

## Weekly Seminar & Events Bulletin

January 14th, 2018 - January 20th, 2018

### Monday, January 15, 2018

- 4:00pm-5:00pm **Special Events** -- Talitha Washington (Associate Professor, Howard University & Program Director, National Science Foundation) *Hidden Figures: Bringing Math, Physics, History, and Race to Hollywood* -- 1324 East Hall
- 4:00pm-5:00pm **Integrable Systems and Random Matrix Theory** -- () *No seminar - MLK day* -- 1866 East Hall

### Tuesday, January 16, 2018

- 3:00pm-4:00pm **Student Geometry/Topology** -- Daniel Irvine (University of Michigan) *Symplectic Embedding Problems* -- 3866 East Hall
- 3:00pm-4:00pm **Student Representation Theory** -- Visu Makam (University of Michigan) *Geometric complexity theory* -- 1866 East Hall
- 3:00pm-4:00pm **Student Commutative Algebra** -- None (University of Michigan) *Planning Meeting* -- 3096 East Hall

### Wednesday, January 17, 2018

- 3:00pm-4:00pm **Student Arithmetic** -- Patrick Kelley (UM) *An introduction to modular forms* -- 1866 East Hall
- 4:00pm-5:00pm **Financial/Actuarial Mathematics** -- Matteo Burzoni (ETH) *On the martingale selection problem and its connection to arbitrage theory* -- 1360 East Hall
- 4:00pm-5:30pm **RTG Seminar on Geometry, Dynamics and Topology** -- Jasmine Powell (U(M)) *Rational maps I* -- 3866 East Hall
- 4:10pm-5:30pm **Algebraic Geometry** -- Uli Walther (Purdue University) *GKZ-systems and mixed Hodge modules* -- 4096 East Hall

### Thursday, January 18, 2018

- 3:00pm-4:00pm **Quant Program Practitioner Seminar** -- Alex Wugalter (Ellington Management) *TBA* -- EH1360
- 4:00pm-5:00pm **Commutative Algebra** -- () *Organizational meeting* -- 3866 East Hall
- 4:10pm-5:30pm **Preprint Algebraic Geometry Seminar** -- () *Organizational meeting* -- 2866 East Hall

### Friday, January 19, 2018

- 3:00pm-4:00pm **Applied Interdisciplinary Mathematics (AIM)** -- Tong Gao (Michigan State University) *Biomimetic studies of fluid-structure interaction: self-assembly, collective dynamics, and autonomous machines* -- 1084 East Hall
- 3:00pm-4:00pm **Geometry** -- Gabriel Khan (OSU) *A conjectural picture of complex structures on tori and other spaces* -- 3866 East Hall
- 3:10pm-4:10pm **Student Algebraic Geometry** -- Kannappan Sampath (UM) *Resolution of Singularities.* -- 3096 East Hall
- 4:10pm-5:00pm **Combinatorics** -- Joshua Swanson (U. Washington) *Major Index Asymptotics* -- 4088 East Hall
- 4:10pm-5:00pm **Student AIM Seminar** -- Nathan Vaughn (University of Michigan) *GPU Programming on FLUX* -- 1084 East Hall
- 4:10pm-5:30pm **Group, Lie and Number Theory** -- Jeff Manning (Univ of Chicago) *Taylor-Wiles-Kisin patching and mod  $l$  multiplicities in Shimura curves (Note special day/room)* -- 2866 East Hall

**Abstracts for the week of January 14th, 2018 - January 20th, 2018**

**Special Events**

**Monday, January 15, 2018, 4:00pm-5:00pm**

**1324 East Hall**

**Talitha Washington (Associate Professor, Howard University & Program Director, National Science Foundation)**

*Hidden Figures: Bringing Math, Physics, History, and Race to Hollywood*

(The movie will show before the talk at 1:30pm in 1360 East Hall. Seating is limited).

In January 2017, the movie *Hidden Figures* was released by 20th Century Fox studios. This movie tells the story of three African-American women mathematicians and engineers (Katherine Johnson, Mary Jackson and Dorothy Vaughan) who would play a pivotal role towards the successful mission of John Glenn's spacecraft orbit around the Earth and the NASA missions to the moon.

For this talk, we give a brief review of the space race going on at the time between the United States of America and the former Soviet Union. We will discuss the lives and contributions that NASA mathematician Katherine Johnson and the NASA engineers Mary Jackson and Dorothy Vaughan made to the space race. In particular, their work as concerns John Glenn's orbit around the Earth in 1962 and to the moon missions. Also, we will talk about the experiences of being a mathematical consultant for this film. (This talk was designed and originally to be presented by Professor Rudy Horne, who passed away in December 2017. Professor Washington kindly agreed to present in his stead.)

Reception to follow in the Mathematics Atrium.

**Integrable Systems and Random Matrix Theory**

**Monday, January 15, 2018, 4:00pm-5:00pm**

**1866 East Hall**

**()**

*No seminar - MLK day*

## Weekly Seminar & Events Bulletin

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### **Student Geometry/Topology**

**Tuesday, January 16, 2018, 3:00pm-4:00pm**

**3866 East Hall**

**Daniel Irvine (University of Michigan)**

*Symplectic Embedding Problems*

A natural question in symplectic geometry is when there exists an embedding from one symplectic manifold into another that preserves the symplectic structure. This question is surprisingly difficult, because symplectic geometry exhibits a strange blend of rigidity and flexibility that is only partially understood. For this reason, embedding results are only known for a few simple manifolds. I will begin by explaining how these problems are closely related to the time evolution of a mechanical system. I will then survey some known results about embedding some simple symplectic manifolds. This leads to an interesting combinatorial/number theoretic problem. If time permits, I will discuss a connection with the Uncertainty Principle. This talk will feature much of the same vocabulary and setup as my talk from last semester.

### **Student Representation Theory**

**Tuesday, January 16, 2018, 3:00pm-4:00pm**

**1866 East Hall**

**Visu Makam (University of Michigan)**

*Geometric complexity theory*

The P vs NP problem is one of the seven millennium prize problems. Leslie Valiant formulated a purely algebraic version of this problem, widely known as VP vs VNP, which can be attacked by algebraic methods. Mulmuley and Sohoni's ambitious approach to this problem is to reduce it to a special case of the following problem -- for a representation  $V$  of a group  $G$ , does the orbit closure of a point  $v$  contain another point  $w$ ? This approach is called geometric complexity theory (GCT) and has captured the imagination of computer scientists, representation theorists and algebraic geometers alike. In this talk, we will give a very accessible overview of this GCT program.

### **Student Commutative Algebra**

**Tuesday, January 16, 2018, 3:00pm-4:00pm**

**3096 East Hall**

**None (University of Michigan)**

*Planning Meeting*

During this meeting, we will discuss possible topics for this semester and whether we want to meet roughly weekly or biweekly, have traditional talks, mini-workshops, or something else entirely. Anybody who is interested in commutative algebra is welcome, including first year grad students, the student AG crowd, and postdocs.

**Weekly Seminar & Events Bulletin**

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**Student Arithmetic**

**Wednesday, January 17, 2018, 3:00pm-4:00pm**

**1866 East Hall**

**Patrick Kelley (UM)**

*An introduction to modular forms*

We will survey the basic definitions and results concerning modular forms and their associated L-functions. If time permits, we will discuss a few ways that modular forms have been generalized.

**Financial/Actuarial Mathematics**

**Wednesday, January 17, 2018, 4:00pm-5:00pm**

**1360 East Hall**

**Matteo Burzoni (ETH)**

*On the martingale selection problem and its connection to arbitrage theory*

Given a collection of random set, the martingale selection problem consists in finding a selection of these sets and a probability measure with respect to which the selection is a martingale. We solve this problem in a pointwise framework, i.e. in absence of a reference probability and in discrete time. In a second part we show how the solution of this problem is strongly connected with arbitrage theory and show how to derive fundamental theorems of asset pricing in various context, from frictionless markets to general transaction costs.

This is a joint work with Mario Sikic.

**RTG Seminar on Geometry, Dynamics and Topology**

**Wednesday, January 17, 2018, 4:00pm-5:30pm**

**3866 East Hall**

**Jasmine Powell (U(M))**

*Rational maps I*

This will be an introduction to the theory of iterating rational maps on the Riemann sphere.

**Weekly Seminar & Events Bulletin**

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**Algebraic Geometry**

**Wednesday, January 17, 2018, 4:10pm-5:30pm**

**4096 East Hall**

**Uli Walther (Purdue University)**

*GKZ-systems and mixed Hodge modules*

I will define GKZ-systems, and talk a little about their properties from the algebraic, analytic, and combinatorial point of view. Then I will discuss a theorem of Gelfand et al, and a sharpening by Mathias Schulze and myself, on the question which GKZ-systems arise as (D-module-)direct image of a natural D-module on a torus. In such cases, the GKZ-system can inherit a mixed Hodge module structure. I will then explain work with Thomas Reichelt that computes the weight filtration of this MHM structure on a class of GKZ-systems that comes up naturally in mirror symmetry. This complements work of Reichelt and Christian Sevenheck who computed the Hodge filtration, and supersedes computations of Batyrev who determined the weight filtration in a generic point. Very few of such explicitly computed structures seem to be known.

**Quant Program Practitioner Seminar**

**Thursday, January 18, 2018, 3:00pm-4:00pm**

**EH1360**

**Alex Wugalter (Ellington Management)**

*TBA*

**Commutative Algebra**

**Thursday, January 18, 2018, 4:00pm-5:00pm**

**3866 East Hall**

**()**

*Organizational meeting*

**Preprint Algebraic Geometry Seminar**

**Thursday, January 18, 2018, 4:10pm-5:30pm**

**2866 East Hall**

**()**

*Organizational meeting*

## Weekly Seminar & Events Bulletin

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### **Applied Interdisciplinary Mathematics (AIM)**

**Friday, January 19, 2018, 3:00pm-4:00pm**

**1084 East Hall**

**Tong Gao (Michigan State University)**

*Biomimetic studies of fluid-structure interaction: self-assembly, collective dynamics, and autonomous machines*

New physics and phenomena of how active structures interact with fluids have generated considerable excitement in the past decade. Uncovering physical mechanisms of the reciprocal dynamics in the biological/synthetic active systems often require developing ad-hoc theoretical models and simulation methods. In this talk, I will first discuss multiscale modeling and simulation of a bio-active synthetic fluid made from a microtubule/motor protein assembly. I will illustrate how the local particle-particle interactions lead to self-organization, and manifest themselves as large-scale collective motions due to a cascade of hydrodynamic instabilities. Furthermore, I will show that manipulation of active matter can be achieved by applying appropriate rigid or soft boundary confinements to guide them to perform useful mechanical work. Next, I will introduce a fictitious domain/active strain computation framework in simulation and design of bio-inspired soft robotic swimmers that can propel themselves in fluids by performing large deformations, as well as its applications for resolving a class of fluid-structure interaction problems in biomedical research.

### **Geometry**

**Friday, January 19, 2018, 3:00pm-4:00pm**

**3866 East Hall**

**Gabriel Khan (OSU)**

*A conjectural picture of complex structures on tori and other spaces*

One of the central questions in complex geometry is to understand the moduli space of complex structures on a given manifold. In general, this is a mysterious object. Locally, we can study deformations of complex structures using Kodaira-Spencer theory. However, the global geometry can be very complicated and have singularities. In this talk, we consider the case where we have a Riemannian-flat metric and show how this can be used to understand the geometry of the moduli space. From here, we lay out some conjectures about how this can be done more generally, and give some heuristic evidence for these conjectures.

### **Student Algebraic Geometry**

**Friday, January 19, 2018, 3:10pm-4:10pm**

**3096 East Hall**

**Kannappan Sampath (UM)**

*Resolution of Singularities.*

We will discuss resolution of singularities of complex algebraic curves and surfaces through many explicit examples; in particular, we will examine the resolutions of Hirzebruch-Jung type singularities. This talk will be accessible to anyone who has taken 631.

**Weekly Seminar & Events Bulletin**

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**Combinatorics**

**Friday, January 19, 2018, 4:10pm-5:00pm**

**4088 East Hall**

**Joshua Swanson (U. Washington)**

*Major Index Asymptotics*

We discuss the representation theory and asymptotic behavior of major index statistics for words and tableaux.

Classic work of MacMahon gave a succinct expression for the major index generating function on words of fixed content. Canfield-Janson-Zeilberger (2011) gave precise asymptotic estimates for the number of such words with a given major index. In another direction, Lusztig and Stanley related the major index statistic on standard tableaux to the graded irreducible decomposition of the type A coinvariant algebra.

Kraskiewicz-Weyman connected the major index modulo  $n$  to the Lusztig-Stanley decomposition and certain induced representations. We will describe recent work giving precise estimates for the number of standard tableaux with a given major index, modulo  $n$ . A key step involves certain normalized symmetric group character estimates using a formula of Fomin--Lulov. Time permitting, we will also describe ongoing joint work with Sara Billey and Matjaz Konvalinka generalizing Canfield-Janson-Zeilberger's investigations to skew shape tableaux.

**Student AIM Seminar**

**Friday, January 19, 2018, 4:10pm-5:00pm**

**1084 East Hall**

**Nathan Vaughn (University of Michigan)**

*GPU Programming on FLUX*

With this talk I aim to introduce you to GPU programming, demonstrate its usefulness in scientific computing, and show you how you can run your very own GPU programs on the FLUX cluster here at Michigan.

Compared to CPUs, which perform very complex tasks serially, GPUs perform thousands of simple tasks concurrently. Taking advantage of this architecture requires careful programming but can result in huge speedups.

**Weekly Seminar & Events Bulletin**

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**Group, Lie and Number Theory**

**Friday, January 19, 2018, 4:10pm-5:30pm**

**2866 East Hall**

**Jeff Manning (Univ of Chicago)**

*Taylor-Wiles-Kisin patching and mod  $l$  multiplicities in Shimura curves (Note special day/room)*

In the early 1990s Ribet observed that the classical multiplicity one results for modular curves, which are a consequence of the  $q$ -expansion principle, fail to generalize to Shimura curves. Specifically he found examples of Galois representations which occur with multiplicity 2 in the mod  $l$  cohomology of a Shimura curve with discriminant  $pq$  and level 1.

I will describe a new approach to proving multiplicity statements for Shimura curves, using the Taylor-Wiles-Kisin patching method (which was shown by Diamond to give an alternate proof of multiplicity one in certain cases), as well as specific computations of local Galois deformation rings done by Shotton. This allows us to re-interpret and generalize Ribet's result. I will prove a "multiplicity  $2^k$ " statement in the minimal level case, where  $k$  is a number depending only on local Galois theoretic data.

Time permitting I will also describe joint work (in progress) with Jack Shotton, in which we use these techniques to prove new cases of Ihara's Lemma for Shimura curves, which are not covered by the work of Diamond and Taylor.