

Arithmetic of Algebraic Cycles

Lodha Mathematical Sciences Institute (Mumbai)

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Olivier Benoist

Title: The Pythagoras number of function fields of curves over number fields.

Abstract. The Pythagoras number is a classical invariant of a field K measuring the complexity of sums of squares problems in K . It is defined as the smallest integer $p(K)$ such that any sum of squares in K is a sum of $p(K)$ squares. We will prove that function fields of curves over number fields have Pythagoras number at most 5, answering a question of Pop and Pfister.

Eden Elmanto

Title: On the failure of “étale descent”.

Abstract. I will explain an invariant which measures the failure of “étale descent” in algebraic K -theory, which we named the Lichtenbaum–Quillen dimension. It turns out to be reasonably computable and, over the complex numbers, reveals a connection between unramified cohomology and the derived category of a variety. I will explain some calculations of this invariant and show how it leads to cases of the integral Hodge conjecture for some Fano fourfolds and to computations of algebraic K -groups of Kuznetsov components. This is joint work with Nick Addington.

Lena Ji

Title: Intermediate Jacobians of conic bundles and applications to rationality over non-closed fields.

Abstract. The intermediate Jacobian obstruction is a powerful rationality obstruction that was first used by Clemens–Griffiths to prove non-rationality of smooth complex cubic threefolds. More recently, the framework of intermediate Jacobians was extended to non-closed fields by work of Benoist–Wittenberg, Hassett–Tschinkel, and others, who used it to detect non-rationality of certain geometrically rational threefolds. In this talk, we discuss intermediate Jacobians of conic bundle threefolds over non-closed fields, building on results of Mumford and Beauville over algebraically closed fields. We give applications to rationality questions for geometrically rational conic bundle threefolds. This talk is based on joint work with Sarah Frei, Soumya Sankar, Bianca Viray, and Isabel Vogt, and on joint work with Mattie Ji.

Amit Hogadi

Title: Transfers on \mathbb{A}^1 -connected components of groups and the norm principle.

Abstract. We show that the sheaf of \mathbb{A}^1 -connected components of a quasi-split group over a perfect field is a strictly \mathbb{A}^1 -invariant sheaf with (Voevodsky) transfers. As a consequence, we prove that the norm principle holds for any quasi-split group over a perfect field. This talk is based on ongoing joint work with Anand Sawant.

Jan Lange

Title: Torsion order and irrationality of complete intersections.

Abstract. We present ideas from joint work with Stefan Schreieder, showing that the torsion order of a very general Fano hypersurface of degree $d \geq 4$ and dimension at most $(d+1)2^{d-4}$ over a field of characteristic different from 2 is divisible by 2. In particular, such hypersurfaces are not (retract) rational, generalizing results of Schreieder and Moe. Building on these ideas, we extend the above bound to complete intersections, improving earlier results of Chatzistamatiou–Levine and Nicaise–Ottem. This is joint work with Guoyun Zhang.

Marc Levine

Title: Localization in the minus part via the real realisation.

Abstract. We report on versions of classical Atiyah–Bott localization in the setting of generalized motivic cohomology theories living in the minus part of the motivic stable homotopy category, with main examples given by Witt sheaf cohomology and Witt theory. The main thrust is to replace the classical approach relying on a \mathbb{G}_m -action with one using instead an action by SL_2 or by the normalizer of the torus in SL_2 . We will also discuss recent work involving other groups. The new input involves a description of the real points of BG , based on work of Ambrosi–de Gaay Fortnam and Mantovani–Matszangosz–Wendt, together with Bachmann’s description of the real realisation as ρ -localisation.

Shuji Saito

Title: A canonical integral structure on cohomology of the structure sheaf.

Abstract. A philosophical implication of Grothendieck’s standard conjectures is the existence of an intrinsic integral structure on Weil cohomology theories. This leads to the following question: let K be a complete discrete valuation field with ring of integers R . Is there a canonical integral (that is, an R -lattice) structure on the de Rham cohomology of proper smooth K -schemes, functorial for K -morphisms? I will report on joint work in progress with A. Merici and K. Rülling aiming to answer this question using a variant of tame cohomology theory introduced by Hübner–Schmidt together with rigid analytic geometry. A main result obtained so far gives a positive answer to the question after replacing de Rham cohomology by cohomology of the structure sheaf.

Fumiaki Suzuki

Title: Potential vanishing of degree 3 unramified cohomology over finite fields.

Abstract. The degree 3 unramified cohomology group $H_{\text{nr}}^3(k(X)/k, \mathbb{Q}_\ell/\mathbb{Z}_\ell(2))$ is a birational invariant that plays an important role in the study of codimension 2 cycles. Over the complex numbers, this group may be infinite; a simple example is provided by the triple self-product of the Fermat cubic curve, due to Schoen and Scavia. We show that over a finite field k of characteristic different from 3, if $\ell > 3$ and k is sufficiently large, the degree 3 unramified cohomology group of this product vanishes. We also establish conditional results that hold for arbitrary smooth projective varieties over finite fields. This is joint work with Federico Scavia.

Burt Totaro (online)

Title: Chow groups with twisted coefficients.

Abstract. Rost defined Chow groups of algebraic cycles with coefficients in a locally constant torsion étale sheaf. We generalize this definition to allow non-torsion coefficients. Chow groups with twisted coefficients are related to Serre’s notion of “negligible cohomology” for finite groups. We generalize a computation of Merkurjev and Scavia of negligible cohomology in terms of twisted Chow groups, and compute the Chow groups of the classifying space BG with coefficients in an arbitrary G -module for several finite groups (cyclic, quaternion, and $\mathbb{Z}/2 \times \mathbb{Z}/2$). There are connections with the theory of algebraic tori, notably the concept of coflasque resolutions. We compare twisted Chow groups with twisted motivic cohomology as defined by Heller–Voineagu–Østvær. Surprisingly, there is a surjection from twisted motivic cohomology to twisted Chow groups, but it is not always an isomorphism.

Charles Vial

Title: de Rham–Betti classes with coefficients.

Abstract. For smooth projective varieties defined over the rational numbers, the de Rham–Betti conjecture is an analogue of the Hodge conjecture in which the Hodge filtration on algebraic de Rham cohomology is replaced by its \mathbb{Q} -vector space structure. It is a special case of the Grothendieck Period Conjecture. I will present joint work with Tobias Kreutz and Mingmin Shen exploring the validity of the de Rham–Betti conjecture, and of its variant with coefficients, for abelian varieties and hyperkähler varieties.

Claire Voisin (online)

Title: Boundedness and unboundedness results for zero-cycles on Fano varieties.

Abstract. In 1976, Coray proved a boundedness result for points on cubic surfaces of index 1, namely that such a surface has a point of degree at most 10 coprime to 3 (a bound later improved to 4). A similar boundedness result was subsequently proved by Colliot-Thélène for all del Pezzo surfaces. A related notion of boundedness, introduced by Colliot-Thélène, concerns the group of zero-cycles of a projective variety over a field K : it is said to be bounded if there exists an integer N such that any zero-cycle of degree at least N on X_L , for any extension L of K , is rationally equivalent to an effective one.

The results discussed in this talk are: (1) boundedness of zero-cycles on del Pezzo surfaces (previously proved by Colliot-Thélène under the assumption of a K -point); (2) unboundedness of zero-cycles on certain higher-dimensional Fano varieties, for instance very general quartic threefolds over the complex numbers; and (3) a refinement of Coray's statement, showing that there exists a quartic threefold defined over a field K such that for any odd integer N there is a field extension L/K for which X_L has a point of degree N (hence index 1) but no point of odd degree smaller than N .