## Weekly Seminar & Events Bulletin
March 8th, 2020 - March 14th, 2020

### Monday, March 09, 2020

<table>
<thead>
<tr>
<th>3:00pm-4:00pm</th>
<th><strong>Student Combinatorics</strong> -- Shelby Cox (UM) <em>Recurrence Problems</em> -- 3088 East Hall</th>
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<td>4:00pm-5:00pm</td>
<td><strong>Integrable Systems and Random Matrix Theory</strong> -- Harini Desiraju (SISSA, Trieste) <em>Fredholm determinant representation of Painlevé-II tau-function</em> -- 1866 East Hall</td>
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<td><strong>Group, Lie and Number Theory</strong> -- Wayne Raskind (Wayne State University) <em>Etale cohomology of algebraic varieties over the maximal cyclotomic extension of a global field</em> -- 4096 East Hall</td>
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<td>5:00pm-6:00pm</td>
<td><strong>Student Analysis</strong> -- Yuchen Liao (University of Michigan) <em>Universal phenomenon in random systems</em> -- 4088 East Hall</td>
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### Tuesday, March 10, 2020

| 3:00pm-4:00pm | **Student Algebraic Geometry** -- Shubhankar Sahai (UM) *Grothendieck Riemann Roch* -- B745 East Hall |

### Wednesday, March 11, 2020

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<th>3:00pm-4:00pm</th>
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<td><strong>Algebraic Geometry</strong> -- Bangere Purnaprajna (University of Kansas) <em>Deformation of canonical morphisms of varieties of general type in all dimensions, with application to moduli</em> -- 4096 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Student Representation Theory</strong> -- Jacob Haley (University of Michigan) <em>The Trace Formula for Compact Groups</em> -- 2866 East Hall</td>
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Student Combinatorics  
**Monday, March 09, 2020, 3:00pm-4:00pm**  
3088 East Hall  
Shelby Cox (UM)  
*Recurrence Problems*  

We will explore some fun recurrence problems including the musical phenomenon Narayana’s cows. We will discuss the solutions to these problems as well as a more general strategy for obtaining a generating function from a known recurrence using a transfer matrix. No background in combinatorics or bovine studies is necessary.

Integrable Systems and Random Matrix Theory  
**Monday, March 09, 2020, 4:00pm-5:00pm**  
1866 East Hall  
Harini Desiraju (SISSA, Trieste)  
*Fredholm determinant representation of Painlevé II tau-function*  

The tau-functions of certain Painlevé equations (III, V, VI) can be expressed as Fredholm determinants of a composition of two suitable Toeplitz operators, called the Widom constant. The key feature of this construction is to reduce the Riemann-Hilbert problem (RHP) associated to the isomonodromic system to a RHP on the circle. In this talk, I will present two results about the Painlevé II tau-function.

1) The determinant of the Airy kernel, which is known to be a special solution of Painlevé II, can be written as a Widom constant.

2) The RHP of Painlevé II can be associated locally to a RHP on a straight line. Developing techniques to construct Fredholm determinant representations of tau-functions corresponding to RHPs on straight line contours, I express the tau-function of Painlevé II as a Fredholm determinant.
Group, Lie and Number Theory  
Monday, March 09, 2020, 4:10pm-5:00pm  
4096 East Hall  
Wayne Raskind (Wayne State University)  
*Etale cohomology of algebraic varieties over the maximal cyclotomic extension of a global field*

Let $k$ be a global field (finite extension of $\mathbb{Q}$ or a function field in one variable over a finite field), and $X$ be a smooth projective variety over $k$. Denote by $L$ a separable closure of $k$, by $K$ the maximal cyclotomic extension of $k$ obtained by adjoining all roots of unity, and put $G=\text{Gal}(L/K)$. Following work of Ribet for $H^1$ and Roessler-Szamuely for odd degree $H^i$, we study the fixed part by $G$ of the etale cohomology groups $H^i(X_L,\mathbb{Q}/\mathbb{Z})$, where we ignore the $p$-part in positive characteristic $p$. We will focus on the even degree case $i=2r$ and prove some positive results in the number field case and negative results in the function field case.

Operators in Complex Analysis  
Monday, March 09, 2020, 5:00pm-6:00pm  
3096 East Hall  
Zhenghui Huo (University of Toledo)  
*Bekollé-Bonami estimates for the Bergman projection on some pseudoconvex domains*

In the 80s, Bekollé and Bonami gave a necessary and sufficient condition for the boundedness of the Bergman projection on the weighted $L^p$ space of the unit ball. Recently, using dyadic harmonic analysis technique, weighted $L^p$ estimates were obtained for the Bergman projection on for example, the upper half plane, the unit ball, and the Hartogs triangle. In this talk, I will present sharp estimates for the weighted $L^p$ norm of the projection on a class of pseudoconvex domains. I will also explain the dyadic operator technique used in the proof. This talk is based on a joint work with Nathan Wagner and Brett Wick.
Fluctuations of large random systems are believed to exhibit universal pattern. Classical central limit theorem is a typical example where sum of i.i.d. random variables always converge to Gaussian distribution after proper renormalization. In this talk I will discuss some other universality classes beyond classical central limit theorem. I will mainly focus on the so-called Kardar-Parisi-Zhang (KPZ) universality class which includes models from random interface growth, interacting particle systems, random matrices, random tilings and so on. After a brief overview of several models in the KPZ class, I will discuss in detail one particular model, the totally asymmetric simple exclusion process (TASEP) which is a famous interacting particle system modeling traffic flows. I will derive exact formula for the transition probability of TASEP using the so-called Bethe ansatz coming from quantum integrable systems. Time permits, I will discuss one-point distribution and asymptotics as well.

Student Algebraic Geometry
Tuesday, March 10, 2020, 3:00pm-4:00pm
B745 East Hall
Shubhankar Sahai (UM)

Grothendieck Riemann Roch

In this (slightly ambitious) talk we will sketch a proof of the Grothendieck-Riemann-Roch formula. Our viewpoint will be to consider it as a natural generalisation of the analytical Hirzebruch-Riemann-Roch, which is itself a generalisation of the Riemann-Roch. To this end, we introduce the Chow Ring and the K group of a scheme, explain their functoriality and connect them using Chern classes.

Time remaining, we will sketch how to develop Higher K-groups of a scheme.
Student Arithmetic  
**Wednesday, March 11, 2020, 3:00pm-4:00pm**  
3088 East Hall  
**Kyu Jun (University of Michigan)**  
*Representation Stability and points over finite fields*  

I will describe how to compute certain combinatorial statistics (expected number of linear factor for squarefree polynomials in $\mathbb{F}_q[T]$ for instance), using the cohomological stability. I will start to talk about Grothendieck-Lefschetz fixed-point theorem with twisted statistics, and how to use fixed point theorem to convert a formula for the multiplicity of irreducible representation $V$ of $S_n$ in cohomology groups to a formula for the number of polynomials over $\mathbb{F}_q$ with specified properties attached to $V$. This talk is based on Church, Ellenberg, and Farb's paper [Arxiv: 1309.6038]

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Financial/Actuarial Mathematics  
**Wednesday, March 11, 2020, 4:00pm-5:00pm**  
1360 East Hall  
**Wenpin Tang (UCLA)**  
*Rank-dependent diffusions and PDEs*  

In this talk, I will discuss rank-dependent diffusions. I will focus on two models: Up the River model and N-player games with fuel constraints. These problems require treating carefully the corresponding PDEs. The former is joint with Li-Cheng Tsai, and the latter joint with Xin Guo and Renyuan Xu.
Algebraic Geometry  
Wednesday, March 11, 2020, 4:00pm-5:20pm  
4096 East Hall  
Bangere Purnaprajna (University of Kansas)  
*Deformation of canonical morphisms of varieties of general type in all dimensions, with application to moduli*

In this talk we present recent results on deformations of canonical morphisms of varieties of general type and some applications. The applications include the description of moduli components and consequences for the geometry of Calabi Yau varieties of arbitrary dimension. To accomplish the above, we deal with the more general setting of deformation of finite maps and show how to use this deformation theory to construct varieties with given invariants in a projective space. Among other things, we give a criterion that determines when a finite map can be deformed to a one-to-one map. We use this general result that holds in all dimensions to construct new varieties of general type with a birational canonical map. Specializing to surfaces, the results address a question that Enriques posed in 1944 for the case of an algebraic surface. Most of known families until now were complete intersections or divisors in three folds, while the varieties we construct are not of this type.

Student Representation Theory  
Wednesday, March 11, 2020, 4:00pm-5:00pm  
2866 East Hall  
Jacob Haley (University of Michigan)  
*The Trace Formula for Compact Groups*

Given a compact topological group, the trace formula relates characters of irreducible representations to Fourier transforms of orbital integrals. We will attempt to understand the statement of the trace formula and some of its applications to representation theory. Time permitting, we will then discuss some analogues for p-adic groups.

Commutative Algebra  
Thursday, March 12, 2020, 3:00pm-4:00pm  
1866EH East Hall  
Marcus Robinson (University of Utah)  
*BCM Test Ideals of Mixed Characteristic Toric Schemes*

In this talk we will give a brief introduction to the topic of big Cohen-Macaulay test ideals, a mixed characteristic analogue of the multiplier/test ideals defined in equal/positive characteristic. We will provide a formula to compute the BCM test ideal in the case of monomial ideals of mixed characteristic toric schemes. Of particular interest is that this formula is consistent with the formula for the multiplier ideal in equal characteristic and test ideal in positive characteristic.
Colloquium Series  
Thursday, March 12, 2020, 4:00pm-5:00pm  
4088 East Hall  
Laure Saint Raymond (ENS, Lyons)  
CANCELLED

TITLE: Forcing and dissipation of internal waves.

Stratification of the density in an incompressible fluid is responsible for the propagation of internal waves. In domains with topography, the interaction of these waves with the boundary produces a cascade towards small wavelengths. Although the equations are linear, this phenomenology is reminiscent from turbulence.

Arithmetic Geometry Learning  
Thursday, March 12, 2020, 4:00pm-5:00pm  
2866 East Hall  
Jakub Witaszek (UM)  
Introduction to Mumford-Tate groups

Special Events  
Thursday, March 12, 2020, 5:00pm-6:00pm  
1360 East Hall  
Purnaprajna Bangere (University of Kansas)  
Geometry and Music

It has long been known that there is a deep connection between Mathematics and Music. In this talk, Purnaprajna shows how modern algebraic geometry inspired by ideas and methods of Alexander Grothendieck sheds light on the connection between different genres of music. He develops a meta geometric framework which gives rise to the so called "Metaraga system"; a system with its own grammar and syntax. This integrates elements of Indian and Western classical music, jazz and the blues. Moreover it gives rise to a music with no vantage point of east or west. Metaraga system's mathematical underpinning lies in category theoretic algebraic geometry, and Grothendieck like topologies. The dictionary that is set up is both ways; music from math and math from music. This power point presentation will contain both audio and visual elements to illustrate some of the thoughts mentioned above.

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Student Homotopy Theory
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3096 East Hall
Reebhu Bhattacharyya (University of Michigan)
Species and Operads

Operads provide a powerful tool to talk about the more familiar notion of various kinds of algebras (associative, commutative, Lie etc.), intuitively one can think of operads as parametrizing operations. We will talk about a combinatorial approach to operads via the notion of species due to André Joyal. If time permits, we will describe how to relate species to more familiar objects, namely power series. This will be an expository talk and there will be no prerequisites except a basic knowledge of category theory.

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Grad Recruitment: Faculty Talk

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Combinatorics
Friday, March 13, 2020, 3:00pm-4:00pm
4096 East Hall
Chris Fraser (University of Minnesota)
Cyclic symmetry loci in Grassmannians

The Grassmannian $\text{Gr}(k,n)$ admits an action by a finite cyclic group of order $n$ via the cyclic shift automorphism. The combinatorial structures underlying both total nonnegativity and clusters for $\text{Gr}(k,n)$ are cyclically equivariant, which is one explanation for the particular elegance of these structures in the case of $\text{Gr}(k,n)$. We will explore the $L$-shift locus in $\text{Gr}(k,n)$, i.e. the subvariety of points fixed by the $L$th power of the cyclic shift. Steven Karp recently showed that the 1-shift locus consists of finitely many points. On the other hand the $n$-shift locus is $\text{Gr}(k,n)$ itself. Our theorems interpolate between these extremes: we provide a simple geometric description of the $L$-shift locus for any $L$, describe its total nonnegativity locus as a stratified space, and propose an atlas of generalized cluster charts (à la Chekhov-Shapiro) whose clusters are total positivity tests.

Student Commutative Algebra
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Bhargav Bhatt (UM)
Grad Recruitment: Faculty Talk
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Applied Interdisciplinary Mathematics (AIM)
Friday, March 13, 2020, 3:00pm-4:00am
1084 East Hall

Lyudmyla Barannyk (University of Idaho, visiting University of Michigan)
Modeling of the solid-liquid phase change in materials with internal heat generation

We study a simple model for the evolution of the solid-liquid interface during melting and solidification (Stefan problem) of a material with constant internal heat generation and prescribed heat flux at the boundary in the cylindrical geometry. The problem is motivated by the need to control the behavior of nuclear fuel rods in a potential meltdown scenario. The equations are solved by splitting them into transient and steady-state components and then using separation of variables. This results in an ordinary differential equation for the interface that involves infinite series. The initial value problem is solved numerically, and solutions are compared to the previously published quasi-static solutions. We show that when the internal heat generation and boundary heat flux are close in value, the motion of the phase change front takes longer to reach steady-state than when the values are farther apart. As the difference between the internal heat generation and boundary heat flux increases, the transient solutions become more dominant and the phase change front does not reach steady-state before the outer boundary or centerline is reached. Hence the difference between the internal heat generation and boundary heat flux can be used to control the motion and speed of the solid-liquid interface. Limitations of the present model and possible future extensions will be discussed.

This is joint work with Sidney Williams (Georgia Tech), Irene Ogidan (University of Idaho), John Crepeau (University of Idaho), and Alexey Sakhnov (Kutateladze Institute of Thermophysics, Novosibirsk, Russia).

Special Events
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Common Room East Hall

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Tea time with 2020 Recruits **** (Note the different time!)

Tea time and AIM Meet & Greet

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4096 East Hall
Mircea Mustata (UM)
Introduction to o-minimal geometry

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