2025 Nairobi Workshop in Algebraic Geometry: The 10^{th} Anniversary Workshop

Chiromo Campus, University of Nairobi

15^{th}-19^{th} September 2025

Speakers and Abstracts

1. **Name:** Ettore Aldrovandi
   Affiliation: Florida State University
   Title: Categorifying Algebraic Cycles and Intersection Theory

Abstract

A notable and nowadays classical formula by Bloch and Quillen establishes an isomorphism between the group of rational isomorphism classes of codimension i cycles in a scheme X and the i-the cohomology of X with coefficients in the K-theory sheaf $\mathcal{K}_{i,X}$.

We present a geometrical and categorical interpretation of the Bloch-Quillen formula by assigning to such a cycle a torsor over the abelian anima $B^i\mathcal{K}_{i,X}$, where B forms the classifying stack. For $i = 1$, this is the classical divisors-line bundles correspondence, and we illustrate it in some details in the case $i = 2$, where to a codimension 2 cycle we associate a $\mathcal{K}_{2,X}$-gerbe. In particular, we give an account of the intersection of divisors, and a construction of the Deligne line bundle associated to two divisors on the total space of a fibration of relative dimension 1. If time permits, I will give a few pointers to the full ∞-categorical picture.

This is based on work (partly in progress) in collaboration with Niranjan Ramachandran (UMD) and Maxime Ramzi (Münster).

2. **Name:** Olivia Caramello
   Affiliation: University of Insubria
   Title: Relative Toposes for the Working Mathematician

Abstract

Relativity techniques for schemes have been central to Grothendieck's categorical refoundation of algebraic geometry. In this talk, we introduce analogous techniques for toposes, developed within the framework of stacks and fibrations. These methods provide a flexible and powerful approach to working over arbitrary base toposes, with wide applicability across different areas of mathematics, including geometry, logic and category theory. The material presented includes joint works with Riccardo Zanfa and Léo Bartoli, and is part of a broader program aimed at systematically 'relativizing' topos theory.

3. **Name:** Paolo Aluffi
Affiliation: Florida State University
Title: The Grothendieck Class of the Moduli Space of Pointed Stable Curves of Genus 0

Abstract

The variety $\overline{\mathcal{M}}_{0,n}$ parametrizes stable genus 0 curves with n marked points. This is a central object in algebraic geometry, as the most studied and best understood moduli space of curves. Explicit constructions of this variety have been known for several decades, and recursion formulas for its Poincaré polynomial were obtained more than 30 years ago, but (to our knowledge) a more explicit expression for its Betti numbers was not available. We obtain just such an expression, in the form of an explicit generating function for the class of $\overline{\mathcal{M}}_{0,n}$ in the Grothendieck group of varieties, and gather more information about related generating functions. As an application, we prove an asymptotic form of log concavity for the Poincaré polynomial of $\overline{\mathcal{M}}_{0,n}$. This is joint work with Stephanie Chen, Matilde Marcolli, and Eduardo Nascimento. Our generating function was recently recovered in work of Eur-Ferroni-Matherne-Pagaria-Vecchi.

4. **Name:** Annet Kyomuhangi
Affiliation: Busitema University
Title: On Cohomology of Line Bundles on the Incidence Correspondence

Abstract

The study of cohomology of line bundles on the incidence correspondence (the partial flag variety parametrizing pairs consisting of a point in projective space and a hyperplane containing it) is an important problem at the intersection of algebraic geometry, commutative algebra, and representation theory. Over a field of characteristic zero, this problem is resolved by the Borel–Weil–Bott theorem. We give recursive formulas for cohomology in positive characteristic, and in characteristic 2, we provide non-recursive formulas describing the cohomology characters in terms of truncated Schur polynomials and Nim symmetric polynomials.

This is joint work with Emanuela Marangone, Claudiu Raicu, and Ethan Reed.

5. **Name:** Ben Davidson
Affiliation: University of Edinburgh
Title: Graph Polynomials and Cohomology of Algebraic Varieties

Abstract

I will talk about polynomial invariants of graphs, in particular the chromatic, Kac, and Tutte polynomials. It turns out that it is possible to give the first two an interpretation in terms of cohomology, meaning that we can recover the coefficients of these polynomials as the Betti numbers of topological spaces, which are moreover algebraic varieties. The Tutte polynomial is a two variable polynomial generalising the chromatic and Kac polynomials. I will describe recent work with Michael McBreen on giving the coefficients of the Tutte polynomial a cohomological interpretation too. This enables us to derive new inequalities regarding these coefficients, using techniques from complex geometry.

6. **Name:** Brian Makonzi
   Affiliation: Muni University
   Title: Deformation of Surfaces via Reconstruction Algebras of Type A

Abstract

I will discuss how to use noncommutative resolutions of non-Gorenstein singularities to construct classical deformation spaces, by computing the Artin component of the deformation space of a cyclic surface singularity using only the quiver of the corresponding reconstruction algebra. This extends work of Brieskorn, Kronheimer and Cassens–Slodowy to the setting of quotients of the affine plane by groups $G \leq GL(2, C)$, and also gives a prediction for what is true more generally.

7. **Name:** Francesco Malaspina
   Affiliation: Politechnico di Torino
   Title: A Quick Journey on Ulrich and Instanton Bundles on Projective Varieties

Abstract

There has been increasing interest on the classification of arithmetically Cohen-Macaulay (for short aCM) sheaves on various projective varieties, which is important in a sense that the aCM sheaves are considered to give a measurement of complexity of the underlying space. A special type of aCM sheaves, called the Ulrich sheaves, are the ones achieving the maximum possible minimal number of generators. The notion of instanton bundle over the projective space is important both in theoretical physics and in differential and algebraic geometry. Recently, using derived category techniques, a notion of instanton bundle on Fano varieties with Picard number one has been given by Faenzi and Kuznetsov. In the talk we will discuss how to extend this notion to any polarized projective variety and we will see how the notion of Ulrich bundle can be considered the first step.

8. **Name:** Damas Mgani
   Affiliation: University of Dar es Salam
   Title: Gluing Categories and Gluing Functors

Abstract

In this presentation, we present a novel approach to the concept of mathematical gluing, offering a unified perspective that applies to a wide array of mathematical structures. These structures encompass topological spaces, presheaves, sheaves, ringed topological spaces, locally ringed topological spaces, and schemes. Our approach hinges on introducing two key notions: the 'gluing categories' and the 'gluing functors.' These concepts provide a rigorous and categorical framework for characterizing the gluing process.

In this discussion, we primarily focus on the categorical gluing of topological spaces and presheaves (resp. sheaves), showcasing how the resulting glued-up topological spaces and presheaves (resp. sheaves) can be succinctly described as a limit of a gluing functor. This perspective not only facilitates a more abstract understanding of gluing, but also casts a fresh light on this mathematical concept.

9. **Name:** Sophie Marquez
Affiliation: Stellenbosch University
Title: Galois Descent Theorem in a General Category

Abstract

The theory of descent, originating from the work of Évariste Galois and further developed by mathematicians such as Weil, Grothendieck, and Janelidze, has become a fundamental tool in algebraic geometry and category theory. This talk presents a categorical framework for Galois descent and establishes a Galois descent theorem.

10. **Name:** Caroline Namanya
Affiliation: Makerere University
Title: Derived Autoequivalences on Algebraic Flops

Abstract

In this talk, I will give a construction of derived autoequivalences associated to an algebraic flopping contraction $X \longrightarrow X_{con}$, where X is quasi-projective with only mild singularities. These functors are constructed naturally using bimodule cones.

11. **Name:** Balazs Szendroi
Affiliation: University of Vienna
Title: Around the Coinvariant Algebra

Abstract

The classical coinvariant algebra is the quotient of the coordinate ring of $(A^1)^n = A^n$ by the ideal generated by positive degree invariant polynomials. This algebra plays a basic role in algebraic combinatorics and the representation theory of the symmetric group S_n, equipping its regular representation with a graded algebra structure. I will introduce this algebra, as well as a variant, the projective coinvariant algebra, which is defined using the coordinate ring of $(P^1)^n$ in its Segre embedding. I will discuss some algebraic and combinatorial properties of this construction.

12. **Name:** Vincent Umutabazi
Affiliation: University of Rwanda
Title: Hyperplane Arrangements and Schubert Varieties

Abstract

Given an inversion arrangement of hyperplanes I_w for some element $w \in A_n$ where A_n is a Coxeter group of type A, let $\mathrm{reg}(w) := \Omega^c$ where Ω^c denotes the complement of $\Omega = \mathbb{R}^n \setminus \bigcup I_w$. The aim of this talk is to study Schubert varieties indexed by $w \in A_n$ for which $|\mathrm{reg}(w)| \leq |[e, w]|$, where $[e, w]$ is the initial Bruhat interval of w. We also show that the Schubert variety X_w is rationally smooth if and only if $|\mathrm{reg}(w)| = |[e, w]|$.