamics within the manifold to be hyperbolic. This type of global bifurcation appears in nearly synchronized deterministic and random systems, and is conjectured to be typical among those breaking the asymptotic stability of a hyperbolic invariant manifold.

2:30 - 2:50 | Tyler White, The George Washington University

Ergodic properties of Chacon's transformation

Abstract: Ergodic theory is the study of dynamical systems from a measure theoretic view point. In this talk, we will start by providing a definition of an ergodic system, as well as provide basic examples. We will then construct a famous example, know as Chacon's transformation. We will conclude presenting some of the more interesting properties of Chacon's transformation.

3:00 - 3:20 | Hunter Brooks, University of Maryland

Kubota and Leopoldt's p-adic L-functions

Abstract: Dirichlet introduced (complex valued) L-functions to prove his classic result on the infinitude of primes in arithmetic progressions, but the first p-adic L-functions were not constructed until more than a hundred years later. We will outline the classical theory of L-functions, then briefly explain how p-adic analogues have been constructed, and illustrate their role in the study of cyclotomic fields.

3:30 - 3:50 | Leah Marshall, The George Washington University

Arnold's cat map – A Markov partition

Abstract: Arnold's cat map is a well-known chaotic map in the subject of dynamical systems. This talk will briefly describe Arnold's cat map and discuss a simple Markov partition of the map.

Session 3 (Saturday, 4:30pm - 6:30pm)

4:30 - 4:50 | Jeffrey Frazier, University of Maryland

A brief introduction to actions on trees

Abstract: Actions of groups on trees arise in many settings in geometry, topology, and algebraic geometry. We will present a few basic results related to these actions, such as the fact that all actions by torsion groups or on finite trees must have a fixed point.

5:00 - 5:20 | Hillary Einziger, The George Washington University

Forest formula for the antipode in incidence Hopf algebras of posets

Abstract: Hereditary families of posets with defined equivalence relation and product operation give rise to incidence Hopf algebras. The antipode map in these Hopf algebras can be computed for each poset by summing over the set of all chains of the poset. We define forests of posets such that there is a surjection from the set of chains of a poset to the poset's set of forests. We define a new formula for the antipode which takes the sum over all forests of a poset. This forest computation will have fewer terms in the calculation than the chain computation has. Both Figueroa's (2005) formula for the antipode in the Hopf algebra of distributive lattices and Haiman and Schmitt's (1987) formula for the antipode in the Faa di Bruno Hopf algebra can be seen as examples of this new formula. The incidence Hopf algebras for which the forest computation will be cancellation-free are exactly those which Loday and Ronco (2008) show are equivalent to pre-Lie algebras.

5:30 - 5:50 | Forest Fisher, The George Washington University

The cozinbiel bialgebra of graphs

Abstract: In abstract algebra, a "multiplication" refers to a binary operation, a way of combining (or "multiplying") two things to get one. If we dualize this notion, we get a "comultiplication," an operation that takes one thing and unravels it into pairs. An R-module with a product and coproduct satisfying certain nice properties is called a bialgebra. In this talk, we introduce a particular bialgebra with a basis indexed by certain graphs, and describe how to decompose its coproduct into two other coproducts. This decomposition allows us to uncover important combinatorial and algebraic properties of our bialgebra.

6:00 - 6:20 | Ken Shoda, The George Washington University

Super-exponential families of nonisomorphic matroids having the same Tutte polynomial

Abstract: Omer Gimenez showed how to construct, for each permutation of $[n]$, a matroid on $4n + 5$ elements so that all $n!$ resulting matroids are nonisomorphic but have isomorphic lattices of cyclic flats of width 2. We show that these matroids in fact have the same Tutte polynomial. Thus, this gives a super-exponential family of nonisomorphic matroids having isomorphic lattices of cyclic flats and the same Tutte polynomial.

Session 4 (Sunday, 9:00am - 10:30am)

9:00 - 9:20 | Andrew Sanders, University of Maryland

What is an infinitesimal rotation

Abstract: In this talk I will attempt to illustrate why Lie algebras are relevant to physics by explaining the concept of an infinitesimal rotation and how it relates to the Lie algebra of the orthogonal transformations of $R3$, $O(3)$. In particular, I want to explain the curious (at least to many math students) statement that orthogonal transformations are "skew symmetric up to first order."

9:30 - 9:50 | Lars Aiken, George Mason University

Non-normality points of beta-X

Abstract: Discovered independently by Marshall Stone and Eduard, the Stone-Cech Compactification of X, denoted beta-X, is the largest compact Hausdorff space into which a completely regular space X can be densely embedded. While this space is normal, it is unknown for which points p does the subspace beta-$X \setminus p$ fail to be normal. Such points are called non-normality points. We will discuss the basic theory of Stone-Cech compactifications as well as some results on non-normality points.

10:00 - 10:20 | John Johnson, Howard University

Ramsey theory and matrices

Abstract: This talk will be about the connection between some additive theorems, from Ramsey Theory, and a special collection of matrices. By studying this collection, the conclusions of these additive theorems follows as a special case.

Panel Discussion (Sunday, 11:00am - 12:30pm)

Working in Mathematics

Get an idea of what it's like to work in mathematics! This panel will be comprised of short talks, as well as a question and answer session with mathematicians working in a variety of capacities.

Panelists:

- Jill Calhoun (National Security Agency)

  Jill Calhoun graduated from the University of Notre Dame in 1990 with a B.S. in Math. She attended college on a Navy ROTC scholarship and immediately went into the military from college. Jill was in active duty for 13 years before becoming a federal government employee at NSA in 2003 as an analyst. She quickly became a program manager and now manager. She is a certified Project Management Professional and very close to finishing her MBA.

- John Conway (The George Washington University)

  John Conway received his PhD from Louisiana State University in 1965 and held positions at Indiana University, The University of Tennessee, and now The George Washington University. At the University of Tennessee he was department head for 13 years and in his current position at GWU is also department chair. John was a rotator at the National Science Foundation from 2003-2006. He has had several research grants and a few for educational purposes. He has also produced 19 PhD students, 7 books, and about 70 papers. For years he has been involved in the governance of the American Mathematical Society and is currently in his second (elected) five-year term as a member of the Board of Trustees of the AMS.

- Eden Costagliola (The New School)

  Eden Costagliola grew up in a very progressive education system in Cambridge, Massachusetts. After receiving a BA in mathematics from Vassar and becoming certified to teach secondary school mathematics in New York state, she taught for three years in a small progressive private school called The Poughkeepsie Day School before going to George Washington University for an MA in mathematics. While at GW she taught College Algebra and tutored. After receiving her MA, Eden returned to Massachusetts to work for one year at the Salem Academy Charter School before coming back south to work at The New School of Northern Virginia, another small progressive private school, where she currently teaches mathematics and dance.

- Dean Evasius (National Science Foundation)

  Dean Evasius is a Program Director in the Division of Mathematical Sciences (DMS) at the National Science Foundation, where he currently heads the Workforce and Infrastructure programs. He was previously the Program Director for the Probability program. Prior to arriving at NSF in 2004, he was a research mathematician at the National Security Agency. He received a B.S. degree from UCLA, and a Ph.D. from Caltech. His research interests include cryptography, harmonic analysis, applied probability, and signals processing.

- Chris McKenna (Towers Perrin–Tillinghast)

  After working in the actuarial department of Sentry Insurance (Stevens Point, WI) for five years, Mr. McKenna has spent the last three years as an actuarial consultant with Towers Perrin in Arlington, VA. He has been involved in both reserving and ratemaking projects in a variety of lines of business, including business-owners package (BOP), medical malpractice, auto liability, workers compensation, and asbestos liability. He became a Fellow of the Casualty Actuarial Society (FCAS) in 2005. Mr. McKenna has a bachelors degree in mathematics from Penn State University. He currently resides in Sterling, VA with his wife and three daughters.

- Teresa Przytycka (NCBI, NLM, NIH)

  Teresa Przytycka is an investigator at the National Center of Biotechnology Information, NLM/NIH. She obtained master degree from Department of Mathematics Mechanics and Informatics and PhD from the Department of Computer Science, University of British Columbia, Canada. Before joining NIH she was a visiting faculty member of the Department of Computer Science, University of California Riverside, a faculty member of the Department of Mathematics and Comp. Science Odense University, Denmark, and a Sloan Fellow at the Biophysics Department Johns Hopkins University. Currently she is heading the AlgoCSB (Algorithmic Methods in Computational and Systems Biology) research group at the National Center of Biotechnology Information. She serves on editorial boards of several professional journals.

Session 5 (Sunday, 1:30pm - 3:30pm)

1:30 - 1:50 | Poorani Subramanian, University of Maryland

A Boundary value problem in genomics

Abstract: With the completion of the draft of the human genome in the last decade, attention has turned to sequencing the genomes of other living things. The human genome was expensive to finish in terms of both cost and time, and as the number of other organisms we wish to sequence grows, we are trying to find cheaper and faster ways of doing assembly. When a genome is sequenced, the initial data consists of short paired segments of sequence called reads. The paired reads together make up a mate pair. We know the sequence of bases in each read as well as approximately how far apart these paired reads are in the original genome. This distance plus the lengths of each of the mates is called the insert length. Given this data, we must now assemble the genome. Currently, there are several assembly algorithms in use which will produce a draft of the genome. This draft may contain gaps and small errors. Traditionally, scientists would go back into the lab and resequence the missing or incorrect regions. This is often an expensive procedure. Our research focuses on using the existing read and mate pair data to fix these mistakes without resorting to expensive techniques. To do this we appeal to an idea from mathematics of solving boundary value problems and apply this reasoning to filling gaps and correcting errors. Using this approach, our algorithm attempts to produce all possible assemblies of reads for a given region. We tested our procedure using data from 22 bacterial genomes with collectively 200 gaps or errors. We were able to fix 125 of these using existing data. We also implemented our algorithm on an assembly of Bos taurus, and were able to fill approximately 4000 gaps in sequence totalling 8 Mbp.

2:00 - 2:20 | Michael Coleman, The George Washington University

Modeling the shape of deployable large aperture antennas

Abstract: For future space exploration and near earth remote sensing missions, deployable large parabolic reflector antennas will be necessary to transfer hundreds of megabits of data per second. Deployable antennas are prefered because of their high packing efficiency– a critical benefit aboard a small launch vehicle. Such an antenna has a light weight membrane reflector sealed together with a transparent canopy to create an enclosed envelope. The envlope is supported by rubber tendons which pull at the rim of the reflector and is pressurized to hold a parabolic shape. In practice, however, attaining the desired parabolic shape to an RMS surface error tolerance of 0.5 millimeters is difficult. The aim of this project is to determine conditions which can mitigate deformations and, in general, minimize the parabolic surface distortions to within the desired RMS tolerance. We determine the equilibirum configuration of the reflector by minimizing the total energy of a corresponding discretized system following the optimization based approach of Baginski and Schur. The energy is computed by an energy functional which includes the pressure potential of the system, the strain energy of the reflector material, gravitational potential energy and strain energy in the elastic support tendons. The reflector's geometry is assessed by an RMS computation and an analysis of the electric and magnetic fields that are reflected to the far field zone of the antenna. We determine certain boundary conditions which are desirable to improve the performance of these antennas.

2:30 - 2:50 | Andrew Samuelson, George Mason University

On the elastodynamics of intracranial aneurysms

Abstract: Intracranial aneurysms are a serious and surprisingly common medical problem. Deciding when to treat such aneurysms depends largely on whether they might rupture. Recently, there have been a few theories proposed for understanding aneurysmal rupture and new mathematical models are being developed in this regard. In this talk, an elastodynamic model for a subclass of intracranial saccular aneurysms coupled with uids will be presented and analyzed using both numerical and analytical techniques.

3:00 - 3:20 | Gregory Cochran, George Mason University

Pattern formation in Cahn-Hilliard systems

Abstract: The ability to analyze pattern forming systems presents itself as a difficult task. Computational Homology has proven to be a powerful tool in studying patterns which evolve with time. I will present an analysis of the Viscous Cahn-Hilliard equation which models spinodal decomposition and nucleation in metals. Using computational Homology, a major flaw with this system is easily seen. In experimental data, the number of cavities and tunnels monotony decays. The Cahn-Hilliard equation always has a period of time where the number of cavities and tunnels increases before monotony decaying off. The stochastic extension to this model shows the desired decay.

Session 6 (Sunday, 4:00pm - 6:00pm)

4:00 - 4:20 | Karl Schmitt, University of Maryland

The synchronization of chaotic systems, an introduction and case study of synchronization conditions

Abstract: Synchronization can occur in a variety of systems, perhaps the most surprising is when chaotic systems synchronization. We will present an introduction to chaos and synchronization. Furthermore we will present selected results from a case study of the synchronization between two nonlinear time-delayed optoelectronic feedback loops, including an evaluation of the conditions under which these two systems synchronize and results on how these regimes relate to the system parameters. We will focus on feedback strength and delay as the primary variables. Applications to private communications and sensing networks are discussed.

(Authors: Karl Schmitt, Rajarshi Roy, Thomas Murphy, James Yorke, Adam Cohen, Bhargava Ravoori.)

4:30 - 4:50 | Emily J. King, University of Maryland

Smooth functions associated with wavelet sets on $\mathbb{R}^d$ and frame bound gaps

Abstract: This talk will introduce the concept of wavelet sets. The geometry of these sets determine powerful and useful analytic properties of certain associated functions. Except for a handful of counter-examples in dimension 2, all known wavelet sets in dimensions larger than 1 are fractal-like. However, there do exist objects called Parseval frame wavelet sets which are easy to manipulate. The reason why one would want to manipulate the sets will be explained, and a counter-intuitive phenomenon will be introduced.

5:00 - 5:20 | Ritaja Sur, University of Maryland

Time series classifications

Abstract: The study of time series classification and discrimination has been an area of great interest in economics, biology, finance, computer science and various other fields. For this purpose of classification, there is a need to identify similarities or dissimilarities in the time series data. This can be done by applying parametric or non-parametric measures. In my talk, I will discuss some of these measures available in the literature. I will introduce a new metric based on the Higher order crossings. The performance of this metric will be compared to some of the existing measures using simulation. The use of this metric in a real life example will also be presented.

5:30 - 5:50 | Timothy Myers, Howard University

The Gauge integral: its relationship and application to the Lebesgue integral

Abstract: In 1957 and 1961 respectively, Jarsolav Kurzweil and Ralph Henstock independently discovered that by modifying the definition of the Riemann integral slightly, the resulting integral, known as the Henstock-Kurzweil (H-K) integral or the gauge integral, is one which actually integrates any real valued function that is Lebesgue integrable on a closed interval $I^n \subset \mathbb{R}^n$.

In this seminar, the presenter will define the gauge integral, discuss its relationship to the Lebesgue integral, and demonstrate the versatility of the gauge integral in proving Stoke's Theorem for the Lebesgue integral.