## Weekly Seminar & Events Bulletin

**September 20th, 2020 - September 26th, 2020**

### Monday, September 21, 2020

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<td>4:00pm-5:00pm</td>
<td><strong>Integrable Systems and Random Matrix Theory</strong> -- Kissing Polynomials: The Story so Far</td>
<td>Ahmad Barhoumi (University of Michigan)</td>
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<td>7:00pm-8:00pm</td>
<td><strong>Student Math Finance</strong> -- Deep backward schemes for high-dimensional nonlinear PDEs</td>
<td>April Nellis (University of Michigan)</td>
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10:00pm-11:00pm  **Quant Program Practitioner** -- Xinye Xu (CITIC Securities)  **Quant Virtual Coffee Chat** - Xinye Xu, CITIC Securities -- https://umich.zoom.us/j/98413272924  Virtual
RTG Seminar on Number Theory

Monday, September 21, 2020, 3:00pm-4:00pm
4088 East Hall
Jacob Haley (UM)

Parameterizations of Unramified Tori in Classical Groups

If G is a reductive group over a p-adic field k, an important question is to understand the maximal k-tori up to G(k)-conjugacy. In the case of tori which split over an unramified extension, DeBacker gives a parameterization using Bruhat-Tits theory. On the other hand, for classical groups, Waldspurger gives an alternate parameterization in terms of triples of partitions ($\mu_0$, $\mu_1$, $\mu_2$). Given one of these triples, Waldspurger constructs a regular semisimple element for the torus by defining an endomorphism of an algebra whose structure is governed by the parts of the three partitions. We will discuss these two parameterizations, and then we will give a comparison of the two, demonstrating how to obtain the data in the DeBacker parameterization from a given Waldspurger triple. We will focus on the case of the symplectic group.

Algebraic Topology

Monday, September 21, 2020, 4:00pm-5:00pm
online Virtual
Foling Zou (University of Michigan)

Nonabelian Poincare duality theorem in equivariant factorization homology

The factorization homology are invariants of $n$-dimensional manifolds with some fixed tangential structures that take coefficients in suitable $E_n$-algebras. In this talk, I will discuss the equivariant factorization homology of framed $G$-manifolds for a finite group $G$. These manifolds are $V$-framed for a $G$-representation $V$, and the coefficients for the theory are $E_V$-spaces or $E_V$-spectra. I will prove the equivariant nonabelian Poincare duality theorem in this case. As an application, in joint work with Asaf Horev and Inbar Klang, we compute the equivariant factorization homology on equivariant spheres for certain Thom spectra.
Kissing polynomials, dubbed so for the peculiar behavior of their zeros, are a family of orthogonal polynomials with respect to an oscillatory, complex-valued weight. These polynomials were first considered in the development of a Gaussian quadrature rule to address highly oscillatory integrals. Since the weight of orthogonality is complex-valued, the quadrature nodes are not necessarily restricted to the real line, nor are we guaranteed n nodes! In this talk, I will discuss some results about the large-degree asymptotics of kissing polynomials in several settings. This is joint work with Alfredo Deaño and Andrew Celsus.

I present a paper by Come Hure, Huyen Pham, and Xavier Warin, which introduces new machine learning schemes for solving high dimensional nonlinear partial differential equations (PDEs). Relying on the classical backward stochastic differential equation (BSDE) representation of PDEs, the algorithms simultaneously estimate the solution and its gradient by deep neural networks. These approximations are performed at each time step by the minimization of loss functions defined recursively by backward induction. The methodology is then extended to variational inequalities arising in optimal stopping problems and applied to pricing American options. Finally, potential extensions to switching problems are discussed. Paper: https://arxiv.org/abs/1902.01599

Suppose that \((x_1,y_1),\ldots,(x_r,y_r)\) is a set of points in the plane. Given a degree \(d\) and multiplicities \(m_i\), does there a nonzero polynomial in two variables of degree at most \(d\) which vanishes to order at least \(m_i\) at \((x_i,y_i)\)? What is the dimension of the space of such polynomials, and how does it vary with the parameters? I will explain some of the basic results and conjectures and show how this problem is connected to some questions of current interest in algebraic geometry.

Zoom information: https://umich.zoom.us/j/97646405029
passcode: 993219
Complex Analysis, Dynamics and Geometry  
Tuesday, September 22, 2020, 5:00pm-6:00pm  
email kochsc@umich.edu for the Zoom info Virtual  
Yusheng Luo (U(M))  

Cusps and a pinching theorem for the boundary of the principal hyperbolic component in the space of polynomials

It is well-known the parabolic polynomials on the boundary of the main cardioid of the Mandelbrot set are in one-to-one correspondence with a rational rotation number; two such parabolic polynomials are mateable if and only if they have non-conjugate rotation number; and the boundary is a Jordan curve.  
In this talk, we will study these three statements for the principal hyperbolic component (the hyperbolic component of polynomials containing z^d) of higher degree. We will classify the geometrically finite polynomials on the boundary of the main hyperbolic component, and characterize their mateablity condition. We also find a new self-bump phenomenon on the boundary of principal hyperbolic component of higher degree: a geometrically finite polynomial that is accessed in two different ways from the principal hyperbolic component.

Student Combinatorics  
Tuesday, September 22, 2020, 5:00pm-6:00pm  
Virtual

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Planning Meeting

Come help brainstorm topics and sign up for talks for the Student Combinatorics Seminar this semester!
Let $f : U \to \mathbb{C}^*$ be an algebraic map from a smooth complex connected algebraic variety $U$ to the punctured complex line $\mathbb{C}^*$. Using $f$ to pull back the exponential map $\mathbb{C} \to \mathbb{C}^*$, one obtains an infinite cyclic cover $U^f$ of the variety $U$. The homology groups of this infinite cyclic cover, which are endowed with $\mathbb{Z}$-actions by deck transformations, determine the family of Alexander modules associated to the map $f$. In this talk, we will discuss how to equip the torsion part of the Alexander modules (with respect to the $\mathbb{Z}$-actions) with canonical mixed Hodge structures. Since $U^f$ is not an algebraic variety in general, these mixed Hodge structures cannot be obtained from Deligne's theory. The resulting mixed Hodge structures on Alexander modules have some desirable properties. For example, the covering space map $U^f \to U$ induces morphisms of mixed Hodge structures in homology, where the homology of $U$ is equipped with Deligne's mixed Hodge structure. We will explore several consequences/applications of this fact, regarding weights and semisimplicity. We will also compare the mixed Hodge structures on Alexander modules to other well studied mixed Hodge structures in the literature, including the limit mixed Hodge structure on the generic fiber of $f$. Joint work with C. Geske, M. Herradón Cueto, L. Maxim, and B. Wang.

**Financial/Actuarial Mathematics**  
**Wednesday, September 23, 2020, 4:00pm-5:00pm**  
**https://umich.zoom.us/j/95407665241 Virtual**  
**Tao Chen (UM)**  
**Adaptive Robust Stochastic Control**

In this talk, we will review the adaptive robust control methodology that we developed for dealing with (Markovian) stochastic control problems under model uncertainty. To address the uncertainty of the model parameters for the underlying stochastic process, this novel robust technique reduces the uncertainty through online learning and updating of the parameter set while optimizing. We will also discuss the difficulties that arise in the implementation of such approach and propose a new machine learning technique to recast the numerical implementation into a statistical learning problem. Finally, we will use several examples to show that the adaptive robust approach can outperform other traditional/popular robust techniques.

**Student Arithmetic**  
**Wednesday, September 23, 2020, 6:00pm-7:00pm**  
**Zoom: 98251522670 Virtual**  
**Various speakers (UM)**  
**Speed talks and planning meeting**

A few older graduate students will give 3--5 minute speed talks (or rather elevator pitches) about their research. Stop by to meet the arithmetic geometry and number theory group. After that, we will have a normal planning meeting where we schedule talks for the semester.
Differential Equations
Thursday, September 24, 2020, 4:00pm-5:00pm
Zoom ID: 983 6567 6067 Virtual
Christof Sparber (University of Illinois, Chicago)

**Solitary waves and scattering in NLS with competing nonlinearities**

We study the interplay between dispersion and orbital (in-)stability of solitary waves in nonlinear Schrödinger equations (NLS) with competing nonlinearities. We will mainly focus on the case of the cubic-quintic NLS in space dimensions up to three. An emphasis will be on the distinction between nonlinear ground states and the set of constraint energy minimizers. Time permitting, we will also consider a closely related log-modified NLS equation in 2D. This is joint work with Remi Carles.

Zoom Link: Join Zoom Meeting
https://umich.zoom.us/j/98365676067

Meeting ID: 983 6567 6067
Passcode: 2020

Student Commutative Algebra
Thursday, September 24, 2020, 5:00pm-6:00pm
Virtual
Shelby Cox (University of Michigan)

**Groebner Bases (and Tropical Bases)**

I will present the basics of Groebner bases, including Buchberger's algorithm. I will also talk about some applications of Groebner bases and define Tropical Bases if time permits. The talk is completely introductory assuming some knowledge of polynomial rings (over a field). Join via https://umich.zoom.us/j/96869586617 or email studentcommalg@umich.edu.

Quant Program Practitioner
Friday, September 25, 2020, 10:00pm-11:00pm
https://umich.zoom.us/j/98413272924  Virtual
Xinye Xu (CITIC Securities)

**Quant Virtual Coffee Chat - Xinye Xu, CITIC Securities**

https://umich.zoom.us/j/98413272924

Saturday, September 26 at 10:00 AM China Standard Time

Representation Stability
Friday, September 25, 2020, 11:00am-11:50am
Online
Will Dana (UM)

TBA
Quant Program Practitioner  
Friday, September 25, 2020, 2:30pm-3:30pm  
https://umich.zoom.us/j/92294612394 Passcode: 684543 Virtual  
Yifei Lu and Patrick Lu (MSCI)  
Quant Virtual Happy Hour - Yifei Lu and Patrick Lu  

https://umich.zoom.us/j/92294612394  
Passcode: 684543

Applied Interdisciplinary Mathematics (AIM)  
Friday, September 25, 2020, 3:00pm-12:00am  
(Zoom) East Hall  
Shilpa Khatri (University of California, Merced)  
Fluid-structure interactions within marine phenomena  

To understand the fluid dynamics of marine phenomena fluid-structure interaction problems must be solved. Challenges exist in developing analytical and numerical techniques to solve these complex flow problems with boundary conditions at fluid-structure interfaces. I will present details of two different problems where these challenges are handled: (1) modeling of pulsating soft corals and (2) accurate evaluation of layer potentials near boundaries and interfaces in three dimensions. The first problem of pulsating soft corals will be motivated by field and experimental work in the marine sciences. I will discuss these related data and provide comparisons with the modeling. For the second problem of accurate evaluation of layer potentials, I will show how classical numerical methods are problematic for evaluations close to boundaries and how newly developed asymptotic methods can be used to remove the error. To demonstrate this method, I will consider the interior Laplace problem.

Student Dynamics/Geometry Topology  
Friday, September 25, 2020, 3:00pm-4:00pm  

Planning meeting F20  

Zoom link: https://umich.zoom.us/j/94090012548

Student Algebraic Geometry  
Friday, September 25, 2020, 3:00pm-4:00pm  
VIRTUAL East Hall  
(UM)  
TBD (possibly mini-talks)

If we can get enough interested speakers, we'll have a series of quick talks on what research topics people are working on, to give younger students a sense of what's going on in the field. If we can't get enough speakers, Devlin will give a talk on a subject to be announced.
Preprint Algebraic Geometry
Friday, September 25, 2020, 4:00pm-5:00pm
Zoom
James Hotchkiss
Vanishing cycles under base change and the integral Hodge conjecture
https://arxiv.org/abs/1901.07091 by Mingmin Shen

Student AIM Seminar
Friday, September 25, 2020, 4:00pm-5:00pm
Virtual
Leighton Wilson (University of Michigan)
A dual tree traversal fast summation method in the TABI-PB boundary integral Poisson-Boltzmann solver

The Poisson--Boltzmann (PB) implicit solvent model is a popular approach for studying the electrostatics of solvated biomolecules. One approach to solving the PB equation is the treecode-accelerated boundary integral PB solver (TABI-PB), which employs a well-conditioned boundary integral formulation for the electrostatic potential and its normal derivative on the molecular surface. The resulting linear system is solved by GMRes iteration, with the dense matrix-vector product accelerated by an O(N log N) Cartesian Taylor treecode. In this presentation, we introduce an O(N) dual tree traversal fast summation method based on barycentric Lagrange interpolation (BLDTT) to accelerate the matrix-vector product. For a typical problem, this approach results in a 6x speedup and a reduced memory footprint for TABI-PB. In addition, it allows for the development of a GPU-accelerated version of TABI-PB, which results in further speedups.