**Weekly Seminar & Events Bulletin**  
**April 1st, 2018 - April 7th, 2018**

### Monday, April 02, 2018

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker/Details</th>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Integrable Systems and Random Matrix Theory</strong> -- Promit Ghosal (Columbia University) Lower tail of the KPZ equation -- 1866 East Hall</td>
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<td><strong>Complex Analysis, Dynamics and Geometry</strong> -- Matt Stevenson (University of Michigan) A non-Archimedean Ohsawa-Takegoshi extension theorem -- 3096 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Student Combinatorics Seminar</strong> -- Trevor Hyde (University of Michigan) Hopf monoids -- 3866 East Hall</td>
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<td>4:10pm-5:30pm</td>
<td><strong>Group, Lie and Number Theory</strong> -- Brad Rodgers (UM) Recent progress on the de Bruijn-Newman constant -- 4088 East Hall</td>
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### Tuesday, April 03, 2018

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<tr>
<td>12:00pm-1:30pm</td>
<td><strong>Teaching Mathematics</strong> -- Harrison Bray (Univ of Michigan) Learning Community for Inclusive Teaching Session 4 -- 4866 East Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Student Geometry/Topology</strong> -- Samantha Pinella (University of Michigan) Interval Exchange Transformations -- 3866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Student Representation Theory</strong> -- Trevor Hyde (University of Michigan) Combinatorial species, generating functions, and representations of the symmetric group -- 1866 East Hall</td>
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<td>4:00pm-5:00pm</td>
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<td><strong>Colloquium Series</strong> -- Nizar Touzi (Ecole Polytechnique, France) Mathematics for optimal contract theory -- 1360 East Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Financial/Actuarial Mathematics</strong> -- Sergey Nadtochiy (UM) Optimal Contract for a Fund Manager, with Capital Injections and Endogenous Constraints. -- 4096 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Financial/Actuarial Mathematics</strong> -- Nizar Touzi (Ecole Polytechnique) New developments in second order backward SDEs -- 1360 East Hall</td>
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<td>4:10pm-5:30pm</td>
<td><strong>Algebraic Geometry</strong> -- Akhil Mathew (University of Chicago) Kaledin’s noncommutative degeneration theorem and topological Hochschild homology -- 4096 East Hall</td>
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### Friday, April 06, 2018

10:00am-11:00am **Symplectic Reading Group** -- Jun Zhang (Tel Aviv University) *Sheaf-theoretic methods in Hofer's geometry (after Asano and Ike)* -- 1360 East Hall

12:10pm-2:00pm **Student Homotopy Theory** -- Attilio Castano (University of Michigan) *Homological Algebra from the perspective of Infinity Categories* -- 1360 East Hall

3:00pm-4:00pm **Applied Interdisciplinary Mathematics (AIM)** -- Christoph Borgers (Tufts University) *Rhythms in neuronal networks with recurrent excitation* -- 1084 East Hall

3:00pm-4:00pm **Geometry** -- Jun Zhang (Tel Aviv University) *Applications of persistent homology in symplectic and Riemannian geometry* -- 3866 East Hall

3:10pm-4:00pm **Student Algebraic Geometry** -- Emanuel Reinecke (UM) *The Tate module of an elliptic curve* -- 3096 East Hall

4:10pm-5:00pm **Student AIM Seminar** -- Matthew Kvalheim (University of Michigan) *Oscillators, Asymptotic Phase, and Reduction of Dynamical Systems* -- 1084 East Hall

4:10pm-5:00pm **Combinatorics** -- Neriman Tokcan (University of Michigan) *Newton Polytopes in Algebraic Combinatorics* -- 4088 East Hall

4:10pm-6:00pm **Special Events** -- Zili Zhang (UM) *Introduction to derived categories and t-structures* -- 4096 East Hall

### Saturday, April 07, 2018

9:30am-10:30am **Special Events** -- Alex Perry (Columbia University) *Homological projective geometry - Part I* -- 1068 East Hall

11:00am-12:00pm **Special Events** -- Jack Huizenga (Penn State University) *Birational geometry of moduli spaces of sheaves and Bridgeland stability - Part I* -- 1068 East Hall

2:00pm-3:00pm **Special Events** -- Alex Perry (Columbia University) *Homological projective geometry - Part II* -- 1068 East Hall

4:00pm-5:00pm **Special Events** -- Jack Huizenga (Penn State University) *Birational geometry of moduli spaces of sheaves and Bridgeland stability - Part II* -- 1068 East Hall
Integrable Systems and Random Matrix Theory  
Monday, April 02, 2018, 4:00pm-5:00pm  
1866 East Hall  
Promit Ghosal (Columbia University)  
Lower tail of the KPZ equation

Over the last decade, KPZ equation gained immense attention for variety of of different reasons. From this perspective, tail probabilities of the one point distribution of the KPZ equation are important. However, the exact rate of decay was unknown. To illustrate its complexity, let us mention that an optimal bounds on the lower tail probability of the one point distribution of the KPZ equation under narrow wedge initial condition needs solving an infinite dimensional Riemann-Hilbert problem. In this talk, I will demonstrate how one can avoid such difficulties and still get (almost) tight upper and lower bounds on the lower tail probability of the narrow wedge solution. Our results make use of the recent work of Thomas Bothner on the Ablowitz-Segur solution of the second Painleve equation and stochastic Airy operator.

This is a joint work with my advisor Prof. Ivan Corwin. If time permits, I will discuss few more interesting facets like tail bounds under general initial conditions, large deviation of the lower tail of the narrow wedge solution, tail bounds of other integrable models etc.

Complex Analysis, Dynamics and Geometry  
Monday, April 02, 2018, 4:00pm-5:00pm  
3096 East Hall  
Matt Stevenson (University of Michigan)  
A non-Archimedean Ohsawa-Takegoshi extension theorem

The Ohsawa-Takegoshi extension theorem, in its simplest form, asserts that one can construct a holomorphic function (or 1-form) on the open unit disc in the complex plane with a specified value at a given point, and whose weighted L^2-norm is bounded by the weight at the given point. We will discuss a version of this extension theorem on the Berkovich unit disc over a non-Archimedean field.

Student Combinatorics Seminar  
Monday, April 02, 2018, 4:00pm-5:00pm  
3866 East Hall  
Trevor Hyde (University of Michigan)  
Hopf monoids

Hopf monoids are families of combinatorial structures which may be merged together and broken apart. In this talk we discus Hopf monoids, generalized permutahedra, and antipodes following recent work of Aguiar and Ardila.
N.G. de Bruijn introduced a one-parameter family of entire functions $H_t(z)$ with properties that i) the zeros of $H_0(z)$ characterize the zeros of the Riemann zeta function -- the Riemann hypothesis ends up being equivalent to the claim that $H_0(z)$ has only real zeros -- and ii) there exists a number $\lambda$, known as the de Bruijn-Newman constant, such that $H_t(z)$ has only real zeros exactly when $t \geq \lambda$. The Riemann hypothesis is equivalent to the claim that $\lambda \geq 0$.

De Bruijn in 1950 showed that $\lambda \leq 1/2$, while C. Newman in 1976 proved that $\lambda > -\infty$ and conjectured that $\lambda \geq 0$, a curious complement to the Riemann hypothesis. In this talk I will outline some of what's known about the zeros of the Riemann zeta function and the functions $H_t(z)$ and discuss a recent proof joint with Terence Tao of Newman's conjecture.

An interval exchange transformation is simple to describe- you take an interval, chop it into pieces, then rearrange them. I will discuss the dynamics of this map, including symbolic dynamics, Rauzy induction, and translation surfaces.
Student Representation Theory
Tuesday, April 03, 2018, 3:00pm-4:00pm
1866 East Hall
Trevor Hyde (University of Michigan)

*Combinatorial species, generating functions, and representations of the symmetric group*

Species are a powerful tool for working with families of combinatorial objects. In this talk we introduce the theory of combinatorial species, discuss their associated generating functions, and show how it all relates to the representation theory of the symmetric groups.

Financial/Actuarial Mathematics
Tuesday, April 03, 2018, 4:00pm-5:00pm
1360 East Hall
Nizar Touzi (Ecole Polytechnique)

*Math Colloquium/Inaugural Van Eenam Lecture*

Mathematics for optimal contract theory

Abstract: Contract theory plays a major role in modern economic modeling and has genuine application in real life, and many potential applications in connection with new technologies. The main concern is to design a management delegation contract between a Principal and an Agent which sets the basis of a satisfactory collaboration so as to put the best incentive for the Agent to fulfill the objective of the Principal. The problem is naturally formulated as a (Stackelberg) differential game. A general solution approach is provided by using recent representation results from backward stochastic differential equations.

Colloquium Series
Tuesday, April 03, 2018, 4:10pm-5:00pm
1360 East Hall
Nizar Touzi (Ecole Polytechnique, France)

*Mathematics for optimal contract theory*

Contract theory plays a major role in modern economic modeling and has genuine application in real life, and many potential applications in connection with new technologies. The main concern is to design a management delegation contract between a Principal and an Agent which sets the basis of a satisfactory collaboration so as to put the best incentive for the Agent to fulfill the objective of the Principal. The problem is naturally formulated as a (Stackelberg) differential game. A general solution approach is provided by using recent representation results from backward stochastic differential equations.

Reception for the Speaker will follow at 5:00 PM in the Upper Atrium in East Hall on April 3, 2018

Sponsored by the Van Eenam Lectures Series
In this paper, we construct a solution to the optimal contract problem for delegated portfolio management of the first-best (risk-sharing) type. The novelty of our result is (i) in the robustness of the optimal contract with respect to perturbations of the wealth process (interpreted as capital injections), and (ii) in the more general form of principal's objective function, which is allowed to depend directly on the agent's strategy (which, in turn, allows us to incorporate endogenous constraints in the contract). We reduce the optimal contract problem to the following inverse problem: for a given portfolio (defined in a feedback form, as a random field), construct a stochastic utility whose optimal portfolio coincides with the given one. We characterize the solution to this problem through a linear Stochastic Partial Differential Equation (SPDE), prove its well-posedness, and compute the solution explicitly in the Black-Scholes model. Remarkably, the optimal contract computed in the Black-Scholes model satisfies the limited liability condition and has additional properties which show that it also solves the second-best (moral hazard) version of the problem, in which the principal cannot fully deduce the agent's strategy from her observations.

Backward stochastic differential equations extend the martingale representation theorem to the nonlinear setting. This can be seen as path-dependent counterpart of the extension from the heat equation to fully nonlinear parabolic equations in the Markov setting. This paper extends such a nonlinear representation to the context where the random variable of interest is measurable with respect to the information at a finite stopping time. We provide a complete wellposedness theory which covers the semilinear case (backward SDE), the semilinear case with obstacle (reflected backward SDE), and the fully nonlinear case (second order backward SDE).

Sponsored by the Van Eenum Lecture Series
Algebraic Geometry  
Wednesday, April 04, 2018, 4:10pm-5:30pm  
4096 East Hall  
Akhil Mathew (University of Chicago)  
*Kaledin's noncommutative degeneration theorem and topological Hochschild homology*

For a smooth proper variety over a field of characteristic zero, the Hodge-to-de Rham spectral sequence (relating the cohomology of differential forms to de Rham cohomology) is well-known to degenerate, via Hodge theory. A "noncommutative" version of this theorem has been proved by Kaledin for smooth proper dg categories over a field of characteristic zero, based on the technique of reduction mod p. I will describe a short proof of this theorem using the theory of topological Hochschild homology, which provides a canonical one-parameter deformation of Hochschild homology in characteristic p.

Financial/Actuarial Mathematics  
Thursday, April 05, 2018, 3:00pm-4:00pm  
1360 East Hall  
Nizar Touzi (Ecole Polytechnique)  
*Branching particles representation for nonlinear Cauchy problems*

We provide a probabilistic representations of the solution of some semilinear hyperbolic and high-order PDEs based on branching diffusions. This is a direct extension of our previous work in the context of semilinear parabolic PDEs based on the classical Mc Kean representation for KPP equations. These representations pave the way for a Monte-Carlo approximation of the solution, thus bypassing the curse of dimensionality. We illustrate the numerical implications in the context of some popular PDEs in physics such as nonlinear Klein-Gordon equation, a simplified scalar version of the Yang-Mills equation, a fourth-order nonlinear beam equation and the Gross- Pitaevskii PDE as an example of nonlinear Schrodinger equations.

Sponsored by the Van Eenam Lecture Series

Commutative Algebra  
Thursday, April 05, 2018, 3:00pm-4:00pm  
B735 East Hall  
Paolo Mantero (University of Arkansas)  
*Singularities of Rees-like algebras*

Recently, J. McCullough and I. Peeva provided the first counterexamples to the Eisenbud-Goto Regularity Conjecture. These examples are obtained by a construction dubbed Rees-like algebra. Since there is still hope that the Regularity Conjecture may hold under additional assumptions (e.g. in the smooth case), it is natural to ask: How "bad" can the singularities of Rees-like algebras be? How are singularities affected by the Rees-like algebra construction?

In this talk, based on joint work with J. McCullough and L. Miller, we will provide quantitative and qualitative answers to these questions.
Topology
Thursday, April 05, 2018, 3:00pm-4:00pm
1866 East Hall
Konstantinos Tsouvalas (UM)
Euler characteristics on virtually free products

A generalized Euler characteristic on a class of groups is an invariant satisfying similar properties with the usual topological Euler characteristic of CW complexes. Euler characteristics have been defined on various classes of groups and examples include the rank gradient and the L^2-Betti numbers of groups. In this talk, we will define Euler characteristics on classes of residually finite and virtually torsion free groups and we will see that they satisfy certain formulas for fundamental groups of graph of groups with finite edge groups. Moreover, we will see an application on the number of edges of splittings of an accessible group over finite subgroups.

Differential Equations
Thursday, April 05, 2018, 4:00pm-5:00pm
4088 East Hall
Fritz Gesztesy (Baylor University, Waco TX)
On factorizations of differential operators and Hardy-Rellich-type inequalities

We will illustrate how factorizations of singular, even-order partial differential operators yield an elementary approach to classical inequalities of Hardy-Rellich-type. More precisely, using this factorization method, we will derive a general (and, apparently, new) inequality and demonstrate how particular choices of the parameters contained in this inequality yield well-known inequalities, such as the classical Hardy and Rellich inequalities as special cases. Actually, other special cases yield additional and apparently less well-known inequalities. We will indicate that our method, in addition to being elementary, is quite flexible when it comes to a variety of generalized situations involving the inclusion of remainder terms and higher-order operators. This is based on various joint work with L. Littlejohn, I. Michael, M. Pang, and R. Wellman.
Student Dynamics
Thursday, April 05, 2018, 4:00pm-5:00pm
1866 East Hall
Feng Zhu (University of Michigan)
Equidistribution and counting in negative curvature

How many lattice points are there in a ball of radius R? How many closed geodesics of length at most L are there on a closed surface? In negatively curved geometries, such counting problems can be solved by appealing to dynamics: the geodesic flow is mixing, and this leads to equidistribution results which yield answers to these counting problems. Margulis first had this insight for hyperbolic manifolds, and the theory has subsequently been generalized to other settings, including CAT(-1) spaces and strictly convex Hilbert geometries.

I will introduce the main ideas behind these counting via mixing and equidistribution arguments, briefly describing the more singular settings.

Logic
Thursday, April 05, 2018, 4:00pm-5:30pm
3088 East Hall
Andreas Blass (University of Michigan)
Well-Ordered Choice

The axiom of well-ordered choice is a weak form of the axiom of choice. It says that every well-ordered family of nonempty sets has a choice function. I plan to prove two long-known but perhaps not well-known results about this axiom. The first is the construction of a permutation model (of set theory with atoms) in which the axiom of well-ordered choice holds but the full axiom of choice fails. The second is that well-ordered choice implies the axiom of dependent choice. Dependent choice is the assertion that, given any directed graph in which every vertex has at least one outgoing arrow, and given any vertex v in that graph, there exists an infinite sequence of vertices that starts at v and then follows the arrows. If time permits, I'll also indicate why that second result is nontrivial, even though dependent choice seems to require only a countable (hence well-ordered) sequence of choices.

Preprint Algebraic Geometry Seminar
Thursday, April 05, 2018, 4:10pm-5:30pm
2866 East Hall
Matt Stevenson (UM)
On arithmetic general theorems for polarized varieties (following Grieve)

https://arxiv.org/abs/1712.04367
Symplectic Reading Group  
Friday, April 06, 2018, 10:00am-11:00am  
1360 East Hall  
Jun Zhang (Tel Aviv University)  
*Sheaf-theoretic methods in Hofer's geometry (after Asano and Ike)*

Classical Hofer's geometry depends on a detailed application of pseudo-holomorphic curve. However, in recent years, initiated by D. Tamarkin, M. Kashiwara, P. Schapira and S. Guillermou developed a sheaf method with keyword - Tamarkin's category. I will introduce this category in relatively details with examples. Moreover, I will demonstrate how this sheaf method can be modified to fit into the study, e.g. displacement energy or Hamiltonian dynamics so that it can recover some classical results in symplectic topology. Finally, further potential research directions will be outlined.

Student Homotopy Theory  
Friday, April 06, 2018, 12:10pm-2:00pm  
1360 East Hall  
Attilio Castano (University of Michigan)  
*Homological Algebra from the perspective of Infinity Categories*

According to Lurie "There is a very useful analogy between topological spaces and chain complexes with values in an abelian category. For example, it is customary to speak of homotopies between chain maps, contractible complexes, and so forth. The analogue of the homotopy category of topological spaces is the derived category of an abelian category $A$, a triangulated category which provides a good setting for many constructions in homological algebra. However, it has long been recognized that for many purposes the derived category is too crude: it identifies homotopic morphisms of chain complexes without remembering why they are homotopic. It is possible to correct this defect by viewing the derived category as the homotopy category of an underlying infinity-category $D(A)$. The infinity-categories which arise in this way have special features that reflect their "additive" origins: they are stable."
Applied Interdisciplinary Mathematics (AIM)  
Friday, April 06, 2018, 3:00pm-4:00pm  
1084 East Hall  
Christoph Borgers (Tufts University)  
Rhythms in neuronal networks with recurrent excitation

Interacting excitatory and inhibitory neuronal populations often generate oscillations in electrical fields in the brain. I will briefly review this mechanism and the reasons to believe that it is important in brain function. Most of the talk will be focused on the effects of recurrent excitation, i.e., of the neurons of a local network in the brain exciting each other. Recurrent excitation can sustain activity in a network that would otherwise be quiescent; this is believed to be the basis of working memory. It can also lead to a runaway process, with excitation generating more excitation etc., much as the presence of a quadratic term on the right-hand side of a differential equation can lead to blow-up in finite time; this may be related to epileptic seizures. For model problems, we prove that abrupt transitions to runaway activity require recurrent excitation with fast kinetics, while working memory activity is more robust with recurrent excitation with slow kinetics.

Geometry  
Friday, April 06, 2018, 3:00pm-4:00pm  
3866 East Hall  
Jun Zhang (Tel Aviv University)  
Applications of persistent homology in symplectic and Riemannian geometry

Riemannian metrics are usually not easy to be compared in a quantitative way. In this talk, we will view this problem from symplectic geometry. The tools that will be introduced are persistent homology and symplectic homology. The former one with root in applied algebraic topology now has a fast development in various branches of geometry while the latter one is a standard tool (with origins of Floer theory) for study of nice domains of symplectic manifold. More concretely, we will introduce a quantitative measurement between two “normalized” metrics and our main result is that this measurement can be controlled by some combinatorics data, which implies some coarse geometry type result on the space of Riemannian metrics.
Student Algebraic Geometry
Friday, April 06, 2018, 3:10pm-4:00pm
3096 East Hall
Emanuel Reinecke (UM)
The Tate module of an elliptic curve

We begin the talk with the classification of the possible endomorphism rings for complex elliptic curves, using their first integral singular homology groups. Then, we move on to positive characteristic. First, we discuss an observation due to Serre that in this setting, we cannot have a reasonable homology theory with integral coefficients. As a remedy, we introduce the Tate module of an elliptic curve. With this new tool at our disposal, we classify the possible endomorphism rings for elliptic curves in arbitrary characteristic. This talk will be accessible to anyone who is in or has taken 632.

Student AIM Seminar
Friday, April 06, 2018, 4:10pm-5:00pm
1084 East Hall
Matthew Kvalheim (University of Michigan)
Oscillators, Asymptotic Phase, and Reduction of Dynamical Systems

What do circadian rhythms, robot locomotion, and spiking neurons have in common? Each can be modeled by an "oscillator," or a dynamical system having a stable and periodic limiting behavior. Oscillators are usually associated with the existence of an "asymptotic phase" which governs the long-term dynamics of the oscillator and affords dimensionality reduction. Asymptotic phase has applications in diverse areas such as chemical kinetics, neuroscience, and animal locomotion.

In this talk, I will give an introduction to oscillators, asymptotic phase, and the requisite dynamical systems theory. I will also explain how asymptotic phase relates to the "Phase Response Curves" used in neuroscience. I will place the theory in the context of current research in which we develop a new algorithm to compute the asymptotic phase of an unknown oscillator, using short and noisy time series measurements. Our algorithm utilizes basic topological insights in conjunction with machine learning methods and has substantial advantages over existing techniques which require knowledge of the equations of motion, long time series, or some combination thereof.

Finally, I will show that oscillators and asymptotic phase are just one piece in a larger picture of invariant manifolds and invariant foliations and I will explain why these objects are useful for model reduction.
Combinatorics
Friday, April 06, 2018, 4:10pm-5:00pm
4088 East Hall
Neriman Tokcan (University of Michigan)
Newton Polytopes in Algebraic Combinatorics

Abstract: A polynomial has saturated Newton polytope (SNP) if every lattice point of the convex hull of its exponent vectors corresponds to a monomial. We compile instances of SNP in algebraic combinatorics (some with proofs, others conjecturally). Our principal construction is the Schubitope. For any subset of $[n] \times [n]$, we describe it by linear inequalities. This generalized permutahedron conjecturally has positive Ehrhart polynomial. We conjecture it describes the Newton polytope of Schubert and key polynomials. This is joint work with Cara Monical and Alexander Yong.

Special Events
Friday, April 06, 2018, 4:10pm-6:00pm
4096 East Hall
Zili Zhang (UM)
Introduction to derived categories and t-structures

Preparatory Lecture - The goal is to acquaint local graduate students with the basic material that is needed in order to understand what is going on in the mini-courses. Other participants are welcome to join as well.

Derived categories were introduced to have a better foundation for the theory of derived functors. In this talk, we will start with the general construction of derived categories for abelian categories. Then we restrict to the bounded derived category derived categories of coherent sheaves on schemes and we will defined push-forward, pull-back and tensor product in the derived sense. We will focus on illustrating why working on chain complexes is better than single objects. As applications, the projection formula and Serre duality can be promoted to a derived version. We will also define t-structures of triangulated categories and their hearts. An interesting example will be presented showing that an injective morphism becomes surjective when t-structures change.
The subject of the birational geometry of moduli spaces seeks to understand the possible compactifications of a moduli space parameterizing "nice" objects. Compactifying a moduli space usually requires that we allow our space to parameterize certain "degenerate" objects, in addition to the objects we initially wanted to study. In recent years the concept of Bridgeland stability has led to tremendous activity in the study of the birational geometry of moduli spaces of sheaves. We will begin by recalling the classical birational geometry of Hilbert schemes of points, which are some of the simplest moduli spaces of sheaves. Then we will see that Bridgeland stability conditions allow us to better understand this birational geometry and describe the "degenerate" objects that are added in new compactifications. Finally, we will see how the positivity lemma of Bayer and Macri allows us to prove new results about the birational geometry of moduli spaces of sheaves. In particular, we will focus on the computation of the ample cone of the moduli space of sheaves on a surface.

This minicourse is concerned with the structure of derived categories of algebraic varieties. One of the most fundamental problems in this area is to determine when the derived categories of two varieties are equivalent, or more generally have a large subcategory in common. Besides being of intrinsic interest, such relations between derived categories often have strong geometric consequences.

Our goal is to explain some surprising "homological" counterparts of constructions and results in classical projective geometry, which give powerful tools for attacking the above problem. We will start by studying semiorthogonal decompositions -- a way to break up the derived category into smaller pieces -- through many examples. Then we will discuss Kuznetsov's theory of homological projective duality, which gives a mechanism for understanding the derived categories of linear sections of a fixed variety. Finally, we will discuss a categorical version of the join of two projective varieties, and explain how it can be used to greatly expand the applicability of homological projective duality. An underlying theme of the lectures will be the use of "noncommutative" varieties, especially as resolutions of singularities.
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