Titles and Abstracts

December 23, 2024, Monday

Noncommutative invariants for 3-fold flops

Will Donovan
Tsinghua University

Flops of curves on 3-folds have a rich geometry, blending deformation theory and Dynkin combinatorics. In the early 2010s, Wemyss and I introduced a certain noncommutative algebra as an invariant for such curves, to extend classical invariants and to further understand the homological algebra of the 3-fold. After contributions by many people, it is now known that this invariant completely determines the analytic type of the flop, by work of Jasso-Muro and Keller, and by a different method in new work of Karmazyn-Lepri-Wemyss. I will discuss the ingredients in these recent advances.

Finite abelian groups acting on rationally connected threefolds

Konstantin Loginov
HSE University

Finite abelian groups are one of the simplest objects studied in algebra. In turn, rational varieties form a reasonably simple class of varieties considered in algebraic geometry. However, the question of which finite abelian groups can act on rational (or rationally connected) varieties, is far from being an easy question.

In dimension 2 the answer to this question was given by A. Beauville and J. Blanc. In my talk I will consider this question in dimension three.

Boundedness of klt complements on Fano fibrations

Bingyi Chen
Sun Yat-sen University

The theory of complements was introduced by Shokurov when he investigated log flips on threefolds, which turns out to be a very powerful tool in birational geometry. For a Fano fibration from X to Z with X being ϵ-log canonical, Shokurov proposed a conjecture on the boundedness of klt complements, i.e. the existence of klt n-complements for some bounded natural number n. When Z is a point or a curve, this conjecture was proved by Birkar. On the other hand, Birkar proposed another conjecture on the boundedness of the log canonical threshold of a hypersurface on the base space of a Fano fibration. In this talk, I will discuss my recent work on showing the equivalence between these two conjectures and confirming both conjectures when the base space is of dimension two.

Birational geometry of adjoint foliated structures

Jihao Liu
Peking University

We discuss recent progress on the birational geometry of adjoint foliated structures and applications to boundedness and moduli problems of foliations. The talk is based on joint work and ongoing joint works with Paolo Cascini, Jingjun Han, Fanjun Meng, Calum Spicer, Roberto Svaldi, and Lingyao Xie.

Some Chern class inequalities for Fano varieties

Haidong Liu
Sun Yat-sen University

In the classification of varieties with ample (nef and big) anti-canonical divisors, Miyaoka type and Kawamata-Miyaoka type inequalities concerning

the relations between the first and the second Chern classes play an important role. In this talk, I will show some recent progress on these inequalities and their applications. Part of these works are jointed with Masataka Iwai and Chen Jiang, parts are jointed with Jie Liu, and parts are jointed with Chen Jiang and Jie Liu.

<center>**December 24, 2024, Tuesday**</center>

On surjective endomorphisms of projective varieties

<center>**Sheng Meng**
East China Normal University</center>

Let X be a normal projective variety over C. Let f be a surjective endomorphism of X. In this talk, I will try to explain our current program on the classification and the building blocks of (f,X), involving two main tools: equivariant minimal model program and dynamical Iitaka fibration. In this talk, I will focus on its application to the Kawaguchi-Silverman conjecture, which asserts the equality of the arithmetic degree and the first dynamical degree for points of Zariski dense orbit. This is based on several joint works with Guolei Zhong and De-Qi Zhang.

On the Noether inequality for algebraic threefolds

<center>**Meng Chen**
Fudan University</center>

In this lecture I will introduce the outline of a complete proof for the following theorem that the inequality $K^3 \geq 4/3 p_g - 10/3$ holds for all minimal 3-folds of general type, which covers joint works with Jungkai Chen, Yong Hu and Chen Jiang in the past 20 years.

Nonlinear Hodge theory in characteristic p

Mao Sheng

Tsinghua University

We generalize the nonabelian Hodge correspondence in char p, due to Ogus-Vologodsky, to a nonlinear Hodge correspondence in char p. We also generalize the theory of Higgs-de Rham flows in char p, due to Lan-Sheng-Zuo, to a theory of nonlinear Higgs-de Rham flows in char p. These two parts together makes a theory which we shall call nonlinear Hodge theory in char p.

F-trivial vector bundles on curves

Ho Hai Phung

Vietnam Academy of Science and Technology

Let X be a proper scheme over a perfect field k of characteristic $p>0$. F-trivial vector bundles are those vector bundles that become trivial when pulled back by a power of the Frobenius. This concept was introduced by Mehta and Subramanian to study the Nori fundamental group. In this work we report some progress on the study of F-trivial vector bundles on a projective curve.

Calabi-Yau varieties with extreme behavior

Chengxi Wang

Tsinghua University

A projective variety X is called Calabi-Yau if its canonical divisor is Q-linearly equivalent to zero. The smallest positive integer m with mK_X linearly equivalent to zero is called the index of X. Using ideas from mirror symmetry, we construct Calabi-Yau varieties with index growing doubly exponentially with dimension. We conjecture they are the largest index in each dimension based on evidence in low dimensions. This is a joint work

with Louis Esser and Burt Totaro. We also give Calabi-Yau varieties with large orbifold Betti numbers or small minimal log discrepancy.

<p style="text-align:center">December 25, 2024, Wednesday</p>

Smooth projective variety with big tangent bundle

Jeongseop Kim
Korea Institute for Advanced Study

After Mori's solution to Hartshorne's conjecture regarding ample tangent bundles, a series of questions has arisen concerning various positivity of tangent bundles. In the first part of the talk, I will introduce some results focused on the question of big tangent bundles, with recent progress initiated by A. Höring, J. Liu, and F. Shao. I will then present various examples and counterexamples of smooth projective varieties with big tangent bundles, including Fano threefolds, weak del Pezzo surfaces, and projective bundles. This talk is based on joint work with Hosung Kim and Yongnam Lee.

On deformation invariants of higher rank flag sheaves over complex surfaces and threefolds.

Artan Sheshmani
BIMSA

We study moduli space of holomorphic triples E1--->E2, composed of torsion-free sheaves Ei,i=1,2 and a holomorphic mophism between them, over a smooth complex projective variety of dimensions 1,2,3. The triples are equipped with Schmitt stability condition. We observe that when Schmitt stability parameter q(m) becomes sufficiently large, the moduli space of triples benefits from having a perfect relative and absolute deformation-obstruction theory in some cases. We further generalize our construction by gluing triple moduli spaces, and extend the earlier work of Gholampour-Sheshmani-Yau [Adv in Math, Vol 365, 13, May 2020]

where the obstruction theory of nested Hilbert schemes over the surface was studied. Here we extend the earlier results to the moduli space of chains $E1- \to E2- \to \cdots - \to En$, where maps are injective morphisms and $\mathrm{rk}(Ei) \geq 1, \forall i.$ There is a connection, by wallcrossing in the master space in the sense of Mochizuki, between the theory of such higher rank flags, and the theory of Higgs pairs on the supporting variety, which provides the means to relate the flag invariants to the local DT invariants of surfaces, threefold, and 4 folds given by total space of a line bundle on the base variety. In case where the base variety is a surface, and the line bundle is the canonical bundle, such DT invariants provide the means to compute the contribution of higher rank flag sheaves to partition function of the well known Vafa-Witten theory on X.

Derived Categories and Rational Points for a class of toric Fano varieties

Lamarche Alicia
Tsinghua University

In forthcoming work with Matthew Ballard, we use the derived category of coherent sheaves to detect the existence of rational points on a particular family of arithmetic toric Fano varieties. More precisely, in this talk I will explain how we show that a member of this family is rational if and only if its bounded derived category of coherent sheaves admits a full étale exceptional collection.

Motivic mass formulas and permutation quotient singularities

Takehiko Yasuda
Osaka University

Krasner, Serre and Bhargava showed mass formulas for counting extensions of local fields. As an application, we can prove that quotient singularities by permutation actions are always canonical in any characteristic. This strengthens the previously known fact that such

singularities are log canonical, as a consequence of the fact that such singularities are F-pure, which was observed by Hochster and Huneke.

Generic MMP and a uniform termination

Zhengyu Hu
Chongqing University of Techonology

Given a log smooth family of projective pairs $(X,B) \to Z$, together with a divisor M which is nef on very general fibres, this gives the structure of polarised pairs (X_z,B_z+M_z) on very general fibres. Suppose some of them have minimal models. Then we can run a relative MMP near these fibres and after finite steps the MMP terminates near these fibres. This is joint with Caucher Birkar.

December 26, 2024, Thursday

Kahler-Ricci shrinkers and Fano fibrations

Song Sun
Zhejiang University

In this talk I will discuss complete (possibly non-compact) gradient shrinking Kahler-Ricci solitons, also known as Kahler-Ricci shrinkers, which are differential geometric objects arising from the study of singularities of Kahler-Ricci flows. We will first connect Kahler-Ricci shrinkers to algebraic geometry by showing that they are naturally quasi-projective varieties and admit the structure of a polarized Fano fibration (in the sense of minimal model program). The proof uses the boundedness result of Birkar for Fano type varieties. Then we will explain a Yau-Tian-Donaldson type conjecture for the existence of Kahler-Ricci shrinkers and a 2-step degeneration picture for determining a Kahler-Ricci shrinker at a finite time singularity of Kahler-Ricci flow. The latter is similar to the setting of metric tangent cones for singular Kahler-Einstein metrics. Based on joint work with Junsheng Zhang, arXiv:2410.09661.

Simplicial arrangements and the geometry of planar cubic curves

Guillaume Tahar
BIMSA

In their solution to the orchard-planting problem, Green and Tao established a structure theorem which proves that in a line arrangement in the real projective plane with few double points, most lines are tangent to the dual curve of a cubic curve. We provide geometric arguments to prove that in the case of a simplicial arrangement, the aforementioned cubic curve cannot be irreducible. Combining this theorem with a rigidity result on regular simplicial arrangements, we obtain that Grünbaum's conjectural asymptotic classification of simplicial arrangements holds under the additional hypothesis of a linear bound on the number of double points. This is a joint work with Dmitri Panov.

On boundedness of complements for arbitrary coefficients

Jingjun Han
Fudan University

The theory of complements introduced by Shokurov plays a key role in the recent development of birational geometry, including the solution of Borisov-Alexeev-Borisov conjecture and the algebraic version of Yau-Tian-Donaldson conjecture. These applications mainly based on the boundedness of complements for finite rational coefficients proved by Birkar.

In this talk, I will report on our progress on the boundedness of complements in recent years, mainly focus on the case when the coefficient set is [0,1]. The talk is based on joint works with Guodu Chen, Yang He, Jihao Liu, Vyacheslav Shokurov, Lingyao Xie, and Qingyuan Xue.

Higher dimensional geometric Shafarevich conjecture

Junchao Shentu

University of Science and Technology of China

The classical geometric Shafarevich conjecture posits that the set of admissible families of smooth projective curves of a fixed genus (over a fixed base) is finite. In this presentation, I will elaborate on the higher-dimensional extension of the geometric Shafarevich conjecture, encompassing singular pairs arbitrary Kodaira dimension. This extension is inspired by the development of compact moduli spaces for varieties, specifically the KSBA moduli and Birkar's compact moduli of stable minimal models. Subsequently, I will present findings concerning the geometric Shafarevich conjecture on admissible \epsilon-log canonical families.

Towards Universal Bounds in String Theory

Seung-Joo Lee

Institute of Basic Science

Recent developments in the so-called swampland program indicate that many instances have yet to be found of the intriguing interplay between string theory and algebraic geometry. In this talk, we will review the swampland program from the perspective of the string landscape, and will illustrate such an interplay with a few examples. Our focus will mostly be on the 6-dimensional QFT models obtained by compactifying F-theory on elliptic Calabi-Yau varieties.