Topology of complex algebraic varieties
May 30th - June 3rd 2016

Ekaterina Amerik: Automorphisms of hyperkähler manifolds via lattice embeddings.

This is a joint work with Misha Verbitsky. In an earlier paper we have shown that the Beauville-Bogomolov squares of classes bounding the Kähler cone on an irreducible holomorphic symplectic manifold are bounded in absolute value (a version of the Morrison-Kawamata cone conjecture). A recent refinement of this result states that the bound in question only depends on the topology of the manifold. This allows us to show that e.g. every irreducible holomorphic symplectic manifold with $b_2 \geq 5$ has a deformation admitting a positive entropy automorphism, by studying the primitive sublattices in the second cohomology.

Nicolas Bergeron: On O'Grady's generalized Franchetta conjecture.

Consider the universal polarized K3 surface $X \longrightarrow \mathcal{K}_g$ of degree $2g-2$. It was asked by O'Grady if the restriction of any class in $CH^2(X)$ to a closed fiber X_s is a multiple of the Beauville-Voisin canonical class $c_{X_s} \in CH_0(X_s)$. This has strong consequences on the degree 4 rational cohomology of X. I will sketch a proof of these consequences.

Fedor Bogomolov: On invariant domains for automorphisms of infinite order of projective varieties.

The talk is based partly on our joint with Kamenova, Lu and Verbitsky. I will discuss a result which provides a strong restriction on the geometry of invariant open subsets under automorphisms of infinite order in some projective manifolds. It applies to the proof of everywhere degeneration of the Kobayashi pseudo-metrics on such varieties.

Yohan Brunebarbe: A strong hyperbolicity property of locally symmetric varieties.

We show that all subvarieties of a quotient of a bounded symmetric domain by a sufficiently small arithmetic group are of general type.

Frederic Campana: Positive foliations and fibrations with (orbifold) rationally connected fibres.

Foliations with positive minimal slope relatively to a movable class on a complex projective manifold X are shown to correspond exactly to fibrations with rationally connected fibres, extending results by Miyaoka and Bogomolov-Mc Quillan. The proof covers the case of smooth 'orbifold pairs' (X,D) as well, once the notions of tangent bundle, foliation, rational connectedness, and 'rational quotient' are suitably defined in this broader context. This is joint work with M. Paun, relying on previous joint work with T. Peternell.

Serge Cantat: From birational transformations to regular automorphisms.

Birational transformations may have indeterminacy points and they may contract hypersurfaces on lower dimensional subsets. Pseudo-automorphisms are birational transformations acting as regular automorphisms in codimension 1. I shall explain how ideas from geometric group theory can be used to "replace" large groups of birational transformations by groups of pseudo-automorphisms.

Mark de Cataldo: Frobenius semisimplicity and surjectivity

I will discuss a new conjecture concerning the action of Frobenius in cohomology and how to establish it in a couple of cases of geometric interest, also by means of methods valid over $\mathbb{C}$.

Fabrizio Catanese: New examples of rigid varieties and criteria for fibred surfaces to be $K(\pi, 1)$-spaces.

Given an algebraic variety defined by a set of equations, an upper bound for its dimension at one point is given by the dimension of the Zariski tangent space. The infinitesimal deformations of a variety X play a somehow similar role, they yield the Zariski tangent space at the local moduli space, when this exists, hence one gets an efficient way to estimate the dimension of a moduli space.

It may happen that this moduli space consists of a point, or even a reduced point if there are no infinitesimal deformations. In this case one says that X is rigid, respectively inifinitesimally rigid.

A basic example is projective space, which is the only example in dimension 1. In the case of surfaces, infinitesimally rigid surfaces are either the Del Pezzo surfaces of degree ≥ 5, or are some minimal surfaces of general type.

As of now, the known surfaces of the second type are all projective classifying spaces (their universal cover is contractible), and have universal cover which is either the ball or the bidisk (these are the noncompact duals of P^2 and $P^1 \times P^1$), or are the examples of Mostow and Siu, or the Kodaira fibrations of Catanese-Rollenske.

Motivated by recent examples constructed with Dettweiller of interesting VHS over curves, which we shall call BCD surfaces, together with ingrid Bauer, we showed the rigidity of a class of surfaces which includes the Hirzebruch-Kummer coverings of the plane branched over a complete quadrangle.

I shall also explain some results concerning fibred surfaces, e.g. a criterion for being a $K(\pi, 1)$-space; I will finish mentioning other examples and several interesting open questions.

Jeremy Daniel: Variations of loop Hodge structures.

Non-abelian Hodge theory studies the correspondence between flat bundles and Higgs bundles over a compact Kähler manifold. This relation is obtained via the intermediate notion of harmonic bundle. I will explain an equivalence of categories between harmonic bundles and variations of loop Hodge structures, these structures being analogues in infinite dimension of classical Hodge structures. Thanks to this approach, one is able to associate a period map to any harmonic bundle and to mimic the techniques of classical Hodge theory.

Alexandru Dimca: A computational approach to Milnor fiber cohomology

In this talk we consider the Milnor fiber F associated to a reduced projective plane curve C. A computational approach for the determination of the characteristic polynomial of the monodromy action on the first cohomology group of F, also known as the Alexander polynomial of the curve C, is presented. This leads to an effective algorithm to detect all the roots of the Alexander polynomial and, in many cases, explicit bases for the monodromy eigenspaces in terms of polynomial differential forms. The case of line arrangements, where there are many open questions, will illustrate the complexity of the problem. These results are based on joint work with Morihiko Saito, and with Gabriel Sticlaru.

Richard Hain: Galois actions on unipotent fundamental groups of curves.

In this talk I will survey recent progress on the problem of understanding the action of the absolute Galois group on the unipotent fundamental group of an "almost degenerate" curve. I will also discuss its Hodge analogue. This is joint work with Francis Brown.

Vincent Koziarz: Maximal representations of uniform complex hyperbolic lattices

Let Γ be a uniform complex hyperbolic lattice, G a semisimple Lie group of Hermitian type and $\rho : \Gamma \to G$ a representation. I will recall the definition of the Toledo invariant of ρ and show that it satisfies a Milnor-Wood type inequality. By definition, maximal representations are those for which the upper bound is attained. I will prove that they are of a very special type. In particular, up to a representation in a compact subgroup of G, they are rigid. This is a joint work with Julien Maubon.

Madhav Nori: CM Hodge structures.

We discuss an attempt to represent certain Hodge classes on products $X \times A$, where A is an Abelian variety, by algebraic cycles. This is work in progress with Kapil Paranjape.

Mihnea Popa: Hodge ideals.

I will present joint work with M. Mustata, in which we study a sequence of ideals arising naturally from M. Saito's Hodge filtration on the localization along a hypersurface. The multiplier ideal of the hypersurface appears as the first step in this sequence, which as a whole provides a more refined measure of singularities. We give applications to the comparison between the Hodge filtration and the pole order filtration, adjunction, and the singularities of hypersurfaces in projective space and theta divisors on abelian varieties.

Pierre Py: Kähler groups and CAT(0) cubical complexes.

CAT(0) cubical complexes are polyhedral complexes obtained by gluing Euclidean cubes isometrically along faces, and which satisfy moreover a nonpositive curvature assumption. There singular spaces have played a prominent role in geometric group theory in the last few years. Although it is known that actions of Kähler groups on CAT(0) cubical complexes are very constrained, no definitive result on these actions exists so far. In this work, we prove factorization results for actions of Kähler groups on finite dimensional locally finite CAT(0) cubical complexes. Among other results, we prove for instance that if a compact Kähler manifold X has the homotopy type of a compact locally CAT(0) cubical complex, then X must be biholomorphic to a torus bundle over a product of Riemann surfaces. This is a joint work with Thomas Delzant.

Xavier Roulleau: Construction of new simply connected surfaces of general type.

Chern numbers c_1^2, c_2 of a complex minimal surface of general type are topological invariants that satisfies the so called Bogomolov-Miyaoka-Yau inequality: $c_1^2 \leq 3c_2$. By a well-known result of Yau, a surface X satisfies the equality $c_1^2 = 3c_2$ if and only if its universal cover is the unit ball $\mathbb{B}^2$. In that case the fundamental group of X is a discrete, torsion free and co-compact subgroup of $PU(2,1)$, and such a surface is never simply connected. At the end of the 70's Bogomolov asked if one can improve the Bogomolov-Miyaoka-Yau inequality by an inequality of the type $c_1^2 \leq Ac_2$ with $A < 3$ if one suppose moreover that X is simply connected. In this talk, we will explain how to construct simply connected surfaces of general type with c_1^2/c_2 arbitrarily close to 3. Thus the answer to Bogomolov's question is negative. Paradoxically, our construction uses surfaces which are quotient of the unit ball. This is a joint work with G. Urzua.

Stefan Schreieder: A boundedness result for the Chern numbers of Spin threefolds.

Which algebraic invariants of a smooth complex projective variety are determined by the underlying smooth manifold up to finite ambiguity? I will explain that in dimensions at least four, the Chern numbers do in general not have that property. I will then concentrate on the case of threefolds, where we prove that on a given Spin 6-manifold, the Chern numbers of all complex projective structures take on only finitely many values. This is based on joint work with Luca Tasin.

Carlos Simpson: Rank 3 rigid representations of projective fundamental groups.

This is joint with Adrian Langer. Let X be a smooth complex projective variety. We show that every rigid integral irreducible representation $\pi_1(X,x) \to SL(3,C)$ is of geometric origin, i.e. it comes from a family of smooth projective varieties. The underlying theorem is a classification of VHS of type (1,1,1) using some ideas from birational geometry.

Matthew Stover: Variations on an example of Hirzebruch.

In '84, Hirzebruch constructed a very explicit noncompact ball quotient manifold in the process of constructing smooth projective surfaces with Chern slope arbitrarily close to 3. I will discuss how this and some closely related ball quotients are useful in answering a variety of other questions. Some of this is joint with Luca Di Cerbo.

Zhiyu Tian: Fake Tori

I will discuss some results on the structure of algebraic varieties which have the same hodge numbers as those of an abelian variety. This is based on joint work with Jungkai Chen and Zhi Jiang.

Bertrand Toen: Matrix factorizations and Bloch's conductor formula.

This is a joint work in progress with A. Blanc, M. Robalo and G. Vezzosi. For a flat proper scheme over an henselian trait, Bloch's conductor formula relates on the one side a topological invariant (the difference between Euler characteristics of special and generic fibers, suitably modified by the Swan conductor) and on the other side an algebraic invariant given as an intersection number and related to differential forms. This formula is known in some cases, notably when the reduced special fiber is a normal crossing divisor (by the work of Kato-Saito). However, it remains open in general. In this talk I will explain how Bloch's formula can be interpreted as a trace formula in l-adic cohomology for the non-commutative space given by matrix factorizations (where the potential is taken to be the uniformizer of the base). This provides a proof of Bloch's formula under the extra assumption that the monodromy is unipotent. We hope that our method can also be adapted to prove the general case, which I will discuss at the end of the talk if time permits.