**Weekly Seminar & Events Bulletin**  
*April 10th, 2022 - April 16th, 2022*

**Monday, April 11, 2022**

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>RTG Seminar on Number Theory</strong> -- Kartik Prasanna (University of Michigan) <em>Modular forms of weight one and the Jacquet-Langlands correspondence</em> -- 4088 East Hall</td>
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<td><strong>Integrable Systems and Random Matrix Theory</strong> -- Jonathan Husson (University of Michigan) <em>Asymptotics of spherical integrals and large deviations of the largest eigenvalues for random matrices.</em> -- ZOOM ID: 926 6491 9790 Virtual</td>
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<td>5:00pm-6:00pm</td>
<td><strong>Student Dynamics/Geometry Topology</strong> -- Ekaterina Shchetka (University of Michigan) <em>Semi-classical approach in dynamics and spectral theory</em> -- 3866 East Hall</td>
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<td><strong>Special Events</strong> -- Karol Koziol &amp; Guiseppe Martone (UM) <em>Jobs in Academia for Mathematicians Workshop - Research statements</em> -- 1866 East Hall</td>
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**Tuesday, April 12, 2022**

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<td><strong>MC AIM Colloquium</strong> -- Abhay Ashtekar (The Pennsylvania State University) <em>Emergence of General Relativity from a (Diffeomorphism Invariant) Gauge Theory</em> -- 4448 East Hall</td>
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<td>4:00pm-12:00am</td>
<td><strong>RTG Seminar on Geometry, Dynamics and Topology</strong> -- Giuseppe Martone (U Michigan) <em>Pleated surfaces in PSL(d,C) and their coordinates</em> -- 3866 East Hall</td>
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Thursday, April 14, 2022

9:00am-10:00am  **Variational Analysis and Optimization** -- Emilio Vilches (O'Higgins University, Chile) *Moreau envelope of supremum functions* -- Virtual

4:00pm-5:30pm  **Arithmetic Geometry Learning** -- Mirko Mauri () *Relation to the integral Hodge conjecture* -- 4096 East Hall

4:00pm-5:00pm  **Commutative Algebra** -- Peter MacDonald (University of Utah) *TBA* -- https://umich.zoom.us/j/96274532499 (password: algebra) Virtual East Hall

5:30pm-6:30pm  **Financial/Actuarial Mathematics** -- Huyen Pham (University of Paris- Diderot) *Third Van Eenam Lecture: Optimal Bidding Strategies for Digital Advertising With Social Interactions* -- 1360 East Hall

5:30pm-6:30pm  **Special Events** -- Huyên Pham (Université de Paris) *Van Eenam Lecture Series: Optimal Bidding Strategies for Digital Advertising With Social Interactions* -- 1360 East Hall

Friday, April 15, 2022

3:00pm-4:00pm  **Student Algebraic Geometry** -- Lena Ji (UM) *Foliations on Algebraic Varieties* -- 2866 East Hall

3:00pm-4:00pm  **Applied Interdisciplinary Mathematics (AIM)** -- Stéphanie Chaillat (ENSTA-Paris) *TBA* -- Virtual

4:00pm-5:00pm  **Preprint Algebraic Geometry** -- Alex Perry (UM) *The "K-equivalence implies D-equivalence" conjecture, part I* -- 4096 East Hall

4:00pm-4:50pm  **Learning Seminar in Representation Stability** -- () *OTTERS Social* -- 1866 East Hall

4:00pm-5:00pm  **MCAIM Graduate Seminar** -- Neophytos Charalambides (University of Michigan) *Approximate Matrix Multiplication and Laplacian Sparsifiers* -- 3866 East Hall

4:00pm-5:00pm  **Geometry** -- Carsten Peterson (U Michigan) *On quantum ergodicity on Bruhat-Tits buildings* -- 3866 East Hall
Abstracts for the week of April 10th, 2022 - April 16th, 2022

**RTG Seminar on Number Theory**  
**Monday, April 11, 2022, 3:00pm-4:00pm**  
4088 East Hall  
Kartik Prasanna (University of Michigan)  
*Modular forms of weight one and the Jacquet-Langlands correspondence*

The subject of the talk is the relation between Langlands functoriality and the theory of algebraic cycles - for example, it is of interest to know whether functoriality preserves various geometric structures. In previous work, we showed that the Jacquet-Langlands correspondence for cohomological modular forms preserves rational Hodge structures. In this talk, I will discuss an analogous result in the case of weight one forms. Since weight one forms are not cohomological, it is not even clear in the first place how to formulate such a result. (Joint work in progress with Atsushi Ichino.)

**Colloquium Series**  
**Monday, April 11, 2022, 4:00pm-5:00pm**  
1360 East Hall  
Huyen Pham (Paris 7)  
*Deep Learning Methods for Stochastic Control And Partial Differential Equations*

The numerical resolution of high-dimensional partial differential equations (PDEs) and stochastic control is a challenging problem in applied mathematics. Over the last five years, several deep neural networks-based algorithms have been proposed and have show their great efficiency for tackling these issues. In this talk, we give an introduction to this field of research, review the main results in this literature, and present some new developments, notably regarding mean-field control problems and Master equation in Wasserstein space.

**RTG Representation Theory**  
**Monday, April 11, 2022, 4:00pm-5:15pm**  
4088 East Hall  
Calvin Yost-Wolff (UM)  
*Character sheaves for SL2*
Integrable Systems and Random Matrix Theory
Monday, April 11, 2022, 4:00pm-5:00pm
ZOOM ID: 926 6491 9790 Virtual
Jonathan Husson (University of Michigan)

Asymptotics of spherical integrals and large deviations of the largest eigenvalues for random matrices.

The Harish-Chandra-Itzykson-Zuber integral, also called spherical integral is defined as the expectation of exp(Tr(AUBU*)) for A and B two self adjoint matrices and U Haar-distributed on the unitary/orthogonal/symplectic group. It was initially introduced by Harish-Chandra to study Lie groups. Since then, it has known many kinds of applications, from physics to statistical learning. In this talk we will study the asymptotics of these integrals when one of the matrices remains of finite rank. We will also see how to derive from these asymptotics large deviation principles for the largest eigenvalues for random matrix models that satisfy a sub-Gaussian bound.

Financial/Actuarial Mathematics
Monday, April 11, 2022, 4:00pm-5:00pm
1360 East Hall
Huyen Pham (Paris-Didetor)
First Van Eenam Lecture: Deep Learning Methods for Stochastic Control And Partial Differential Equations

The numerical resolution of high-dimensional partial differential equations (PDEs) and stochastic control is a challenging problem in applied mathematics. Over the last five years, several deep neural networks-based algorithms have been proposed and have show their great efficiency for tackling these issues. In this talk, we give an introduction to this field of research, review the main results in this literature, and present some new developments, notably regarding mean-field control problems and Master equation in Wasserstein space.

Donaldson-Thomas Theory
Monday, April 11, 2022, 4:00pm-5:30pm
4096 East Hall
Qiusheng Zhao
Localization of Virtual Classes
Special Events

Monday, April 11, 2022, 4:00pm-5:00pm
1360 East Hall

Huyên Pham (Université de Paris)


The numerical resolution of high-dimensional partial differential equations (PDEs) and stochastic control is a challenging problem in applied mathematics. Over the last five years, several deep neural networks-based algorithms have been proposed and have show their great efficiency for tackling these issues. In this talk, we give an introduction to this field of research, review the main results in this literature, and present some new developments, notably regarding mean-field control problems and Master equation in Wasserstein space.

Student Combinatorics

Monday, April 11, 2022, 4:00pm-5:00pm
3866 East Hall

Scott Neville (UM)

Colourful Convex Structure

Given any 7 points in the plane, can you colour them red, blue, and yellow so that there is a point in the convex hull of each colour? While many combinatorial geometry problems are extremely difficult, this one can be answered completely. We will introduce and prove Tverbergs theorem, including an algorithm to find such a colouring. Along the way, we will see both Cautheodory’s theorem (about how simplices cover convex hulls) and a colourful generalization.

Student Dynamics/Geometry Topology

Monday, April 11, 2022, 5:00pm-6:00pm
3866 East Hall

Ekaterina Shchetka (University of Michigan)

Semi-classical approach in dynamics and spectral theory

We will discuss how semi-classics (or microlocal analysis), dynamics, and spectral theory interact.

Special Events

Monday, April 11, 2022, 5:30pm-6:30pm
1866 East Hall

Karol Koziol & Giuseppe Martone (UM)

Jobs in Academia for Mathematicians Workshop - Research statements
Student Commutative Algebra
Tuesday, April 12, 2022, 3:00pm-4:00pm
3088 East Hall
Alapan Mukhopadhyay (University of Michigan, Ann Arbor)
Frobenius functor and finite projective dimension

Over a local complete intersection ring in positive characteristic, we shall see that the Frobenius functor, i.e. base change along the Frobenius map detects whether a module has finite projective dimension. This result of S.P. Dutta can be thought of as a partial converse to Peskine-Szpiro's celebrated result: the Frobenius functor applied to the resolution of a module of finite projective dimension produces another resolution.

This will be an online talk, with a watch party in EH3088. One can also join via this link: https://umich.zoom.us/j/92127851721?pwd=N2k4d0JTSWsyMzZDeIFlmZ0cXhlZz09

Colloquium Series
Tuesday, April 12, 2022, 4:00pm-5:00pm
1360 East Hall
Yuchen Liu (Northwestern University )
Moduli space of Fano varieties

Fano varieties are complex algebraic varieties admitting positive Ricci curvature metrics. They form one of the three fundamental building blocks of algebraic varieties, thus their classification problem is important. However, it is known that moduli spaces of all Fano varieties have pathological behaviors. In this talk, I will explain that if we impose K-stability on Fano varieties, an algebraic condition arising from the study of K"ahler-Einstein metrics, then we indeed get a compact moduli space. Based on joint works with H. Blum, D. Halpern-Leistner, C. Xu, and Z. Zhuang.

Special Events
Tuesday, April 12, 2022, 5:00pm-6:00pm
2866 East Hall
Michele Intermont & Gavin LaRose (Kalamazoo College & UM)
Jobs in Academia for Mathematicians Workshop - How to apply for a teaching-focused academic job: an overview
Learning Seminar in Algebraic Combinatorics
Wednesday, April 13, 2022, 2:30pm-4:00pm
4096 East Hall
Melissa Sherman-Bennett (University of Michigan)
Toric charts in braid varieties

I'll discuss some of the combinatorics of toric charts in braid varieties, namely algebraic weaves. Conjecturally, braid varieties are cluster varieties and weaves give rise to some seeds. Weaves also can be used to provide stratifications of braid varieties, which I may also discuss.

MCAIM Colloquium
Wednesday, April 13, 2022, 3:00pm-4:00pm
4448 East Hall
Abhay Ashtekar (The Pennsylvania State University)
Emergence of General Relativity from a (Diffeomorphism Invariant) Gauge Theory

Space-time metric and Einstein’s equations lie at the foundation of general relativity. Somewhat surprisingly, one can start with an SU(2)-gauge theory, write down the simplest equations one can, without making reference to any background field, and show that the Riemannian geometry and Einstein’s equations emerge by setting up an appropriate dictionary. Equations of the ‘fundamental’ gauge theory are simple low order polynomials. Complexity of Einstein's equations can be traced back to the fact that the explicit dictionary from the gauge theory to general relativity is rather intricate. The gauge theory framework provides new insights into general relativity, including an interesting interplay between the Lie algebra of volume-preserving diffeomorphisms and the ‘integrable’ sector of (anti-)self-dual solutions to Einstein's equations. It also leads to a new infinite dimensional Lie algebra that generalizes the Lie algebra of the diffeomorphism group, opening up directions for new mathematical work. I will make a special effort to make the summary of these structures and results accessible to mathematicians as well as physicists.

Event will take place in-person and online via Zoom:

Zoom Info:

Join Zoom Meeting
https://umich.zoom.us/j/91494048285

Meeting ID: 914 9404 8285
Passcode: 387662
Financial/Actuarial Mathematics  
Wednesday, April 13, 2022, 4:00pm-5:00pm  
1360 East Hall  
Huyen Pham (Paris 7)  
*Second Van Eenam Lecture: Mean-Field Markov Decision Processes With Common Noise And Open-Loop Controls*

We develop an exhaustive study of Markov decision process (MDP) under mean field interaction both on states and actions in the presence of common noise, and when optimization is performed over open-loop controls on infinite horizon. Such model, called CMKV-MDP for conditional McKean-Vlasov MDP, arises and is obtained here rigorously with a rate of convergence as the asymptotic problem of N-cooperative agents controlled by a social planner/influencer that observes the environment noises but not necessarily the individual states of the agents. We highlight the crucial role of relaxed controls and randomization hypothesis for this class of models with respect to classical MDP theory. We prove the correspondence between CMKV-MDP and a general lifted MDP on the space of probability measures, and establish the dynamic programming Bellman fixed point equation satisfied by the value function, as well as the existence of epsilon-optimal randomized feedback controls. The arguments of proof involve an original measurable optimal coupling for the Wasserstein distance. This provides a procedure for learning strategies in a large population of interacting collaborative agents.

Algebraic Geometry  
Wednesday, April 13, 2022, 4:00pm-5:30pm  
4096 East Hall  
Yuchen Liu (Northwestern University)  
*K-stability and moduli of quartic K3 surfaces*

We show that K-moduli spaces of $(\mathbb{P}^3, cS)$ where $S$ is a quartic surface interpolates between the GIT moduli space and the Baily-Borel compactification as $c$ varies in $(0,1)$. We completely describe the wall crossings of these K-moduli spaces. As a consequence, we verify Laza-O'Grady-Grady and prediction on the Hassett-Keel-Looijenga program for quartic K3 surfaces. This is based on joint work with K. Ascher and K. DeVleming.
Thurston introduced pleated surfaces as a powerful tool to study hyperbolic 3-manifolds. Passing to universal covers, a pleated surface is a map $f$ from the hyperbolic plane into hyperbolic 3-space which is a totally geodesic immersion on the complement of geodesic lamination and is equivariant with respect to a representation from the fundamental group of a hyperbolic surface into the Lie group $\text{PSL}(2,\mathbb{C})$ of orientation preserving isometries of hyperbolic 3-space.

For a fixed maximal geodesic lamination $L$, Bonahon described a holomorphic parametrization of the space of pleated surfaces with pleating locus $L$ which in turn provides a holomorphic parametrization of an open subset of the character variety of $\text{PSL}(2,\mathbb{C})$.

In this talk, we will discuss a generalization of this theory to surface group representations into $\text{PSL}(d,\mathbb{C})$. In particular, we introduce a notion of $d$-pleated surface which is motivated by the theory of Anosov representations, and we define shear-bend-eruption coordinates for these representations.

This talk is based on joint work with Sara Maloni, Filippo Mazzoli and Tengren Zhang.
Special Events
Wednesday, April 13, 2022, 4:00pm-5:00pm
1360 East Hall
Huyên Pham (Université de Paris)
Van Eenam Lecture Series: Mean-Field Markov Decision Processes With Common Noise And Open-Loop Controls

We develop an exhaustive study of Markov decision process (MDP) under mean field interaction both on states and actions in the presence of common noise, and when optimization is performed over open-loop controls on infinite horizon. Such model, called CMKV-MDP for conditional McKean-Vlasov MDP, arises and is obtained here rigorously with a rate of convergence as the asymptotic problem of N-cooperative agents controlled by a social planner/influencer that observes the environment noises but not necessarily the individual states of the agents. We highlight the crucial role of relaxed controls and randomization hypothesis for this class of models with respect to classical MDP theory. We prove the correspondence between CMKV-MDP and a general lifted MDP on the space of probability measures, and establish the dynamic programming Bellman fixed point equation satisfied by the value function, as well as the existence of epsilon-optimal randomized feedback controls. The arguments of proof involve an original measurable optimal coupling for the Wasserstein distance. This provides a procedure for learning strategies in a large population of interacting collaborative agents.

Arithmetic Geometry Learning
Thursday, April 14, 2022, 4:00pm-5:30pm
4096 East Hall
Mirko Mauri ()
Relation to the integral Hodge conjecture

Commutative Algebra
Thursday, April 14, 2022, 4:00pm-5:00pm
https://umich.zoom.us/j/96274532499 (password: algebra) Virtual East Hall
Peter MacDonald (University of Utah)
TBA
With the emergence of new online channels and information technology, digital advertising tends to substitute more and more to traditional advertising by offering the opportunity to companies to target the consumers/users that are potentially interested by their products or services. We introduce a continuous time model for the study of optimal bidding strategies associated to different types of advertising, namely, commercial advertising for triggering purchases or subscriptions, and social marketing for alerting population about unhealthy behaviours (anti-drug, vaccination, road-safety campaigns). Our framework encodes users online behaviours via their web-browsing at random times, social interactions in a large population of users, and the targeted advertising auction mechanism widely used on Internet. We address the attribution problem of how to efficiently diffuse advertising information by means of digital channels in order to generate conversion. Our main results are to provide semi-explicit formulas for the optimal value and bidding policy in various contexts of commercial advertising and social marketing. We show sensitivity properties of the solution with respect to model parameters, and analyse how the different sources of digital information accessible to users including the social interactions affect the optimal bid for advertising auctions. We also study how to efficiently combine targeted advertising and non-targeted advertising mechanisms. Finally, some classes of examples with fully explicit formulas are derived.
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In this talk, we show results concerning the Moreau envelope of the supremum of a family of convex, proper, and lower semicontinuous functions. Under mild assumptions, we prove that the Moreau envelope of a supremum is the supremum of Moreau envelopes, which allows us to approximate possibly nonsmooth supremum functions by smooth regularization, which is also the suprema of continuously differentiable mappings. Consequently, we approximated optimization problems from infinite and stochastic programming for which we obtain zero-duality gap results and optimality conditions without the verification of constraint qualification conditions.

Joint work with Pedro Pérez-Aros, Instituto de Ciencias de la Ingeniería, Universidad de O'Higgins, Rancagua, Chile.
Student Algebraic Geometry
Friday, April 15, 2022, 3:00pm-4:00pm
2866 East Hall
Lena Ji (UM)
Foliations on Algebraic Varieties

In this talk, we will introduce foliations on algebraic varieties. After discussing foliations in characteristic 0, we will also briefly describe the very different behavior that arises from foliations in positive characteristic.

Applied Interdisciplinary Mathematics (AIM)
Friday, April 15, 2022, 3:00pm-4:00pm
Virtual
Stéphanie Chaillat (ENSTA-Paris)
TBA

Preprint Algebraic Geometry
Friday, April 15, 2022, 4:00pm-5:30pm
4096 East Hall
Alex Perry (UM)
The "K-equivalence implies D-equivalence" conjecture, part I

Learning Seminar in Representation Stability
Friday, April 15, 2022, 4:00pm-4:50pm
1866 East Hall

OTTERS Social
MCAIM Graduate Seminar
Friday, April 15, 2022, 4:00pm-5:00pm

Neophytos Charalambides (University of Michigan)
Approximate Matrix Multiplication and Laplacian Sparsifiers

A ubiquitous operation in numerical analysis and scientific computing is matrix multiplication. However, it presents a major computational bottleneck when the matrix dimension is high, as can occur for large data size or feature dimension. A common approach in approximating the product, is to subsample row vectors from the two matrices, and sum the rank-1 outer products of the sampled pairs. We propose a sampling distribution based on the leverage scores of the two matrices. We give a characterization of our approximation in terms of the Euclidean norm, analogous to that of a L_2-subspace embedding. We then show connections between our algorithm; CR-multiplication, with Laplacian spectral sparsifiers, which also have numerous applications in data science, and how approximate matrix multiplication can be used to devise sparsifiers.

Geometry
Friday, April 15, 2022, 4:00pm-5:00pm
3866 East Hall
Carsten Peterson (U Michigan)
On quantum ergodicity on Bruhat-Tits buildings

Quantum ergodicity refers to equidistribution of eigenfunctions of Laplace-like operators which arise from "quantizing" an ergodic dynamical system. The original quantum ergodicity theorem was about eigenfunctions of the Laplacian in the high eigenvalue limit on a manifold with ergodic geodesic flow (such as a hyperbolic surface). More recently Anantharaman and Le Masson studied eigenfunctions of the adjacency operator on sequences of regular graphs Benjamini-Schramm converging to the tree. Inspired by these results, Le Masson and Sahlsten obtained analogous results for sequences of hyperbolic surfaces Benjamini-Schramm converging to the hyperbolic plane, and Brumley and Matz for sequences of locally symmetric spaces Benjamini-Schramm converging to the symmetric space SL(n, R)/SO(n). By reinterpreting (certain) regular graphs as quotients of the Bruhat-Tits building associated to SL(2, F), where F is a p-adic field, a natural question is if analogous results hold for quotients of higher rank Bruhat-Tits buildings (which may be viewed as p-adic symmetric spaces). We obtain analogous results for the Bruhat-Tits building associated to SL(3, F). No prior background on quantum ergodicity or buildings will be assumed in this talk.