### Weekly Seminar & Events Bulletin
January 14th, 2018 - January 20th, 2018

**Monday, January 15, 2018**

<table>
<thead>
<tr>
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<tr>
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<td><strong>Special Events</strong> -- Talitha Washington (Associate Professor, Howard University &amp; Program Director, National Science Foundation) <em>Hidden Figures: Bringing Math, Physics, History, and Race to Hollywood</em></td>
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<td><strong>Algebraic Geometry</strong> -- Uli Walther (Purdue University) <em>GKZ-systems and mixed Hodge modules</em></td>
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<td><strong>Combinatorics</strong> -- Joshua Swanson (U. Washington) <em>Major Index Asymptotics</em></td>
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http://www.math.lsa.umich.edu/seminars_events/ - Page 1/7
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
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.
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.
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.

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Thursday, January 18, 2018, 3:00pm-4:00pm
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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-5:00pm
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.
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.