ARITHMETIC AND GEOMETRY OF ALGEBRAIC VARIETIES
WITH SPECIAL EMPHASIS ON
CALABI–YAU VARIETIES AND MIRROR SYMMETRY
OCTOBER 31–NOVEMBER 1, 2009

ABSTRACTS

Vincent Bouchard (University of Alberta)

Topological recursion and Hurwitz numbers

The topological recursion of Eynard and Orantin, which originated in Random Matrix Theory, has already found numerous applications in enumerative geometry. In particular, two years ago we conjectured that the recursion should govern Gromov-Witten theory of toric Calabi-Yau threefolds, and as a special case, Hurwitz theory. The simplest case of Hurwitz numbers has now been proved, by relating the recursion to the cut-and-join equations. In this talk, I will explore the connections between the topological recursion and the cut-and-join equation for Hurwitz numbers. The hope is that similar connections may exist with the cut-and-join approach to the topological vertex, which could be used to prove the conjecture for general toric threefolds and extend it beyond.

Chris Brav (University of Toronto)

Braid groups and Kleinian singularitie

We recall how homological mirror symmetry for Kleinian singularities predicts the action of braid groups on derived categories of coherent sheaves on the minimal resolutions of Kleinian singularities. Building on work of Seidel-Thomas, we show that in fact an extended affine braid group acts faithfully on the derived category and note that this completes Bridgeland's proposed description of spaces of stability conditions associated to Kleinian singularities. This is joint work with Hugh Thomas.

Xi Chen (University of Alberta)

Self rational maps of K3 surfaces

I will talk about my proof that a general K3 surface of genus at least 4 does not admit nontrivial self rational maps.

James Lewis (University of Alberta)

(Co-)Homological Models for Higher Chow Groups

For a smooth complex quasiprojective variety, an explicit description of the regulator map from the higher Chow groups into Beilinson absolute Hodge cohomology was constructed earlier by Kerr, Lewis, Müller-Stach [Compos. 142], and Kerr-Lewis [Invent. 170]. In this talk, I will explore the singular case.

Steven Lu (UQAM, Montreal)

Positivity of the canonical bundle of a hyperbolic manifold

It is well known that the canonical bundle of a compact Riemann surface M, being no other than the complex dual of the tangent bundle, is positive if M is hyperbolic. I will discuss the connection between the abundance conjecture and the solution of the same claim in all dimensions. In particular, the claim is true for a complex projective manifold in dimensions two and three and, in higher dimensions, as soon as M admits a natural fibration with fibers of dimension three or less. A key point comes from Yau's solution to the Calabi conjecture.

This is joint work with Bun Wong and Gordon Heier.

Karol Palka (McGill University/CIRGET)

On the classification of singular Q-acyclic surfaces

Algebraic surfaces with vanishing Betti numbers serve as a class of test examples for working hypothesis as well for conjectures like cancellation problem or Jacobian conjecture, they appear naturally also when studying exotic structures on $\mathbf{C}^n$'s or $\mathbf{C}*$-actions on $\mathbf{C}^n$'s. Singular Q-acyclic surfaces were studied in special cases, mainly under the assumption that the singularities are mild (of quotient type). We will present our recent results on the classification of general singular Q-acyclic surfaces we have obtained in our thesis.

David Ploog (University of Toronto)

Comparing Coxeter functors

Lattices are invariants of singularities which have been studied for a long time. More recently, it has been realised that categories are more fundamental invariants. In some cases, a lattice (and the associated Coxeter element) can be lifted to two very different categories. We give a general result that provides a natural compatibility between those lifts. (Joint with Chris Brav.)

Matthew Szczesny (Boston University)

Feynman graphs, Hecke correspondences, and quasisymmetric functions

I will talk about recent work on the categorical and representation-theoretic structures emerging within Feynman graphs. Feynman graphs can be made into a category somewhat resembling a finitary abelian category. The Hall algebra of this category is the Hopf algebra dual to the Connes-Kreimer Hopf algebra. Hecke correspondences in this category give rise to natural representations of the Connes-Kreimer Lie algebra. Using the Hall algebra philosophy also allows us to construct a Hopf algebra homomorphism from the Connes-Kreimer Hopf algebra to the Hopf algebra of quasisymmetric functions.

Valdemar Tsanov (Queen's University)

Pullbacks in equivariant cohomology of flag varieties

We study equivariant embeddings of homogeneous complex varieties with semisimple automorphism groups. Specifically, given an embedding of semisimple complex Lie groups $G \subset \widetilde{G}$, one can embed the flag variety $X = G/B$ in the flag variety $\widetilde{X} = \widetilde{G}/\widetilde{B}$, provided a choice of Borel subgroups $B \subset \widetilde{B}$ is made. We investigate the properties of the resulting pullback on cohomology of equivariant line bundles

$$H^*(\widetilde{X}, \widetilde{\mathcal{L}}) \longrightarrow H^*(X, \iota^*\widetilde{\mathcal{L}})$$

The Borel-Weil-Bott theorem implies that these cohomology spaces realize irreducible representations of the respective groups $\widetilde{G}$ and G. By Schur's lemma, the G-equivariant pullback is either surjective of zero. The seminal work of Kostant on Lie algebra cohomology contains, among other results, a translation of the equivariant sheaf cohomology to Lie algebra cohomology, and an equivariant Hodge theory in this setting. Using Kostant's theory we aim at necessary and sufficient conditions for nonvanishing of the pullback. The first known result to me in this direction, by Dimitrov and Roth, provides such a condition for the case of diagonal embeddings. In this talk I will present a condition, in terms of Lie algebra cohomology, valid for root embeddings, diagonal embeddings, general embeddings but line bundles with one dimensional cohomology spaces.

This work is done under the supervision of Professor Ivan Dimitrov.

Ursula Whitcher (Harvey Mudd College)

Mirror Manifolds and Discrete Symmetry Groups

One of the first constructions of mirror families of Calabi-Yau three-folds, due to Greene and Plesser, described the mirror family of quintic hypersurfaces in projective space $\mathbf{P}^3$ using a pencil of quintic hypersurfaces with a discrete symmetry group known as the Fermat pencil. More recently, other pencils of quintic hypersurfaces admitting discrete symmetry groups have been used to study new points in the moduli space of the mirror family. We'll describe Picard-Fuchs equations satisfied by forms on these pencils. We will then investigate pencils of K3 surfaces, realized as quartic hypersurfaces of the projective plane, which admit discrete symmetry groups. This talk describes joint work with Charles Doran and Simon Judes.

Noriko Yui (Queen's University)

On the modularity of certain quotients of $K3 \times E$

I will discuss the modularity question for Calabi-Yau threefolds obtained by quotienting $K3 \times E$ by finite group actions, and then resolving singularities. This is a progress report of my joint work with Y. Goto and R. Kloosterman.