Abstracts

C. J. Bott: Mirror symmetry for $K3$ surfaces

Mirror symmetry is the phenomenon, originally discovered by physicists, that Calabi-Yau manifolds come in dual pairs, with each member of the pair producing the same physics. Mathematicians studying enumerative geometry became interested in mirror symmetry around 1990, and since then, mirror symmetry has become a major research topic in pure mathematics. One important problem in mirror symmetry is that there may be several ways to construct a mirror dual for a Calabi-Yau manifold. Hence it is a natural question to ask: when two different mirror symmetry constructions apply, do they agree?

We specifically consider two mirror symmetry constructions for $K3$ surfaces known as BHK and LPK3 mirror symmetry. BHK mirror symmetry was inspired by the Landau-Ginzburg/Calabi-Yau correspondence, while LPK3 mirror symmetry is more classical. In particular, for algebraic $K3$ surfaces with a purely non-symplectic automorphism of order n, we ask if these two constructions agree. Results of Artebani-Boissière-Sarti (2011) originally showed that they agree when $n = 2$, and Comparin-Lyon-Priddis-Suggs (2012) showed that they agree when n is prime. However, the n being composite case required more sophisticated methods. Whenever n is not divisible by four (or $n = 16$), this problem was solved by Comparin and Priddis (2017) by studying the associated lattice theory more carefully. We complete the remaining case of the problem when n is divisible by four by finding new isomorphisms and deformations of the $K3$ surfaces in question, develop new computational methods, and use these results to complete the investigation, thereby showing that the BHK and LPK3 mirror symmetry constructions also agree when n is composite. We start with a review of moduli spaces and their compactifications. Then, we describe them in detail for varieties with a well-behaved period map.

Dawei Chen: Counting geodesics on flat surfaces

An abelian differential induces a flat metric with saddle points such that the underlying Riemann surface can be realized as a polygon whose edges are pairwise identified by translation. Varying the shape of such polygons induces a $GL(2, \mathbb{R})$ action on the Hodge bundle, called Teichmueller dynamics. Generic flat surfaces in a $GL(2, \mathbb{R})$ orbit closure exhibit similar properties from the viewpoint of counting geodesics of bounded lengths, whose asymptotic growth rates satisfy a formula of Siegel-Veech type. In this talk I will give an introduction to this topic, with a focus on computing certain Siegel-Veech constants via intersection theory.

Xi Chen: Rationality of multi-variable Poincaré series

Zariski conjectured that the Poincare series of a divisor on a smooth projective surface is rational. This was proved by Cutkosky and Srinivas in 1993. We are considering a generalization of this statement to multi-variable Poincare series. This is a joint work with J. Elizondo.

Matteo Costantini: Lyapunov exponents and moduli space of flat bundles

Lyapunov exponents are invariants associated to a flat bundle over a Riemann surface. They describe the asymptotic growth of the norm of vectors moving under parallel transport over the geodesic flow. They were firstly considered in the field of flat surfaces, since they can be associated to the dynamics of billiard tables. It was in this context where Eskin, Kontsevich and Zorich proved that they can be computed as the degree of a holomorphic subbundle of the flat bundle, if this one is induced by the cohomology of a family of Riemann surfaces. In this talk we show how this result generalizes and describe some properties of the Lyapunov exponent function on the moduli space of holomorphic flat vector bundles.

Yu-Wei Fan: Categorical entropy of autoequivalences on Calabi-Yau manifolds

Calabi-Yau manifolds have many "hidden symmetries", which are autoequivalences that can not be generated by the standard ones like automorphisms, tensoring line bundles, and shiftings. By studying categorical entropy introduced by Dimitrov-Haiden-Katzarkov-Kontsevich, we show that the dynamical systems formed by the hidden symmetries and the actual symmetries have different behaviours.

Patricio Gallardo: On compact moduli spaces

We start with a review of moduli spaces and their compactifications. Then, we describe them in detail for varieties with a well-behaved period map.

Andrew Harder: Tori and the weight filtration

The $P = W$ conjecture of de Cataldo, Hausel, and Migliorini implies that Deligne's weight filtration on the homology of the Betti moduli space of G-bundles on a curve can be identified with the pushforward of the homology of certain submanifolds. In particular, there should be a compact, special Lagrangian torus of dimension equal to half of that of the Betti moduli space which determines the lowest weight piece. In this talk, I will discuss work in progress which say that for any smooth, quasiprojective manifold U, there is a collection of compact tori in U which supports the lowest weight piece of the weight filtration on homology, and that if U is log Calabi-Yau, there is a single Lagrangian torus with this property. This gives strong restrictions on the mixed Hodge structure on a log Calabi-Yau manifold. I will explain how, if one assumes conjectures of Simpson and Auroux, this result implies the $P = W$ conjecture at the highest weight.

Fei Hu: Dynamical degrees on abelian varieties in positive characteristic

In 2013, Esnault and Srinivas proved that as in the de Rham cohomology over the field of complex numbers, the algebraic entropy of an automorphism of a smooth projective surface over a finite field $\mathbb{F}_q$ is taken on the span of the Néron-Severi group inside of ℓ-adic cohomology. Later, motivated by this and Weil's Riemann Hypothesis, Truong asked whether the spectral radius $\chi_{2k}(f)$ of the pullback $f^*\colon H^{2k}(X, \mathbb{Q}_\ell) \to H^{2k}(X, \mathbb{Q}_\ell)$ is the same as the spectral radius $\lambda_k(f)$ of the pullback $f^*\colon N^k(X)_\mathbb{R} \to N^k(X)_\mathbb{R}$, where $f\colon X \to X$ is a surjective self-morphism of a smooth projective variety X of dimension n defined over an algebraically closed field $\mathbb{K}$ and $N^k(X)$ denotes the finitely generated abelian group of algebraic cycles of codimension-k modulo the numerical equivalence. He has shown that $\max\limits_{0\le i\le 2n} \chi_i(f) = \max\limits_{0\le k\le n} \lambda_k(f)$. I give an affirmative answer to his question in the case of abelian varieties and $k = 1$.

Matt Kerr: Hodge theory of degenerations

The asymptotics and monodromy of periods in degenerating families of algebraic varieties are encountered in many settings – for example, in comparing (GIT, KSBA, Hodge-theoretic) compactifications of moduli, in computing limits of geometric normal functions, and in topological string theory. In this talk, based on work with Radu Laza, we shall describe several tools (beginning with classical ones) for comparing the Hodge theory of singular fibers to that of their nearby fibers, and touch on some relations to birational geometry.

John Lesieutre: Numerical dimension revisited

The Iitaka dimension of a line bundle D on a projective variety X is the dimension of the image of the rational map given by $|mD|$ for large and divisible m. This is not a numerical invariant of D, and there are several approaches to constructing a "numerical dimension" of D, which should be an analogous invariant depending only on the numerical class of D. I will discuss an example of a divisor with surprising properties with respect to these different definitions. The example is based on the existence of pseudoautomorphisms of Calabi-Yau varieties with a certain kind of dynamical positivity. As time permits, I will explain some implications of this same positivity condition for questions in arithmetic dynamics.

Chaya Norton: Variational Formulas for the Period Matrix and Cusps of Shimura-Teichmüller Curves

Using a parametric jump problem one can study the behaviour of the period matrix near the boundary of the Deligne-Mumford compactification of M_g. These formulas are used to show any cusp of a Shimura-Teichmüller curve has two irreducible components. In joint work with David Aulicino we complete the classification of Teichmüller curves with completely degenerate Lyapunov exponents.

Gregory Pearlstein: Transcendental algebraic geometry

We begin with a review of Hodge decompositions and period maps, which we then describe in detail for special cubic fourfolds.

Peter Whang: Diophantine analysis on moduli of local systems

We consider the Diophantine geometry of moduli spaces for special linear rank two local systems on topological surfaces. After motivating their Diophantine study, we use differential geometric tools to obtain a structure theorem for their integral mapping class group orbits. We also give an effective analysis of integral points for nondegenerate algebraic curves on the moduli spaces. Time permitting, we discuss recent work on related topics as well.