Algebraic Geometry
Géométrie algébrique

(Org: **Katrina Honigs** and/et **Nathan Ilten** (Simon Fraser University))

JIM BRYAN, UBC

SUSAN COOPER, University of Manitoba

Viewing Codes Through the Lens of Fat Points

One can associate a linear code to a fat point set in projective space. It is natural to investigate how we can use properties of one of these objects to understand properties of the other. For example, it has been shown that the minimum Hamming distance of the code can be bounded using graded shifts from the graded minimal free resolution of the fat point set. We will investigate such connections for some special families of fat point sets.

MICHAEL GROECHENIG, University of Toronto

Bialynicki-Birula theory for quotient stacks

BB-theory allows one to describe motivic invariants of a variety acted on by a torus in terms of the fixpoints. It is a useful computational tool akin to Morse theory in differential geometry. I will report on joint work in progress with Evan Sundbo devoted to extending Bialynicki-Birula theory to the setting of algebraic stacks.

KALLE KARU, The University of British Columbia

Anisotropy in Stanley-Reisner rings

A smooth projective toric variety defined by a complete simplicial fan satisfies the classical Hard Lefschetz theorem and Hodge-Riemann bilinear relations. I will discuss the extensions of these theorems to the case of not necessarily projective simplicial fans, and more generally, to simplicial homology spheres. We construct an algebra of simplicial spheres, where the algebra operation is the connected sum of spheres. Using this algebra, one can decompose the cohomology ring of a simplicial sphere into elementary pieces and study each piece separately. We apply this to generalize the anisotropy theorem of Papadakis and Petrotou. This is a joint work with Elizabeth Xiao.

ARNAB KUNDU, University of Toronto

Motivic cohomology in mixed-characteristic

Motivic cohomology is a cohomology theory that can be defined internally within Grothendieck's category of motives. Voevodsky developed this theory for smooth varieties, demonstrating its profound connections to algebraic cycles and algebraic K-theory. However, its behavior beyond the smooth case remains less well understood. Building upon recent advancements by Bachmann, Elmanto, Morrow, and Bouis, we establish its $\mathbb{A}^1$-homotopy invariance for a broader class of "smooth" schemes. This is part of ongoing work in collaboration with Tess Bouis.

JAKE LEVINSON, Université de Montréal

Limits in tropical compactifications and tropical psi classes

Tropical intersection theory allows us to express intersections of subvarieties of algebraic tori using piecewise linear data, in particular polyhedral complexes in $\mathbb{R}^n$. In a similar vein, a method due to Katz shows how to use tropical data to compute flat limits of subvarieties X_t of a toric variety Y, where as $t \to 0$, X_t degenerates to a union of boundary strata of Y (with multiplicities). I will describe an extension of this method in which X_t instead degenerates to a union of boundary strata of an appropriately stratified subvariety $\overline{M} \subseteq Y$. Time permitting, I will describe an application to tropical psi classes on the moduli space of genus zero curves. This work is joint with Sean T. Griffin, Rohini Ramadas and Rob Silversmith.

HAGGAI LIU, Simon Fraser University
Moduli Spaces of Weighted Stable Curves and their Fundamental Groups

The Deligne-Mumford compactification, $\overline{M_{0,n}}$, of the moduli space of n distinct ordered points on $\mathbb{P}^1$, has many well understood geometric and topological properties. For example, it is a smooth projective variety over its base field. Many interesting properties are known for the manifold $\overline{M_{0,n}}(\mathbb{R})$ of real points of this variety. In particular, its fundamental group, $\pi_1(\overline{M_{0,n}}(\mathbb{R}))$, is related, via a short exact sequence, to another group known as the cactus group. Henriques and Kamnitzer gave an elegant combinatorial presentation of this cactus group.

In 2003, Hassett constructed a weighted variant of $\overline{M_{0,n}}(\mathbb{R})$: For each of the n labels, we assign a weight between 0 and 1; points can coincide if the sum of their weights does not exceed one. We seek combinatorial presentations for the fundamental groups of Hassett spaces with certain restrictions on the weights. In particular, we express the Hassett space as a blow-down of $\overline{M_{0,n}}$ and modify the cactus group to produce an analogous short exact sequence. The relations of this modified cactus group involves extensions to the braid relations in S_n. To establish the sufficiency of such relations, we consider a certain cell decomposition of these Hassett spaces, which are indexed by ordered planar trees.

AHMAD MOKHTAR, Simon Fraser University
Connectedness of Fano schemes of matrices of bounded rank

Fano schemes are fine moduli spaces that parameterize linear spaces contained in an embedded projective variety. The study of Fano schemes of matrices with bounded rank provides a geometric approach to the classical problem of classifying spaces of matrices with rank conditions. In this talk, I will present a complete combinatorial classification of the connectedness of Fano schemes of matrices with bounded rank. Our approach will treat rectangular, symmetric, and alternating matrices simultaneously. Furthermore, I will characterize the irreducibility of these Fano schemes in the case of symmetric matrices and propose a conjecture for the alternating case.

SHUBHODIP MONDAL, University of British Columbia
Unipotent homotopy theory of schemes

Building on Toen's work on affine stacks, I will discuss a notion of homotopy theory for algebraic varieties, which we call "unipotent homotopy theory". Over a field of characteristic $p > 0$, I will explain how our unipotent homotopy group schemes recover (1) unipotent completion of the Nori fundamental group scheme, (2) p-adic etale homotopy groups, and (3) certain formal group laws arising from algebraic varieties constructed by Artin and Mazur. Time permitting, I will discuss unipotent homotopy types of Calabi–Yau varieties and show that the unipotent homotopy group schemes π_i^U of Calabi–Yau varieties (of dimension n) are derived invariant for all i; the case $i = n$ corresponds to a recent result of Antieau–Bragg. This is a joint work with Emanuel Reinecke.

SHARON ROBINS, Simon Fraser University
Versal Deformations of Smooth Complete Toric Varieties

Deformation theory is a vital tool for understanding the local structure of a moduli space around a fixed object X. A systematic approach to studying infinitesimal deformations of X involves defining a functor, Def_X, that associates, for every local Artin ring, the set of deformations over that ring up to equivalence. Despite a theoretical understanding of Def_X, explicit computations with examples are challenging. In this talk, I will discuss the combinatorial description of Def_X when X is a smooth complete toric variety. This is joint work with Nathan Ilten.

SASHA ZOTINE, McMaster University
Kawaguchi-Silverman for Projective Bundles on Elliptic Curves

The Kawaguchi-Silverman Conjecture is a recent conjecture equating two invariants of a dominant rational map between projective varieties: the *first dynamical degree*, which measures the topological mixing of the map; and the *arithmetic degree*, which measures the complexity of rational points under iteration. Recently, the conjecture was established for several classes of varieties, including projective bundles over any non-elliptic curve. We will discuss my recent work with Brett Nasserden to resolve the elliptic curve case, hence proving the conjecture for all projective bundles on curves.