## Weekly Seminar & Events Bulletin
December 8th, 2019 - December 14th, 2019

### Monday, December 09, 2019

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>12:00pm-12:50pm</td>
<td>Mathematical Biology -- Idse Heemskerk (UM Department of Cell and Developmental Biology)</td>
<td>335 West Hall</td>
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<td>Morphogen dynamics control patterning in a stem cell model of the human embryo</td>
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<td>Student Dynamics -- (No meeting) ()</td>
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<td>RTG Seminar on Number Theory -- Yuan Liu (University of Michigan)</td>
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<td>Integrable Systems and Random Matrix Theory -- Jiaoyang Huang (Institute for Advanced Study)</td>
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<td>Student Algebraic Geometry -- Andy Jiang (UM) The Cotangent Complex -- B745 East Hall</td>
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<td>Complex Analysis, Dynamics and Geometry -- Mike Zieve (U(M)) Rational functions with a common</td>
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<td>Student AIM Seminar -- Leighton Wilson (University of Michigan) A (Very) Abbreviated History of</td>
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<td>Supercomputing</td>
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<td>Colloquium Series -- Shuichiro Takeda (University of Missouri) Theta correspondence and its applications -- 1360 East Hall</td>
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<td>Algebraic Geometry -- Yusuke Nakamura (University of Tokyo) Rational point problem on singular Fano varieties -- 4096 East Hall</td>
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<td>Arithmetic Geometry Learning -- Andrew Snowden (UM) Globalization, II -- 4096 East Hall</td>
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Abstracts for the week of December 8th, 2019 - December 14th, 2019
Mathematical Biology
Monday, December 09, 2019, 12:00pm-12:50pm
335 West Hall
Idse Heemskerk (UM Department of Cell and Developmental Biology)
Morphogen dynamics control patterning in a stem cell model of the human embryo

During embryonic development, diffusible signaling molecules called morphogens are thought to determine cell fates in a concentration-dependent manner, and protocols for directed stem cell differentiation are based on this picture. However, in the mammalian embryo, morphogen concentrations change rapidly compared to the time for making cell fate decisions. It is unknown how changing ligand levels are interpreted, and whether the precise timecourse of ligand exposure plays a role in cell fate decisions. In this talk I will discuss our work to address this question using human embryonic stem cells (hESCs), focusing on the dynamics of two morphogens that are crucial for vertebrate gastrulation: Nodal and BMP4. We showed that the response of hESCs to BMP4 signaling is indeed determined by the ligand concentration, but that unexpectedly, the expression of many mesodermal targets of Nodal depends on the rate of concentration increase. In addition, we showed that a stem cell model for the human embryo generates a wave of Nodal signaling with cells experiencing rapidly increasing Nodal specifically in the region of mesendoderm differentiation. The BMP4 and Nodal pathways share the signal transducer Smad4. Using live imaging of hESCs with GFP integrated at the endogenous SMAD4 locus combined with Fluorescence Recovery After Photobleaching (FRAP), we demonstrated that response to rate of Activin change is due to adaptive signaling, which relies on sequestration of SMAD4. We also demonstrated that pulsatile stimulation with Activin induces repeated strong signaling and enhances mesoderm differentiation. Our results break with the paradigm of concentration-dependent differentiation and demonstrate an important role for morphogen dynamics in the cell fate decisions associated with mammalian gastrulation. They suggest a highly dynamic picture of embryonic patterning where some cell fates depend on rapid concentration increase rather than on absolute levels, and point to ligand dynamics as a new dimension to optimize protocols for directed stem cell differentiation.

Student Dynamics
Monday, December 09, 2019, 3:00pm-4:00pm
3866 East Hall
(No meeting) ()
RTG Seminar on Number Theory  
Monday, December 09, 2019, 3:00pm-4:00pm  
4088 East Hall  
Yuan Liu (University of Michigan)  
*Counting rational points on Hurwitz schemes*

I will talk about the work of Ellenberg, Venkatesh and Westerland, which establishes a homological stability result for certain Hurwitz schemes and applies this result to prove the moment version of the Cohen-Lenstra heuristics over function fields. If time permits, I will also discuss the recent developments of their method.

Integrable Systems and Random Matrix Theory  
Monday, December 09, 2019, 4:00pm-5:00pm  
1866 East Hall  
Jiaoyang Huang (Institute for Advanced Study)  
*Large Deviation Principles via Spherical Integrals*

In this talk, I'll explain a framework to study the large deviation principle for matrix models and their quantized versions, by tilting the measures using the asymptotics of spherical integrals obtained by Guionnet and Zeitouni. As examples, we obtain

1) the large deviation principle for the empirical distribution of the diagonal entries of $UB_NU^*$, for a sequence of $N\times N$ diagonal matrices $B_N$ and unitary/orthogonal Haar distributed matrices $U$;

2) the large deviation upper bound for the empirical eigenvalue distribution of $A_N+UB_NU^*$, for two sequences of $N\times N$ diagonal matrices $A_N, B_N$, and their complementary lower bounds at “good” probability distributions;

3) the large deviation principle for the Kostka number $K_{\lambda_N \\mu_N}$, for two sequences of partitions $\lambda_N, \mu_N$ with at most $N$ rows;

4) the large deviation upper bound for the Littlewood-Richardson coefficients $c_{\lambda_N \\mu_N \\nu_N}$, for three sequences of partitions $\lambda_N, \mu_N, \nu_N$ with at most $N$ rows, and their complementary lower bounds at “good” probability distributions.

This is a joint work with Belinschi and Guionnet.

Student Algebraic Geometry  
Monday, December 09, 2019, 4:00pm-5:00pm  
B745 East Hall  
Andy Jiang (UM)  
*The Cotangent Complex*

We'll discuss the cotangent complex, its definition, and some basic properties, and, if time allows, some basic examples of computations.
I will describe all pairs of prime-degree complex rational functions $f(x)$ and $g(x)$ for which some iterate of $f(x)$ equals some iterate of $g(x)$. This partially answers a question of Eremenko, and yields new examples. This is joint work with Zachary Luallen.

Student AIM Seminar

Monday, December 09, 2019, 4:00pm-5:00pm

B737 East Hall

Leighton Wilson (University of Michigan)

A (Very) Abbreviated History of Supercomputing

A significant amount of the mathematics that occurs in East Hall finds its most important applications in scientific high-performance computing. In this talk, I plan to give an overview of the history of scientific supercomputing, from the early days of Cray to the modern day exascale machines on the horizon. I'll also touch on the deep relationship between supercomputing and mathematics, as well as some of the details of what it takes to program a supercomputer. Finally, I'll discuss some trends shaping the future of supercomputing, from neuromorphic computing to quantum computing.
Operators in Complex Analysis  
Monday, December 09, 2019, 5:00pm-6:00pm  
3096 East Hall  
Yonatan Shelah (University of Michigan)  
*Exploring the Leray spectrum of convex Reinhardt domains.*

Convex Reinhardt domains lend themselves naturally to spectral analysis of the Leray transform due to their rotational symmetries. In two dimensions and under some hypotheses, D. Barrett and L. Lanzani calculated the SVD spectrum (including the essential part) in terms of integrals involving a useful parametrization, giving conditions for the operator to be bounded. I will discuss the following applications:

1. Calculating the norms for $\ell_p$ balls, the natural objects of the theory, by finding the maximum of each spectrum.
2. Tackling the inverse problem: Can you “hear” the shape of a bounded, sufficiently smooth, convex Reinhardt domain in $\mathbb{C}^2$? If possible, this can only be done up to the natural symmetries: scaling, variable swap and taking the polar/dual domain. I will describe two approaches to the problem which show that the question has a positive answer at least in some natural cases, assuming that our “hearing” is sensitive enough to recognize the Fourier labeling of the point spectrum (a sequence rather than a set).
3. Calculating a family of measures supported on the essential spectrum, which are defined via limits. These play a key role in the aforementioned problem (specifically the second approach), and may be of separate interest.

Despite the underlying topic, all of the tools used are from real analysis. Very little background is assumed.

Chromatic Homotopy Theory  
Monday, December 09, 2019, 5:30pm-6:30pm  
3088 East Hall  
Emanuel Reinecke (UM)  
*Lubin Tate theory.*

Following lectures 21 and 22 from http://www.math.harvard.edu/~lurie/252x.html.

IBL Workshops/Lectures  
Tuesday, December 10, 2019, 11:30am-1:00pm  
4866 East Hall  
()  
*IBL Lunch*

There will be an IBL Lunch in the faculty lounge (4866 EH) from 11:30-1pm. You should feel free to come for any length of time. Lunch will be provided.
Student Commutative Algebra  
Tuesday, December 10, 2019, 3:00pm-3:50pm  
4088 East Hall  
Andrés Servellón (University of Michigan Ann Arbor)  
An introduction to local cohomology

Local cohomology was introduced by Grothendieck in 1961. Since its introduction, the theory has been developed in a number of different directions and draws connections with topology, geometry, and combinatorics. Algebraically, local cohomology modules can be used to measure the dimension and depth of a module over an ideal. As a consequence, local cohomology can be used to test if a ring is Cohen-Macaulay or Gorenstein. Additionally, local cohomology can be used to partially answer the question of how many generators an ideal has up to radical.

This talk will be a brief introduction to local cohomology. As an application, we will discuss a proof of the prime characteristic case, without using Tight Closure Theory, of Hochster and Roberts Theorem on the Cohen-Macaulayness of direct summands of regular rings.

Student Geometry/Topology  
Tuesday, December 10, 2019, 3:00pm-4:00pm  
3866 East Hall  
Yuping Ruan (UM)  
Anosov diffeomorphisms on Tori

In this talk, we will prove the classification theorem for Anosov diffeomorphisms on Tori: Every Anosov diffeomorphism of the n-torus is topologically conjugate to a linear hyperbolic automorphism.

Colloquium Series  
Tuesday, December 10, 2019, 4:00pm-5:00pm  
1360 East Hall  
Shuichiro Takeda (University of Missouri)  
Theta correspondence and its applications

The theory of theta correspondences, which was originated from the work of Roger Howe, has been proven to be extremely successful in the Langlands program. In particular, it allows one to construct (often quite explicitly) representations of one group out of representations of another. In this talk, I will explain the basic mechanism of how this theory works along with some recent developments and discuss some of its applications.
Financial/Actuarial Mathematics  
Wednesday, December 11, 2019, 3:00pm-4:00pm  
1360 East Hall  
Bahman Angoshtari (University of Washington)  
Optimal Consumption under Habit Formation Constraints

I will present two models of optimal consumption under a constraint that prevents the agent's consumption to fall below a certain proportion of her current "consumption habit." In the first model, consumption habit is the running maximum of past consumption, while the second model assumes that habit is the exponentially weighted moving average of past consumption. For each case, a stochastic control problem is formulated with the objective of maximizing the expected discounted utility of consumption stream while investing in a Black-Scholes financial market. The resulting Hamilton-Jacobi-Bellman equations are reduced to non-linear free-boundary problems that are subsequently solved semi-explicitly. The optimal consumption policy in the two models share common features in that they are mainly driven by the wealth-to-habit ratio. Furthermore, there are critical values of the wealth-to-habit ratio that determines when it is optimal to consume at the minimum acceptable rate, when should the consumption rate be above the minimum, and when is it optimal to raise the consumption habit above its current value.

The talk is based on joint work with Erhan Bayraktar and Virginia Young.

Student Homotopy Theory  
Wednesday, December 11, 2019, 3:00pm-4:00pm  
1372 East Hall  
Jia Zhi (Andy) Jiang (University of Michigan)  
Stable infinity categories

I will give an introduction to what a stable infinity category is and construct some examples of stable infinity categories. I will also explain how it relates to the classical construction of derived functors over abelian categories.

Algebraic Geometry  
Wednesday, December 11, 2019, 4:00pm-5:20pm  
4096 East Hall  
Yusuke Nakamura (University of Tokyo)  
Rational point problem on singular Fano varieties

Esnault proved that smooth Fano varieties defined over a finite field have a rational point. It is natural to ask whether one can generalize this result to singular Fano varieties. In joint work with Y. Gongyo and H. Tanaka, we proved that the same statement holds for klt Fano three-folds (p > 5). In this talk, I will also discuss the case when the Fano variety has non-klt singularities.
Arithmetic Geometry Learning
Thursday, December 12, 2019, 4:00pm-5:30pm
4096 East Hall
Andrew Snowden (UM)
Globalization, II

Arithmetic Geometry Learning
Thursday, December 12, 2019, 4:00pm-5:30pm
4096 East Hall
Attilio Castano (UM)
Coherent duality