## Weekly Seminar & Events Bulletin
**October 16th, 2022 - October 22nd, 2022**

### Monday, October 17, 2022
- **4:00pm-5:00pm** [Complex Analysis, Dynamics and Geometry](#) -- Fall Break () *Have a good break!* -- 3096 East Hall

### Tuesday, October 18, 2022
- **12:00am-12:00am** [Colloquium Series](#) -- Fall Break () *Fall Break*

### Wednesday, October 19, 2022
- **2:30pm-4:00pm** [Learning Seminar in Algebraic Combinatorics](#) -- David Speyer (University of Michigan) *Spectral curves for dimers on a torus* -- 4088 East Hall
- **3:00pm-4:00pm** [Student Arithmetic](#) -- Andy Gordon (UM) *How to construct abelian extensions* -- 1866 East Hall
- **4:00pm-5:30pm** [Algebraic Geometry](#) -- Olivia Dumitrescu (University of North Carolina) *Cones of Curves Stratification* -- 4096 East Hall
- **4:00pm-5:00pm** [Financial/Actuarial Mathematics](#) -- Donghan Kim (UM) *Portfolio theory in a market of stochastic dimension* -- 1360 East Hall
- **4:00pm-5:00pm** [Special Events](#) -- Eiichiro Komatsu (Director of the Department of Physical Cosmology Max Planck Institute for Astrophysics, Germany) *The Annual U-M Department of Physics Ta-You Wu Lecture: Cosmic Inflation* -- Amphitheatre Rackham Graduate School (Horace H.)
- **5:00pm-6:00pm** [Differential Equations](#) -- Annegret Burtscher (Radboud University, Dept. Mathematics, Nijmegen, Netherlands) *A weak second Bianchi identity for naked singularities* -- 4088 East Hall

### Thursday, October 20, 2022
- **3:00pm-4:00pm** [Commutative Algebra](#) -- Alapan Mukhopadhyay (University of Michigan) *D-simplicity of local rings.* -- https://umich.zoom.us/j/96274532499 (password: algebra) Virtual East Hall
- **4:00pm-5:00pm** [Differential Equations](#) -- Tarek Elgindi (Duke University) *On the long-time behavior of scale-invariant solutions to the 2d Euler equation* -- 4088 East Hall
- **4:00pm-6:00pm** [Arithmetic Geometry Learning](#) -- David Stapleton () *The Brauer--Manin obstruction for rationally connected varieties* -- 4096 East Hall
- **4:00pm-5:00pm** [Mathematics Communications](#) -- Sam Hansen (University of Michigan) *Research Communication Workshop* -- 1866 East Hall
- **4:00pm-5:00pm** [Student Dynamics/Geometry Topology](#) -- Hyunsuk Kim (University of Michigan) *The "dbar"-equation* -- 3096 East Hall

### Friday, October 21, 2022
- **9:00am-10:00am** [Variational Analysis and Optimization](#) -- Shangzhi Zeng (University of Victoria, Canada) *Difference of convex algorithm for bilevel programs with applications in hyperparameter selection*
- **3:00pm-4:00pm** [Applied Interdisciplinary Mathematics (AIM)](#) -- Nizomjon Jumaniyazov (Tashkent University of Information Technologies (Urgench branch)) *Numerical Solution of the Steady State Fokker-Planck Equation* -- 1084 East Hall
- **3:00pm-3:50pm** [Student Algebraic Geometry](#) -- Hyunsuk Kim (Michigan) *Hilbert Space Techniques in Algebraic Geometry* -- 2866 East Hall
- **3:00pm-4:00pm** [Combinatorics](#) -- () *Cancelled* -- 4088 East Hall
- **4:00pm-5:30pm** [Preprint Algebraic Geometry](#) -- Saket Shah () *Motivic invariants of birational maps* -- 4096 East Hall
- **4:00pm-5:00pm** [MCAIM Graduate Seminar](#) -- Leonardo Heveling (Radboud University) *Causality and time in General Relativity* -- 2866 East Hall
Abstracts for the week of October 16th, 2022 - October 22nd, 2022

Complex Analysis, Dynamics and Geometry
Monday, October 17, 2022, 4:00pm-5:00pm
3096 East Hall
Fall Break

Have a good break!

Colloquium Series
Tuesday, October 18, 2022, 12:00am-12:00am

Fall Break

Learning Seminar in Algebraic Combinatorics
Wednesday, October 19, 2022, 2:30pm-4:00pm
4088 East Hall
David Speyer (University of Michigan)
Spectral curves for dimers on a torus

I will review Kasteleyn's method for planar graphs, its adaptation to graphs on a torus, the notion of slope of a tiling, and the spectral curve of a graph on a torus. I'll explain how the spectral curve controls the asymptotic behavior of periodic tilings as the period domain expands. I'll then state Kenyon and Okounkov's theorem that the spectral curve is always a Harnack curve, and that all Harnack curves are spectral curves.

Student Arithmetic
Wednesday, October 19, 2022, 3:00pm-4:00pm
1866 East Hall
Andy Gordon (UM)
How to construct abelian extensions

This talk will provide an overview of some famous methods of explicitly constructing field extensions with abelian galois groups. We will discuss the set ups in the cases of Q, imaginary quadratic fields, and p-adic fields, aiming to highlight the similarities and espouse a general principle of why they work. This talk should be accessible to anyone who knows what a Galois group is.
The study of curves in projective space is a well-known problem in algebraic geometry, that goes back centuries. The minimal model program in birational geometry has been formulated via the theory of divisors, and it is an interesting question to understand it via the theory of curves.

In this talk, we will discuss the duality between cones of k-moving curves and cones of ample divisors in codimension k following a question of Lazarsfeld -Payne- Choi for Mori Dream Spaces. We introduce the terminology of principal variety, and we prove that the duality of cones holds in this class of examples. This is based on joint work with Rick Miranda and also with Chiara Brambilla, Elisa Postinghel and Luis Sanchez.

Financial/Actuarial Mathematics
Wednesday, October 19, 2022, 4:00pm-5:00pm
1360 East Hall
Donghan Kim (UM)
Portfolio theory in a market of stochastic dimension

In this talk, we present a financial market with a stochastic number of assets, using the notion of piecewise semimartingale of stochastic dimension. For this market with access to the money market, we show the fundamental theorem of asset pricing, i.e., the equivalence of market viability (no arbitrage of the first kind) to the existence of a supermartingale numeraire portfolio. We also show the same fundamental theorem for an open market embedded in this market, where the investors are only allowed to invest in a fixed number of top-capitalization stocks among the entire investing universe of stochastic dimension. When access to the money market is restricted, we develop the theory of functional generation of stock portfolios for such a market consisting of a stochastic number of stocks.
Special Events

Wednesday, October 19, 2022, 4:00pm-5:00pm
Amphitheatre Rackham Graduate School (Horace H.)

Eiichiro Komatsu (Director of the Department of Physical Cosmology Max Planck Institute for Astrophysics, Germany)

The Annual U-M Department of Physics Ta-You Wu Lecture: Cosmic Inflation

**This will be an in-person event and live-streamed on YouTube here:
https://www.youtube.com/watch?v=galZmVFECm0

The Cosmic Microwave Background (CMB) gives a photographic image of the Universe when it was still an "infant," and its detailed measurements have given us a wealth of information, such as the composition and history of the Universe. The CMB research told us a remarkable story: the structure we see in our Universe, such as galaxies, stars, planets, and eventually ourselves, originated from tiny quantum fluctuations in the period of the early Universe called "cosmic inflation." But is this picture true? In this lecture, I will review the physics of CMB and key results from recent experiments and discuss future prospects for the quest to find out about our origins.

Differential Equations

Wednesday, October 19, 2022, 5:00pm-6:00pm
4088 East Hall

Annegret Burtscher (Radboud University, Dept. Mathematics, Nijmegen, Netherlands)

A weak second Bianchi identity for naked singularities

The second Bianchi identity is a differential curvature identity that is satisfied on any manifold with a smooth semi-Riemannian metric tensor. If a Lorentzian metric satisfies the Einstein equations, the twice contracted version of the second Bianchi identity implies a certain local law of energy and momentum conservation for the matter field permeating the spacetime. In this talk we define a distributional version of the twice-contracted second Bianchi identity, and show that it holds for spacetimes with timelike curvature singularities, provided that these singularities are in a precise sense not too strong. Following earlier ideas of Weyl, Einstein, Infeld and Hoffman, one can hope to use this approach to develop a rigorous theory for the motion of matter particles (charged and massive) viewed as timelike singularities in an otherwise vacuum spacetime. As a first test case we show that a large class of static spherically symmetric spacetime metrics with one-dimensional timelike singularities satisfies this identity. Surprisingly, the well-known superextremal Reissner-Weyl-Nordstrom spacetime of a single point charge does not belong to this class, but other nonlinear electromagnetic theories satisfy the second Bianchi identity weakly. This is joint work with M. Kiessling and A.S. Tahvildar-Zadeh.
Let \((R, m, k)\) be a noetherian local \(k\)-algebra. We shall give an alternate characterization of the simplicity of \(R\) under the action of the ring of \(k\)-linear differential operators. As a consequence, we shall show that if \(R\) is \(Dk(R)\)-simple, then \(R \hat{E} \dagger\) is \(Dk(R \hat{E} \dagger)\)-simple. We shall discuss examples to show that the converse is not true. The talk reports an ongoing joint work with Karen Smith.

We give a complete description of the long-time behavior of uniformly bounded scale-invariant solutions to the 2d Euler equation satisfying a discrete symmetry. We show that all such solutions relax in infinite time to rigidly rotating states or steady states. Consequently, all sufficiently symmetric non-constant scale-invariant solutions that are smooth on \(S^1\) become singular in infinite time. On the plane, this corresponds to generic infinite time spiral and cusp formation for bounded and discretely symmetric solutions. This is based on joint works with R. Murray and A. Said.
**Student Dynamics/Geometry Topology**  
*Thursday, October 20, 2022, 4:00pm-5:00pm*  
*3096 East Hall*  
*Hyunsuk Kim (University of Michigan)*  
*The “dbar”-equation*

One of the main goals in complex geometry is to construct holomorphic functions with nice properties. In this talk, we will talk about one approach to this, which is studying the "dbar"-operator.

**Applied Interdisciplinary Mathematics (AIM)**  
*Friday, October 21, 2022, 3:00pm-4:00pm*  
*1084 East Hall*  
*Nizomjon Jumaniyazov (Tashkent University of Information Technologies (Urgench branch))*  
*Numerical Solution of the Steady State Fokker-Planck Equation*

The Fokker-Planck equation (FPE) has important applications to radiative transfer, for example ion and photon transport in biological tissue. The equation describes the radiation intensity for a given choice of absorption and scattering coefficients. This work proposes finite-difference methods for the steady state Fokker-Planck equation in one space dimension and two angle variables (polar $\mu$, azimuthal $\theta$). The talk focuses on a direct method based on a Crank-Nicolson discretization of the transport term in the FPE. Two problems are considered. In the first problem, the solution is independent of the azimuthal angle $\theta$, and convergence is studied with respect to grid refinement. In the second problem, the dependence on the azimuth angle $\theta$ is not neglected; using Fourier techniques, the problem is divided into a set of $\theta$-independent problems whose absorption coefficients become singular, which requires a modification of the scheme. Finally, preliminary results using this method will be presented for the time-dependent FPE.

**Student Algebraic Geometry**  
*Friday, October 21, 2022, 3:00pm-3:50pm*  
*2866 East Hall*  
*Hyunsuk Kim (Michigan)*  
*Hilbert Space Techniques in Algebraic Geometry*

For varieties over the complex numbers, we can use the classical topology which is more natural to think of than the Zariski topology. The advantage of it is that we can use analysis in this setting by studying several complex variables and PDEs. We will see the techniques and benefits of analytic methods and what the motivation is in behind, with some applications including results that positively complement the existent algebraic methods.
Combinatorics  
Friday, October 21, 2022, 3:00pm-4:00pm  
4088 East Hall  
()  
Cancelled

Preprint Algebraic Geometry  
Friday, October 21, 2022, 4:00pm-5:30pm  
4096 East Hall  
Saket Shah ()  
Motivic invariants of birational maps

https://arxiv.org/abs/2207.07389

MCAIM Graduate Seminar  
Friday, October 21, 2022, 4:00pm-5:00pm  
2866 East Hall  
Leonardo Heveling (Radboud University)  
Causality and time in General Relativity

Understanding the causal relationships between spacetime events is an important aspect of General Relativity. In this talk, I will introduce some basic concepts in causality theory, such as the causal and chronological relations, time functions, and causality conditions. Towards the end, I will focus on the most important causality condition, namely global hyperbolicity, and its different characterizations. Time permitting, I will include a recent characterization obtained by Burtscher and myself.
Variational Analysis and Optimization
Friday, October 21, 2022, 9:00am-10:00am

Shangzhi Zeng (University of Victoria, Canada)

*Difference of convex algorithm for bilevel programs with applications in hyperparameter selection*

In this work, we present a difference of convex algorithm for solving bilevel programs in which the upper level objective functions are difference of convex functions, and the lower level programs are fully convex. This nontrivial class of bilevel programs provides a powerful modelling framework for dealing with applications arising from hyperparameter selection in machine learning. Thanks to the full convexity of the lower level program, the value function of the lower level program turns out to be convex and hence the bilevel program can be reformulated as a difference of convex bilevel program. We propose an algorithm for solving the reformulated difference of convex program and show its convergence to stationary points under very mild assumptions.