Griffiths Conference 2018 "Modern Geometry" March 1-4, 2018, University of Miami Titles and Absracts

March 2, 2018

Robert Bryant *From Mechanics, to Algebra, to Geometry: The Notion of Holonomy.*

Abstract: Familiar mechanical phenomena, such as driving and parking a car, rolling a ball, and even the ability of falling cats to land on their feet (usually) are examples of an underlying mathematical concept that, in the 19th century, came to be known as "holonomy." As it became better understood, mathematicians and physicists began to realize that holonomy underlay many disparate phenomena, from the everyday situations mentioned above to understanding the curvature of space in Einstein's theory of general relativity. Nowadays, holonomy lies at the heart of both deep mathematical objects and high-energy physical theories, such as string theory and the still-mysterious M-theory, on which many theoretical physicists would like to base a "theory of everything."

This talk will discuss some holonomic phenomena in everyday life, explore their underlying commonality, their appearance in more advanced situations, and try to provide some insight into why this idea has turned out to be so fundamental.

Robert Bryant *On Self-Dual Curves.*

Abstract: An algebraic curve in the projective plane (or, more generally in a higher dimensional projective space) is said to be 'self-dual' if it is projectively equivalent to its dual curve (after, possibly, an automorphism of the curve). Familiar examples are the nonsingular conics (or, more generally, rational normal curves in higher dimensions) and the 'binomial curves' $y^a = x^b$, but there are many more such curves, even in the plane.

I'll survey some of the literature on these curves, particularly in the plane and 3-space, and some of what is known about their classification and moduli, including their connection with contact curves in certain contact 3-folds, some of which are singular. I will also provide what appear to be some new examples of these curves.

James Carlson *Maximal Variations of Hodge Structure.*

Abstract: As is well-known, Griffiths horizontal distribution is non-integrable. This fact rases many questions, among which: what is the maximum dimension of an integral manifold, and what do integral manifolds of maximum dimension look like. We will discuss some answers and a recent new example.

Herbert Clemens *Building Calabi-Yau Manifolds from Representation Theory.*

Abstract: Starting from the (perhaps naive) point view point that mathematics models for physical phenomena must in some sense be the simplest possible, I will propose a minimal model for Heterotic F-theory duality in String Theory. The guiding principal in the proposal will be that the entire geometric model be built inside' the adjoint representation of E_8.

Ron Donagi *Geometric Langlands and intersections of quadrics.*

Alexander Efimov *On Categorical Smooth Compactifications.*

Abstract: In this talk we disprove two (unpublished) conjectures of Kontsevich which state generalized versions of categorical Hodge-to-de Rham degeneration for smooth and for proper DG categories (but not smooth and proper, in which case degeneration is proved by Kaledin). In particular, we show that there exists a minimal finite-dimensional A_∞-algebra, for which the supertrace of m_3 on the second argument is non-zero.

As a byproduct, we obtain an example of a homotopically finitely presented DG category (over a field of characteristic zero) that does not have a smooth categorical compactification, giving a negative answer to a question of Toën. This can be interpreted as a lack of resolution of singularities in the noncommutative setup.

Mark Green *Hodge Theory and Boundary Components of Moduli of Surfaces.*

Abstract: The main theme of this work, joint with Phillip Griffiths, Radu Laza and Colleen Robles, is that Hodge theory helps to organize and understand the boundary components of the KSBA moduli space. A sub theme is how KSBA singularities affect the limit mixed Hodge structure of the degeneration, and the contrast between KSBA and SSR compactifications of families. The cases we studied, because most of the difficulties of the general case are present, are surfaces with $p_g = 2$, $q = 0$, and $K^2 = 1$ or 2. In the course of this work, we encountered a lot of very beautiful surface geometry, and this talk will give a sample of what we found.

Fabian Haiden *Geometric Flows, Iterated Logarithms, and Balanced Weight Filtrations.*

Abstract: The long term behavior of certain gradient flows, both finite and infinite dimensional, is governed by an algebraically defined balanced weight-type filtration which provides a canonical refinement of the Harder-Narasimhan filtration. In recent joint work with Katzarkov, Kontsevich, and Pandit (arXiv:1802.04123) we consider in detail the case of the Yang-Mills flow on the space of metrics on a holomorphic bundle over a Riemann surface, as well as a modified curve shortening flow on the cylinder. I will discuss these results and how they fit into a philosophy of "categorical Kaehler geometry".

Joe Harris *The Maximal Rank Theorem.*

Abstract: The Brill-Noether theorem establishes a fundamental link between the classical notion of a curve in projective space, given as the zero locus of polynomials, and the (relatively) modern notion of an abstract curve. Specifically, it tells us when and how a given general abstract curve can be embedded in $\mathbb{P}^r$.

But thats just the opening line of the story: having embedded our abstract curve in projective space, we can ask about the geometry and algebra of the image. In particular, we ask what sort of polynomial equations define the image what their degrees are, and how many of them there are. The ***Maximal Rank Conjecture***, recently proved by Eric Larson, gives the answer to this question. In this talk, Ill describe the ideas leading up to this theorem, give an overview of the proof, and discuss the questions that follow.

Dmitry Kaledin *Hyperkahler Metrics, Mixed Hodge Structures and Massey Products.*

Abstract: I want to review an interpretation of mixed $\mathbb{R}$-Hodge structures in terms of bundles on $\mathbb{P}^1$ due to Deligne, and show how this relates a Kahler metric near a point on a manifold, a hyperkahler metric on its cotangent bundle, and a mixed Hodge structure on the algebra of formal functions near the point. If time permits, I will also give some speculations about the meaning of the extension data of this mixed Hodge structure.

Matt Kerr *Apery Extensions.*

Abstract: In an important series of papers, Galkin, Golyshev, and Iritani have introduced the concept of Apery constants of Fano varieties, arising from asymptotics of solutions to their (A-model, irregular) quantum differential equations. In this talk, we propose and give examples of a (B-model, regular) interpretation of these constants in terms of limits of normal functions arising from motivic cohomology classes on the mirror family of Calabi-Yau varieties. The resulting framework leads to a curious conjectural consequence for the hypersurface sections of the Fano varieties themselves.

Radu Laza *Moduli and Periods beyond the Classical Cases.*

Abstract: The period map is the main tool for studying the moduli spaces of abelian varieties and $K3$ surfaces (and a few other related cases such as Hyperkaehlers). After a brief review of the classical case, I will discus an on-going program, joint with Green, Griffiths, and Robles, to use the period map for studying moduli spaces when Griffiths transversality fails. There are two particular cases that seem approachable with our techniques, namely the case of surfaces of general type with $p_g = 2$ and the case of Calabi-Yau 3-folds.

Ernesto Lupercio *Self-Organized Criticality and quantum toric geometry.*

Abstract: In this talk, I will speak about my joint work with Kalinin et al. relating the non-commutative algebraic geometry of toric varieties and the phenomena of self-organized criticality in complex systems.

David Morrison *Higher Chow Groups, van Geemen Lines, and Mirror Symmetry for Open Strings.*

Gregory Pearlstein *Torelli Theorems for Special Horikawa Surfaces and Special Cubic 4-folds.*

Abstract: We will discuss recent work with Z. Zhang on Torelli theorems for bidouble covers of a smooth quintic curve and 2 lines in the plane, and cubic 4-folds arising from a cubic 3-fold and a hyperplane intersecting transversely in $\mathbb{P}^4$.

Colleen Robles *Completion of Period Mappings.*

Abstract: I will present (i) an algebraic compactification of the image of a period map, along with (ii) an extension of the period map to the compactification.

In the case that the period domain is Hermitian (eg, it parameterizes weight one Hodge structures of principally polarized abelian varieties or weight two Hodge Hodge structures of K3 surfaces) we recover the Satake-Baily-Borel compactification and Borel's extension.

The construction (which is joint with M. Green, P. Griffiths and R. Laza) in motivated, in part, by a project to study the boundary components of the KSBA moduli space.

Wilfried Schmid *Hodge Theory and Unitary Representations of Reductive Groups.*

Abstract: Understanding the irreducible unitary representations of reductive Lie groups is the major remaining problem in the representation theory of such groups. I shall describe an algebraic-geometric approach to the study of their unitary representations. This is joint work with Kari Vilonen.

Carlos Simpson *The Ubiquity of Variations of Hodge Structure (II).*

Abstract: We will survey some recent results illustrating the important role played by variations of Hodge structure in the study of local systems over algebraic varieties.

Yuri Tschinkel *Rationality and Unirationality.*

Abstract: I will describe recent advances in these classical problems.

Edward Witten *Developments in Two-Dimensional Gravity.*

Abstract: Recently, Pandharipande, Solomon, Tessler, and Buryak have developed an intersection theory on the moduli space of Riemann surfaces with boundary. I will discuss this subject from the vantage point of topological field theory and matrix models of two-dimensional gravity.