## IMPANGA**15** abstracts

**David Anderson**

*Determinantal and Pfaffian formulas for classical type degeneracy loci*

In 1974, Kempf and Laksov proved an extension of Giambelli's determinantal formula for the locus of degeneracy of a map of vector bundles. A decade later, Pragacz showed that for maps with symmetries, the appropriate analogue of determinant is a Pfaffian. I will describe recent joint work with William Fulton, in which we identify a new class of degeneracy loci which are represented by Pfaffians, determinants, and combinations of both. The proofs run in parallel across types.

**Anders Buch**

*Puzzles, Gromov-Witten invariants, and equivariant cohomology of two-step flag varieties*

I will speak about a proof of my conjectured puzzle formula for the equivariant Schubert structure constants of two-step flag varieties. This formula generalizes Knutson and Tao's puzzle rule for the equivariant cohomology of Grassmannians, as well as the cohomological puzzle rule for two-step flag varieties that was originally conjectured by Knutson. Thanks to the equivariant version of the 'quantum equals classical' result, my formula specializes to a Littlewood-Richardson rule for the equivariant quantum cohomology of Grassmannians.

**Hélène Esnault**

*Fundamental group of varieties in positive characteristic*

We shall review conjectures and theorems to the aim of showing analogies between the fundamental group of varieties in positive characteristic with the topological fundamental group and it complex linear representations over the complex numbers. In particular, we shall discuss (part of) a recent work with Atsushi Shiho (Tokyo University) on de Jong's conjecture.

**Gerard van der Geer**

*Strata on moduli spaces in positive characteristic*

Moduli spaces in positive characteristic admit stratifications that have no clear analogue in characteristic zero. The moduli and abelian varieties and K3 surfaces are examples of this. We show how one can calculate the cycle classes of such strata. This is joint work with Katsura and Ekedahl.

**Annabelle Hartmann**

*The quotient map on the equivariant Grothendieck ring*

The aim of the talk will be to explain the existence of a well defined quotient map on the $G$-equivariant Grothendieck ring of varieties for an abelian finite group $G$. The main problem here is to compute the class of a quotient of an affine bundle with affine $G$-actions in the Grothendieck ring. I will explain why such a class only depends on the rank and the base of the bundle. I will in particular focus on the problems arising in the case of wild group actions. Here one has to work in the modified Grothendieck ring to be able to handle purely inseparable maps. If time permits, I will apply the result to the quotient of the nearby fiber using motivic integration with Galois actions.

**Thomas Hudson**

*K-theoretic determinantal and Pfaffian formulas for grassmann bundles*

Given a vector bundle $E$ over a smooth scheme $X$, a classical result of Kempf-Laksov describes the Schubert classes of grassmann bundles $Gr(d,E)$ by means of a Jacobi-Trudi determinant whose entries are polynomials in the Chern classes of E and the universal bundle $U_d$. More recently, using a similar geometric framework, Kazarian was able to obtain a Pfaffian formula describing the Schubert classes of the Lagrangian grassmann bundle. In this talk I will present how these determinantal and Pfaffian formulas can be generalized to connective K-theory, an oriented cohomology theory which can be specialized to both the Chow ring and the Grothendieck ring of vector bundles. If time permits I will also treat the case of intermediate grassmann bundles. This is a joint work with T. Ikeda, T. Matsumura, H. Naruse.

**June Huh**

*A tropical approach to a Hodge conjecture for positive currents*

Demailly showed that the Hodge conjecture is equivalent to the statement that any closed $(p,p)$-dimensional current with rational cohomology class can be approximated by linear combinations of algebraic subvarieties, and asked whether any positive closed $(p,p)$-dimensional current with rational cohomology class can be approximated by positive linear combinations of algebraic subvarieties. Using tropical geometric ideas, we construct a positive closed $(p,p)$-dimensional current on a smooth projective variety that does not satisfy the latter statement. This is a joint work with Farhad Babaee.

**Sukmoon Huh**

*Globally generated vector bundles on complete intersection Calabi-Yau threefolds*

Globally generated vector bundles play an important role in classical algebraic geometry. Recently there have been several attempts to classify globally generated vector bundles with small first Chern class on some varieties, for example projective spaces, quadric hypersurface, Segre varieties, complete intersection Calabi-Yau threefolds. In this talk, we introduce the recent work on the classification of globally generated vector bundles on complete intersection Calabi-Yau threefolds of degree 5, 8 and 9 with small first Chern class. The main ingredient is the Hartshorne-Serre correspondence. This is a joint work with E. Ballico and F. Malaspina.

**Toshiyuki Katsura**

*Configurations of smooth rational curves on superspecial K3 surfaces in small characteristics*

Let $C$ be a nonsingular complete curve of genus 2, and let $J(C)$ be the Jacobian variety of $C$. If the characteristic $p$ is not equal to 2, then it is well-known that on the Kummer surface $Km(J(C))$, there exisits Kummer's $16_6$-configuration of

32 smooth rational curves. In this talk we consider supersingular K3 surfaces with Artin invariant 1 in characteristic 2, 3 and 5. Using the theory of abelian surface, we show that on these surfaces there exist various interesting configurations of smooth rational curves. For example, there exists the $16_{12}$-configuration (resp. the $16_{10}$-configuration, resp. the $21_5$-configuration) in characteristic 5 (resp. in characteristic 3, resp. in characteristic 2). I will also explain that these facts relate to Leech roots in lattice theory.

**Maxim Kazarian**

*Gysin homomorphism formula and the Thom polynomials for $\Sigma_{i,j}$ singularities.*

We introduce the formalism of generating series for polylinear expansions. This is a convenient tool to describe the action of the Gysin homomorphism for resolution of singularities in many different settings: for Grassmann and flag bundles, their isotropic and analogues, rank drop singularitiers of linear and quadratic morphisms of vector bundles etc. As an example, we derive a closed formula for Thom polynomials of $\Sigma_{i,j}$ singularities of holomorphic maps.

**JongHae Keum**

*Normal projective surfaces with minimal Betti numbers*

These are normal projective surfaces with the same Betti numbers as the projective plane. They are called 'Q-homology projective planes'. For Q-homology projective planes with only quotient singularities, there is a global bound for the number of singularities. On the classification of such surfaces recent progress will be discussed in this talk.

The study of Q-homology projective planes with only quotient singularities is related to the Algebraic version of Montgomery-Yang Problem. In geometric topology, Montgomery-Yang Problem is related to differentiable circle actions on the 5-dimensional sphere, and its algebraic version is the case where the quotient orbifold space becomes a complex surface.

**Allen Knutson**

*Stratifications modeled on Bruhat cells*

The Schubert stratification on a Bruhat cell has many beautiful properties; it is generated by a single equation (or better yet, torus-invariant anticanonical section), and all its strata are normal, Cohen-Macaulay with rational singularities, and compatibly Frobenius split.

We define a Bruhat atlas on a manifold-with-stratification $M$ as an atlas in the usual sense of differential topology, except we insist that each chart be a stratification-preserving isomorphism of an open set in $M$ with a finite-dimensional Bruhat cell of some Kac-Moody group. In particular, the poset of strata embeds into a Bruhat order.

Our principal examples are $G/B$ (where the strata are intersections of Schubert and opposite Schubert varieties), Grassmannians (where the strata are positroid varieties), more generally partial flag manifolds $G/P$ (where the strata are projected from $G/B$), and wonderful compactifications of groups (where the strata are $B \times B$

orbits intersect $(B_{-}) \times (B_{-})$ orbits). This work is joint with Xuhua He and Jiang-Hua Lu.

**Adrian Langer**

*Vector bundles with integrable connections*

I will talk about boundedness of vector bundles with integrable connections on quasi-projective varieties. The talk is based on a joint work with Hélène Esnault.

**Changzheng Li**

*An equivariant Pieri rule for isotropic Grassmannians*

In this talk, we will introduce an equivariant Pieri rule for Grassmannians of Lie type C, as well as type B and D if time is enough. This is a first manifestly positive formula for isotropic Grassmannians beyond the equivariant Chevalley formula. This is my joint work with Vijay Ravikumar.

**Laurentiu Maxim**

*Characteristic classes of complex hypersurfaces*

An old problem in geometry and topology is the computation of topological and analytical invariants of complex hypersurfaces, e.g. Betti numbers, Euler characteristic, signature, Hodge-Deligne numbers, etc. While the non-singular case is easier to deal with, the singular setting requires a subtle analysis of the intricate relation between the local and global topological and/or analytical structure of singularities. In this talk I will explain how to compute characteristic classes of complex hypersurfaces in terms of local invariants of singularities. This is joint work with S. Cappell, J. Schuermann and J. Shaneson.

**Hong Duc Nguyen**

*Milnor number, discriminant and unfolding of isolated singularities in positive characteristic*

We study the unfoldings (deformations with section) over an algebraic variety of an isolated hypersurface singularity $f$ in $K[[x_1, ..., x_1]]$, where $K$ is an algebraically closed field of arbitrary characteristic. We first show that, for any unfolding $h_t$ over $T$, $t_0$ the sum of Milnor number of $h_t$ is constant in some neighbourhood of $t_o$ in $T$. We then prove the purity of discriminant and show that the discriminant of a semi-universal unfolding has a smooth normalization. As an interesting corollary, we show that if $char(K) = 2$ and if n is odd, then Milnor number of $f$ must be even. Finally we construct a groupoid for unfoldings and get the openness of versality of unfoldings by applying a theorem of Artin. As an application we show that the dimension of $\mu$-constant stratum in the base space of a semiuniversal unfolding is not bigger than right modality of $f$.

**Toru Ohmoto**

*Classical enumerative geometry and Thom polynomials*

We revisit classical formulae of numerical characters of projective surfaces in 3 and 4-spaces, due to G. Salmon, A. Cayley, H. G. Zeuthen, C. Segre etc, from a modern approach of Thom polynomials for singularities of maps. It involves not only stable singularities but also unstable ones of projections. Also we discuss an application of equivariant Chern-Schwartz-MacPherson class to singularity loci.

**Sam Payne**
*Algebraic curves, tropical geometry, and moduli*

Tropical geometry gives a new approach to understanding old questions about algebraic curves and their moduli spaces, synthesizing techniques that range from Berkovich spaces to elementary combinatorics. I will discuss an outline of this method, understanding the general fiber of a degenerating family of curves in terms of the dual graph of its special fiber, along with a range of applications that includes new results on the topology of the moduli space of curves, new proofs of the fundamental theorems in the geometry of linear series, and a new result about the Hilbert function of the general curve of fixed degree and genus in projective space.

**Piotr Pragacz**
*TBA*

**Sławomir Rams**
*On lines on smooth quartic surfaces*

The question what is the maximal number of lines on a smooth (complex) quartic surface appeared already in the 19th century. In 1940 B. Segre claimed to show that the number in question is 64, but his proof was based on false claims on configurations of lines on quartics. In the talk I sketch the proof of the fact that maximal number of lines on a smooth quartic over any algebraically closed field of characteristic $\neq 2,3$ is indeed 64, whereas the maximal number for characteristic 3 is 112. Some results concerning characteristic 2 and higher-degree surfaces should also be presented (joint work with M. Schuett/Hannover).

**Steven Sam**
*Twisted commutative algebras and related structures*

A recent series of results prove finiteness results for degrees of equations or syzygies for families of algebraic varieties by packaging them into a single algebraic structure and proving a noetherian result. I will survey some of this work, mostly related to Segre products of projective spaces and their secant varieties. Twisted commutative algebras appear as auxiliary structures and proving analogs of Hilbert's basis theorem for them has proven to be challenging. I will explain some of my recent work in this direction.

**Alejandro Soto**
*Faithful tropicalization of abelian varieties*

One of the most important objects associated to a Berkovich space is its skeleton. It is a piecewise linear subspace on which the whole space retracts. A well known result of Baker-Payne-Rabinoff says that the skeleton of an elliptic curve can be seen in a suitable tropicalization. These tropicalizations are called faithful. We present the situation of abelian varieties over complete non-archimedean fields. In this case the skeleton is a real torus with an integral structure. This is a joint work with T. Foster, J. Rabinoff and F. Shokrieh.

**Tomasz Szemberg**

*Birational invariance of the bounded negativity*

The Bounded Negativity Conjecture is one of the most challenging problems in lower dimensional algebraic geometry. It predicts that on any smooth algebraic surface the self-intersection of reduced curves is bounded from below. As for nor, it is not even clear if such a property is a birational invariant. I will explain recent investigations in this direction.

**Harry Tamvakis**

*Theta polynomials and degeneracy loci*

In 1902, Giambelli proved that the Schur $S$-polynomials, in the form of Jacobi-Trudi determinants, represent the Schubert classes on type A Grassmannians. The theta and eta polynomials of Buch, Kresch, and Tamvakis are natural analogues of these polynomials for symplectic and orthogonal Grassmannians. In 2009, I showed how these objects may be used to obtain intrinsic and positive polynomial representatives for the cohomology classes of the universal Schubert varieties in $G/P$ bundles, where $G$ is a classical Lie group and $P$ any parabolic subgroup of G. Wilson's double theta polynomials give alternate (but equivalent) formulas for symplectic Grassmannian degeneracy loci, generalizing earlier theorems of Kempf-Laskov, Pragacz, and Kazarian. I will give an overview of these results.

**Orsola Tommasi**

*Cohomological stabilization of complements of discriminants*

The discriminant of the space of complex polynomials of degree d in one variable is the locus of polynomials with multiple roots. Arnol'd proved that the cohomology of the complement of this discriminant stabilizes when the degree of the polynomials grows, in the sense that the $k$-th cohomology group of the space of polynomials without multiple roots is independent of the degree of the polynomials considered. In this talk, I will present a similar stability result for the space of non-singular complex homogeneous polynomials in a fixed number of variables and its rational cohomology and discuss an extension to the more general situation of the space of sections of a very ample line bundle on a fixed non-singular variety. This is inspired by work of Vakil and Wood on stabilization behaviour in the Grothendieck group of varieties.

**Magdalena Zielenkiewicz**

*Push-forwards in equivariant cohomology and residues*

I will show how the push-forward in equivariant cohomology (and in equivariant K-theory) can, in certain cases, be computed using residues at infinity of some complex functions. I will relate this description to the 'nonabelian localization theorem' by L. Jeffrey and F. Kirwan and show some computational applications.