# Weekly Seminar & Events Bulletin

**December 4th, 2022 - December 10th, 2022**

## Monday, December 05, 2022

<table>
<thead>
<tr>
<th>Time</th>
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<th>Speaker/Details</th>
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<tbody>
<tr>
<td>3:00pm-4:15pm</td>
<td><strong>RTG Seminar on Number Theory</strong> -- Elad Zelingher (UM) <em>Introduction to the relative trace formula</em> -- 4088 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Integrable Systems and Random Matrix Theory</strong> -- Maria Ntekoume (Rice University) <em>Critical well-posedness for the derivative nonlinear Schrödinger equation on the line</em> -- ZOOM ID: 926 6491 9790 Virtual</td>
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<td><strong>Student Combinatorics</strong> -- João Pedro Carvalho (University of Michigan) <em>The Littelmann Path Model</em> -- 3866 East Hall</td>
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## Tuesday, December 06, 2022

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<td><strong>Student Commutative Algebra</strong> -- Calvin Yost-Wolff (UM) <em>Big Cohen-Macaulay modules in mixed characteristic via perfectoid algebras</em> -- 3866 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Colloquium Series</strong> -- Zhang Xin (University of Vienna) <em>Wasserstein space of continuous time filtered processes.</em> -- 1360 East Hall</td>
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<td>5:00pm-6:00pm</td>
<td><strong>Student Analysis</strong> -- Zakaria Zerrouki (University of Michigan) <em>C</em>-algebras - An Elementary Introduction* -- 3096 East Hall</td>
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<td><strong>Learning Seminar in Algebraic Combinatorics</strong> -- Yucong Lei (University of Michigan) <em>Construction for Ergodic Gibbs measure and Classification of Phases</em> -- 4088 East Hall</td>
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<td><strong>Algebraic Geometry</strong> -- Lisa Marquand (Stony Brook University) <em>Symplectic Birational Involutions of manifolds of OG10 type</em> -- 4096 East Hall</td>
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<td><strong>Financial/Actuarial Mathematics</strong> -- Lane Yeung (Columbia University) <em>Mean field approximations via log-concavity, and a non-asymptotic perspective on mean field control</em> -- 1324 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Laurel Ohm (Princeton University) <em>A PDE perspective on the hydrodynamics of flexible filaments</em> -- 3866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Commutative Algebra</strong> -- Seungsu Lee (University of Utah) <em>Perfectoid signature and an application to @tale fundamental groups.</em> -- <a href="https://umich.zoom.us/j/96274532499">https://umich.zoom.us/j/96274532499</a> (password: algebra)</td>
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<td><strong>Differential Equations</strong> -- Riccardo Montalto (University of Milan) <em>Quasi-periodic solutions and inviscid limit for Euler and Navier Stokes equations via KAM methods</em> -- 4088 East Hall</td>
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<td>9:00am-10:00am</td>
<td><strong>Variational Analysis and Optimization</strong> -- Ebrahim Sarabi (Miami University) <em>Role of Subgradients in Variational Analysis of Composite Functions</em> -- Virtual</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Student AIM Seminar</strong> -- Nikolaos Evangelou (Johns Hopkins University) <em>TBA</em> -- 2866 East Hall</td>
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<td><strong>Geometry</strong> -- Steven Kerckhoff (Stanford) <em>Hyperbolic cone-manifolds: degenerating towards flexibility</em> -- 3866 East Hall</td>
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Abstracts for the week of December 4th, 2022 - December 10th, 2022

RTG Seminar on Number Theory
Monday, December 05, 2022, 3:00pm-4:15pm
4088 East Hall
Elad Zelingher (UM)

*Introduction to the relative trace formula*

I will discuss the motivation for the relative trace formula and explain the ideas of using it in the proof of Ichino--Ikeda conjecture for unitary groups.

Integrable Systems and Random Matrix Theory
Monday, December 05, 2022, 4:00pm-5:00pm
ZOOM ID: 926 6491 9790 Virtual
Maria Ntekoume (Rice University)

*Critical well-posedness for the derivative nonlinear Schrödinger equation on the line*

This talk focuses on the well-posedness of the derivative nonlinear Schrödinger equation on the line. This model is known to be completely integrable and $L^2$-critical with respect to scaling. However, until recently not much was known regarding the well-posedness of the equation below $H^{\frac 1 2}$. In this talk we prove that the problem is well-posed in the critical space $L^2$ on the line, highlighting several recent results that led to this resolution. This is joint work with Benjamin Harrop-Griffiths, Rowan Killip, and Monica Visan.

A recording of the talk can be found [here](https://youtu.be/uoeD9kF9Ss8).

Student Combinatorics
Monday, December 05, 2022, 4:00pm-5:00pm
3866 East Hall
João Pedro Carvalho (University of Michigan)

*The Littelmann Path Model*

Combinatorial models have proved themselves very useful in the study of the representation theory of Lie groups and algebras. Most famously, semi-standard Young tableaux model the algebraic representations of $sl_n$, and they also provide nice ways of counting multiplicities in tensor of representations (the Littlewood-Richardson rule). In this talk we explore the Littelmann path model, a combinatorial device that works for all semi-simple Lie algebras, generalizing results from $sl_n$ to other types of algebras.
Student Commutative Algebra
Tuesday, December 06, 2022, 3:00pm-4:00pm
3866 East Hall
Calvin Yost-Wolff (UM)
Big Cohen-Macaulay modules in mixed characteristic via perfectoid algebras

I will give an introduction to perfectoid algebras. Then I will show how to construct big Cohen-Macaulay modules in mixed characteristic following a note by Linquan Ma.

Colloquium Series
Tuesday, December 06, 2022, 4:00pm-5:00pm
1360 East Hall
Zhang Xin (University of Vienna)
Wasserstein space of continuous time filtered processes.

Researchers from different areas have independently defined extensions of the usual weak topology between laws of stochastic processes. This includes Aldous’ extended weak convergence, Hellwig’s information topology and convergence in adapted distribution in the sense of Hoover-Keisler. In this talk, we show that on the set of continuous processes with canonical filtration these topologies coincide and are metrized by a suitable adapted Wasserstein distance. Moreover we show that the resulting topology is the weakest topology that guarantees continuity of optimal stopping.

While the set of canonical processes is not complete, we establish that its completion is the space of filtered processes. We also observe that this complete space is Polish, Martingales form a closed subset and approximation results like Donsker’s theorem extend to the adapted Wasserstein distance. This talk is based on the joint work with Daniel Bartl, Mathias Beiglböck, Gudmund Pammer and Stefan Schrott.

Student Analysis
Tuesday, December 06, 2022, 5:00pm-6:00pm
3096 East Hall
Zakaria Zerrouki (University of Michigan)
C*-algebras - An Elementary Introduction

This presentation is intended to serve as a brief and elementary introduction to the theory of C*-algebras. In particular, the emphasis of the presentation will be on the basic definitions and immediate results surrounding the following concepts:

- Algebras
- The Spectrum and the Exponential
- Characters
- Fundamental Representation Theorems
Learning Seminar in Algebraic Combinatorics  
**Wednesday, December 07, 2022, 2:30pm-4:00pm**  
4088 East Hall  
Yucong Lei (University of Michigan)  
*Construction for Ergodic Gibbs measure and Classification of Phases*

In this talk, I will introduce Ergodic Gibbs Measures (EGM) for infinite periodic bipartite graphs and the definition of phases based on height fluctuations wrt this measure. I will present a sketch of how to construct EGMs with fixed slopes as well as how phase classifications can be done using information about the amoeba of characteristic functions of the graph. I will illustrate the theory using honeycomb dimers.

RTG Seminar on Geometry, Dynamics and Topology  
**Wednesday, December 07, 2022, 4:00pm-5:30pm**  
3866 East Hall  
Davi Obata (U Chicago)  
*Generic properties of the strong unstable foliation for certain hyperbolic skew products.*

The understanding of invariant foliations is very important in the theory of uniformly and partially hyperbolic dynamics. The main theme of this talk is to study transitive Anosov (or uniformly hyperbolic) systems having a decomposition of the form $E^s + E^c + E^u$, where $E^c$ expands uniformly. There are two foliations that we will consider, the (center)unstable foliation $W^{cs}$ and the strong unstable foliation $W^u$, tangent to $E^c + E^u$ and $E^u$, respectively.

The foliation $W^{cu}$ is very well understood. It is known that the foliation is minimal, i.e. every leaf is dense, and that there is only one ergodic invariant measure "compatible" with that foliation, the so-called SRB measure. However, the strong unstable foliation is not well understood. In this talk, I will survey some recent progress in the direction of understanding topological and ergodic properties of the strong unstable foliation. Then, I will talk about a recent result with Sylvain Crovisier and Mauricio Poletti, where we show that in a certain class of Anosov systems, generically there is only one ergodic measure "compatible" with the strong unstable foliation (the so-called u-Gibbs measures) and that the strong unstable foliation is minimal.
Algebraic Geometry  
Wednesday, December 07, 2022, 4:00pm-5:30pm  
4096 East Hall  
Lisa Marquand (Stony Brook University)  
*Symplectic Birational Involutions of manifolds of OG10 type*

Compact Hyperkähler manifolds are one of the building blocks of Kähler manifolds with trivial first Chern class, but very few examples are known. One strategy for potentially finding new examples is to look at finite groups of symplectic automorphisms of the known examples, and study the fixed loci or quotient. In this talk, we will obtain a classification of birational symplectic involutions of manifolds of OG10 type. We do this from two vantage points: firstly following classical techniques relating birational transformations to automorphisms of the Leech lattice. Secondly, we look at involutions that are obtained from cubic fourfolds via the compactified intermediate Jacobian construction. In this way, we obtain new involutions that could potentially give rise to new holomorphic symplectic varieties. If time permits, we will mention ongoing work to identify the fixed loci in one of these examples.

Financial/Actuarial Mathematics  
Wednesday, December 07, 2022, 4:00pm-5:00pm  
1324 East Hall  
Lane Yeung (Columbia University)  
*Mean field approximations via log-concavity, and a non-asymptotic perspective on mean field control*

We propose a new approach to deriving quantitative mean field approximations for any strongly log-concave probability measure. The main application discussed in this talk is to a class of stochastic control problems in which a large number of players cooperatively choose their drifts to maximize an expected reward minus a quadratic running cost. For a broad class of potentially asymmetric rewards, we show that there exist approximately optimal controls which are decentralized, in the sense that each player's control depends only on its own state and not the states of the other players. Moreover, the optimal decentralized controls can be constructed non-asymptotically, without reference to any mean field limit. Our framework is inspired by the recent theory of nonlinear large deviations of Chatterjee-Dembo, for which we offer an efficient non-asymptotic perspective in log-concave settings based on functional inequalities. If time allows, we discuss additional implications for continuous Gibbs measures on large graphs. Joint work with Daniel Lacker and Sumit Mukherjee.
Many fundamental biophysical processes, from cell division to cellular motility, involve dynamics of thin structures immersed in a very viscous fluid. Various popular models have been developed to describe this interaction mathematically, but much of our understanding of these models is only at the level of numerics and formal asymptotics. Here we seek to develop the PDE theory of filament hydrodynamics.

First, we propose a PDE framework for analyzing the error introduced by slender body theory (SBT), a common approximation used to facilitate computational simulations of immersed filaments in 3D. Given data prescribed only along a 1D curve, we develop a novel type of boundary value problem and obtain an error estimate for SBT in terms of the fiber radius. This places slender body theory on firm theoretical footing.

Second, we consider a classical elastohydrodynamic model for the motion of an immersed inextensible filament. We highlight how the analysis can help to better understand undulatory swimming at low Reynolds number. This includes the development of a novel numerical method to simulate inextensible swimmers.

F-signature plays a crucial role when measuring singularities of varieties in positive characteristics. For example, if $R$ is a local ring, $s(R) = 1$ implies $R$ is regular, and $0 < s(R) < 1$ implies $R$ is strongly F-regular, which is a char $p$ analog of klt singularities. In this talk, we will introduce a mixed characteristic analog of the F-signature using Falting's normalized length. As an application, we will show the finiteness of \text{\acute{a}tale} fundamental group of the regular locus of BCM-regular rings, which is analogous to the result of Carvajal-Rojas, Schwede, Tucker in positive characteristic for strongly F-regular rings. This is joint work with Hanlin Cai, Linquan Ma, Karl Schwede, and Kevin Tucker.
Differential Equations  
Thursday, December 08, 2022, 4:00pm-5:00pm  
4088 East Hall  
Riccardo Montalto (University of Milan)  
*Quasi-periodic solutions and inviscid limit for Euler and Navier Stokes equations via KAM methods*

In this talk I will discuss some recent results on Euler and Navier Stokes equations concerning the construction of quasi-periodic solutions and the problem of the inviscid limit for the Navier Stokes equation. I will discuss the following two results:

1) Construction of quasi-periodic solutions for the Euler equation with a time quasi-periodic external force, bifurcating from a constant, diophantine velocity field

2) I shall discuss the inviscid limit problem from the perspective of KAM theory, namely I shall prove the existence of quasi-periodic solutions of the Navier Stokes equation converging to the one of the Euler equation constructed in 1).

The main difficulty is that this is a singular limit problem. We overcome this difficulty by implementing a normal form methods which allow to prove sharp estimates (global in time) with respect to the viscosity parameter.

Student AIM Seminar  
Friday, December 09, 2022, 4:00pm-5:00pm  
2866 East Hall  
Nikolaos Evangelou (Johns Hopkins University)  
*TBA*

Geometry  
Friday, December 09, 2022, 4:00pm-5:00pm  
3866 East Hall  
Steven Kerckhoff (Stanford)  
*Hyperbolic cone-manifolds: degenerating towards flexibility*

Hyperbolic structures on 3-manifolds tend to be rigid, relative to certain boundary data. Families of such structures, with varying boundary data, can degenerate to other types of geometric structures that are much more flexible. The particular limit structures typically are solutions to extremal problems. This lecture will discuss several examples of this phenomenon.
Variational Analysis and Optimization  
Friday, December 09, 2022, 9:00am-10:00am  
Virtual  
Ebrahim Sarabi (Miami University)  
*Role of Subgradients in Variational Analysis of Composite Functions*

In this talk, we discuss the role that subgradients play in various second-order variational analysis constructions and its consequences. Focusing mainly on the behavior of the second subderivative and subgradient proto-derivative of certain composite functions, we demonstrate that choosing the underlying subgradient, utilized in the definitions of these concepts, from the relative interior of the subdifferential mapping ensures stronger second-order variational properties such as strict twice epi-differentiability and strict subgradient proto-differentiability. Using this observation, we provide a simple characterization of continuous differentiability of the proximal mapping of our composite functions. As another application, we discuss the equivalence of metric regularity and strong metric regularity of a class of generalized equations at their nondegenerate solutions. This talk is based on joint works with Nguyen T. V. Hang.