Perspectives in Algebraic Geometry

December 15 – December 19, 2025
B109, IBS, Daejeon, Republic of Korea

Speaker: **Karl Christ** (University of Turin)

Title: Geometry of Severi varieties on toric surfaces

Abstract: In this talk I will give an overview of a series of works together with Xiang He and Ilya Tyomkin on the geometry of Severi varieties of toric surfaces. The main focus will be on the question of their irreducibility, the so called Severi problem, and its applications to the irreducibility of other moduli spaces of curves. Time permitting, I will also discuss a different line of inquiry where we study the number of moduli of the curves in the Severi variety.

Speaker: **Sung Gi Park** (Princeton University)

Title: GIT stability and Hodge structures of hypersurfaces via minimal exponent

Abstract: The moduli space of smooth degree d hypersurfaces in projective space arises as a geometric quotient by linear changes of coordinates and admits a natural GIT compactification. For certain degrees and dimensions, Hodge theory provides a second compactification via the period map, namely the Baily–Borel compactification. Building on recent advances in higher singularities and a new stability criterion using the minimal exponent (a refinement of the log canonical threshold), I will discuss the birational geometry of these two compactifications and highlight consequences for the boundary behavior of the period map.

Speaker: **Lorenzo Barban** (IBS-CCG)

Title: Chow quotients of flag varieties

Abstract: The Chow quotient of a smooth projective variety under a group action was introduced by Kapranov, Sturmfels and Zelevinsky with the aim to construct an intrinsic notion of quotient, which would not depend on a particular choice of a linearization as in the case of the Mumford's GIT quotient. In this talk we report on a joint work with L. E. Solá Conde and G. Occhetta, where we compute the Chow quotient of the complete flag of vector subspaces of 4-dimensional affine space under the action of the maximal torus of $\mathbf{PGL}(4)$. We show that such Chow quotient is a smooth, rational, weak Fano threefold of Picard number 12. We also discuss its

birational geometry, and the relation with the Chow quotients of partial flag varieties.

Speaker: **Shin-young Kim** (Kangwon National University)

Title: Deformation rigidity of some quasi-homogeneous varieties with Picard number one

Abstract: We investigate the global deformation rigidity problem of rational homogeneous manifolds of Picard number one which were developed by Hwang, Mok and others. In particular, we focus on the role of varieties of minimal rational tangents. Starting with similar ideas, we introduce some recent global deformation rigidity results of some quasi-homogeneous varieties, symmetric varieties and horospherical varieties, with Picard number one.

Speaker: **Haidong Liu** (Sun Yat-sen University)

Title: Fano indices of canonical Fano threefolds

Abstract: According to the minimal model program, Fano varieties are fundamental research objects in birational geometry. Some numerical invariants, such as Picard numbers, degrees, Fano indices, play important roles in the classification of Fano threefolds with mild singularities. In this talk, I will show that the optimal upper bound of Fano indices of canonical Fano threefolds is 66. This is a joint work with Chen Jiang.

Speaker: **Lei Song** (Sun Yat-sen University)

Title: Syzygies of ample line bundles on abelian surfaces

Abstract: Cohomological rank functions on polarized abelian varieties were introduced by Jiang and Pareschi. In particular, the first cohomological rank function of the ideal sheaf of a point is closely related to the syzygies of ample line bundles. Using Bridgeland stability conditions, Lahoz and Rojas defined Chern degree functions on polarized surfaces, and showed these coincide with the cohomological rank functions for abelian surfaces. Employing this perspective, we can improve results of Ito and of Rojas concerning the syzygies of ample line bundles on abelian surfaces, and affirmatively answer a question of Gross and Popescu. This is joint work in progress with Chunyi Li and Xiao Wang.

Speaker: **Junho Choe** (KIAS)

Title: Hypercube equations of tangent varieties

Abstract: In this talk we explain how to produce quadratic equations of tangent varieties via multiplication hypercubes (4-way tensors) whose entries are linear forms. Our approach is parallel to the classical matrix-minor technique for equations of higher secant varieties, admitting various "matryoshka"—structural results and speculations. Moreover, such a treatment can be generalized easily and successfully to higher secant varieties of higher osculating varieties.

Speaker: **Claudia Stadlmayr** (University of Neuchâtel)

Title: Del Pezzo surfaces with global vector fields

Abstract: If X is a del Pezzo surface (or a weak del Pezzo, or an RDP del Pezzo), then its automorphism scheme Aut_X is a, possibly non-reduced, affine group scheme of finite type. In particular, X has infinitely many automorphisms if and only if Aut_X is positive-dimensional and then X admits global vector fields. The last implication is an equivalence in characteristic 0, but its converse can fail in positive characteristic. Over the complex numbers, a del Pezzo surface with rational double point singularities admits global vector fields if and only if its minimal resolution, the corresponding weak del Pezzo surface, does. In small characteristics, one implication of this equivalence breaks down due to the existence of non-lifting vector fields on rational double points. I will explain how to overcome these obstacles in order to classify weak and RDP (if $p \neq 2$) del Pezzo surfaces with global vector fields. Further, I will show examples displaying interesting behaviour of such surfaces in small characteristics. This is joint work with G. Martin.

Speaker: **Fei Hu** (Nanjing University)

Title: Parity and symmetry of polarized endomorphisms on cohomology

Abstract: We show that the eigenvalues of any polarized endomorphism acting on the ℓ-adic étale cohomology of a smooth projective variety satisfy certain parity and symmetry properties, as predicted by the standard conjectures. These properties were previously known for Frobenius endomorphisms. Besides the hard Lefschetz theorem, a key new ingredient is a recent Weil's Riemann hypothesis-type result due to J. Xie. We also prove a "Newton over Hodge" type property for abelian varieties and Grassmannians.

Speaker: **Sheng Meng** (ECNU)

Title: On dynamical Iitaka program

Abstract: This program aims to provide a general picture of studying endomorphisms of projective varieties. The main purpose of this program is to seek a new equivariant fibration, especially when the equivariant minimal model program fails. This is a joint work with De-Qi Zhang.

Speaker: **Sukmoon Huh** (Sungkyunkwan University)

Title: Resolution of a rational map from the space of plane cubics

Abstract: The family of plane cubic curves is parametrized by the projective space of dimension nine. The assignment to a plane cubic curve its Hessian cubic is a 3-1 map. The Hessian cubic comes with a non-trivial 2-torsion divisor class, and it allows one to represent the Hessian as the symmetric determinant of a net of cubics. This defines a birational map from the projective space to the Grassmannian $\mathrm{Gr}(3, 6)$. We use the notion of net logarithmic sheaves

to describe this picture and resolve the birational map. This is a joint work with Simone Marchesi and Joan Pons-Llopis.

Speaker: **Wenfei Liu** (Xiamen University)

Title: The Chevalley-Weil formula on higher dimensional compact complex manifolds

Abstract: Let G be a finite automorphism group of a compact Riemann surface $\mathbb{C}$. In the 1930s, Chevalley and Weil described the space of global sections $H^0(C, \omega_C^{\otimes n})$ of the pluricanonical sheaf $\omega_C^{\otimes n}$ as a G-representation, using the fixed points of the G-action to decompose it into irreducible components. In 1980, Ellingsrud and Lønsted generalized this formula to an expression for the Euler (virtual) G-module $\chi^G(C, E) := [H^0(C, E)] - [H^1(C, E)] \in R(G)$ of a G-equivariant locally free sheaf E. Building on this, various refinements of the Chevalley–Weil formula for smooth projective algebraic curves have been developed from different perspectives. However, no attempt has been made to provide a corresponding formula for compact complex manifolds/smooth projective varieties of dimension two or higher. Based on the Atiyah–Singer holomorphic Lefschetz fixed-point formula, in this talk, I will define the (virtual) ramification G-module of the fixed locus and thereby present a higher-dimensional generalization of the Chevalley–Weil formula. This is joint work with Renjie Lyu.

Speaker: **Jeong-Seop Kim** (KIAS)

Title: Weak del Pezzo surfaces with big tangent bundles

Abstract: As projective spaces are the only projective manifolds with ample tangent bundles, the positivity of tangent bundles imposes restrictions on the geometry of the underlying manifolds. There has been recent progress on big tangent bundles, including the classification of del Pezzo surfaces and certain Fano threefolds with big tangent bundles. In this talk, I will present a partial classification of rational surfaces with big tangent bundles whose anticanonical divisors are nef, discuss the limitations of existing methods, and propose an alternative approach via the singularities of their anticanonical models. This talk is based on joint work with Hosung Kim and Yongnam Lee.

Speaker: **Jaehyun Kim** (Ewha Womans University)

Title: Rigid affine cones over singular del Pezzo surfaces

Abstract: It is well known that the affine cone over a Fano variety obtained as the compactification of an $\mathbb{A}^1$-bundle admits a nontrivial additive group action. This correspondence provides a geometric framework for studying the existence of such actions on affine varieties. Within this context, an affine cone is called rigid if it admits no nontrivial additive group action. In this talk, we classify rigid affine cones over certain singular del Pezzo surfaces embedded in weighted projective spaces by proving that the underlying surfaces

have no $\mathbb{A}^1$-bundle structures. This is joint work with In-Kyun Kim and Joonyeong Won.

Speaker: **Sho Tanimoto** (Nagoya University)

Title: Homological stability and arithmetic applications

Abstract: I present our proofs for a version of Manin's conjecture over $\mathbb{F}_q$ for q large and Cohen–Jones–Segal conjecture over $\mathbb{C}$ for rational curves on split quartic del Pezzo surfaces. The proofs share a common method which builds upon prior work of Das–Tosteson. We call this method as homological sieve method. The main ingredients of this method are (i) the construction of bar complexes formalizing the inclusion-exclusion principle and its point counting estimates, (ii) dimension estimates for spaces of rational curves using conic bundle structures, (iii) estimates of error terms using arguments of Sawin–Shusterman based on Katz's results, and (iv) a certain virtual height zeta function revealing the compatibility of bar complexes and Peyre's constant. Our argument verifies the heuristic approach to Manin's conjecture over global function fields given by Batyrev and Ellenberg–Venkatesh, and it is a nice combination of various tools from algebraic geometry (birational geometry of moduli spaces of rational curves), arithmetic geometry (simplicial schemes, their homotopy theory, and Grothendieck–Lefschetz trace formula), algebraic topology (the inclusion-exclusion principle and Vassiliev type method of the bar complexes) and some elementary analytic number theory. This is joint work with Ronno Das, Brian Lehmann, and Phil Tosteson with a help by Will Sawin and Mark Shusterman. If time permits, I also discuss our investigation of homological stability in the context of weak approximation. This is joint work with Yuri Tschinkel.

Speaker: **Wern Yeong** (UCLA)

Title: Hyperbolicity of adjoint linear series on varieties with positive tangent bundle

Abstract: A smooth complex projective variety is Brody hyperbolic if it admits no entire curves, which are non-constant holomorphic maps from the complex line. In 1995, Demailly introduced a (weaker) algebraic analogue of this notion known as algebraic hyperbolicity. In previous joint work with J. Moraga, motivated by Fujita's freeness conjecture, we conjectured that for a polarized smooth projective variety (X, L), a very general section of $|K_X + mL|$ is algebraically hyperbolic whenever $m \geq 3 \dim X + 1$. In this talk, we present some old and new evidence for this conjecture and discuss a proof in the case of projective homogeneous spaces. This is based on joint work with Atsushi Ito, Joaquín Moraga and Debaditya Raychaudhury.

Speaker: **Haesong Seo** (KAIST/IBS-CCG)

Title: Algebraic hyperbolicity of adjoint linear systems on spherical varieties

Abstract: A projective manifold is called hyperbolic if it admits no non-constant holomorphic map from the complex plane. Demailly proved that hyperbolic manifolds are algebraically hyperbolic, meaning that the degrees of curves are bounded in terms of their genera. Motivated by Fujita's conjecture, Moraga and Yeong conjectured that for a smooth projective variety X and an ample divisor A on X, very general elements in the adjoint linear system $|K_X + mA|$ for $m \geq 3 \dim X + 1$ are algebraically hyperbolic. In this talk, we confirm this conjecture for smooth projective spherical varieties with smooth orbit closures. This is based on a joint work with Minseong Kwon.

Speaker: **Luca Rizzi** (IBS-CGP)

Title: On supported deformations and birational isotriviality

Abstract: Consider a family of complex projective varieties, $f\colon X \to B$. It is well known that the general fibers of f are isomorphic if the general Kodaira–Spencer class vanishes. In analogy with this case, it is natural to ask whether the birationality of general fibers can be studied through conditions on the general Kodaira-Spencer class. In this talk, I will show that a natural condition to examine is when the Kodaira–Spencer class is supported on a divisor, i.e. it can be represented, as a cohomology class, by a current with support on this divisor. This talk is based on joint work with Francesco Zucconi.

Speaker: **Gebhard Martin** (University of Bonn)

Title: The Enriques surface of minimal entropy

Abstract: Salem numbers appear naturally as dynamical degrees of isometries of hyperbolic lattices and hence in the study of entropy of surface automorphisms. The conjecturally smallest Salem number is Lehmer's number λ_{10}, which can be realized by automorphisms of K3 surfaces and rational surfaces by work of McMullen. In this talk, I will explain how to generalize a result of Oguiso asserting the non-realizability of λ_{10} for automorphisms of Enriques surfaces over the complex numbers to odd characteristics. Then, I will describe the unique counterexample in characteristic 2. This is joint work with Giacomo Mezzedimi and Davide Veniani.