Algebraic Geometry and its Broader Implications

a celebration of Robin Hartshorne's 80th and the book's 40th birthday

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Friday, March 23

3:00pm - 4:00pm Lecture Center A1	Joe Harris (Harvard) **The Maximal Rank Theorem**
4:30pm - 5:30pm Lecture Center A1	Arthur Ogus (Berkeley) **Monodromy and Log Geometry**

Saturday, March 24

Coffee & Tea in SEO 300 at 9:00am	
10:00am - 11:00am Lecture Center C4	Robin Hartshorne (Berkeley) **My favorite problems**
11:30am - 12:30pm Lecture Center C4	Marta Casanellas (Barcelona) **The relationship between algebraic geometry and phylogenetics**
Lunch	
3:00pm - 4:00pm Lecture Center C4	Christian Peskine (Jussieu) **Complete intersections of 2 hyperquadrics in $\mathbb{P}^5(\mathbb{C})$ and their Fano varieties (once more)**
4:30pm - 5:30pm Lecture Center C4	Craig Huneke (Virginia) **Unfinished Business: Problems on Local Cohomology**
Banquet at 7:00pm	

Sunday, March 25

Coffee & Tea in SEO 300 at 9:00am	
9:30am - 10:30am Lecture Center C4	Karen Smith (Michigan) **Non-Commutative Resolutions of Singularities for Toric Varieties**
11:00am - 12:00pm Lecture Center C4	David Eisenbud (Berkeley) **Correspondence Scrolls**

Abstracts – Friday, March 23

Lectures are 60 minutes and take place in Lecture Center A1

Joe Harris (Harvard) - 3:00pm
The Maximal Rank Theorem

The Brill-Noether theorem establishes a fundamental link between the classical notion of a curve in projective space, given as the zero locus of polynomials, and the (relatively) modern notion of an abstract curve. Specifically, it tells us when and how a given general abstract curve can be embedded in $\mathbb{P}^r$.

But that's just the opening line of the story: having embedded our abstract curve in projective space, we can ask about the geometry and algebra of the image. In particular, we ask what sort of polynomial equations define the image – what their degrees are, and how many of them there are. *The Maximal Rank Conjecture*, recently proved by Eric Larson, gives the answer to this question. In this talk, I'll describe the ideas leading up to this theorem, give an overview of the proof, and discuss the questions that follow.

Arthur Ogus (Berkeley) - 4:30pm
Monodromy and Log Geometry

Log geometry was developed to study compactification and degeneration phenomena in algebraic and analytic geometry. It is fair to say that log schemes play the role of "algebraic manifolds with boundary." I will attempt to review the main concepts of log geometry and then to illustrate how they help us understand the topology of degenerations in the complex setting. For example, a proper semistable family over a disc gives rise to a smooth proper and saturated morphism X/S of log analytic spaces over the log disc. It turns out that the underlying germ of the map of topological spaces $X_{\text{top}}/S_{\text{top}}$ can be recovered from the log fiber X_0/S_0 of X/S over the log point. Furthermore, there are simple formulas for the d_2 differentials and the action of the monodromy on the E_2 terms of the "nearby cycles" spectral sequence, in terms of the combinatorics of the log structure on X_0/S_0. This is joint work with Piotr Achinger.

Abstracts – Saturday, March 24

Lectures are 60 minutes and take place in Lecture Center C4

Robin Hartshorne (Berkeley) - 10:00am
My favorite problems

I will talk about some problems I have worked on, some solved, some unsolved, together with comments on the life of a mathematician.

Abstracts – Saturday, March 24

Lectures are 60 minutes and take place in Lecture Center C4

Marta Casanellas (Barcelona) - 11:30am

The relationship between algebraic geometry and phylogenetics

Many of the evolutionary models used in phylogenetics can be viewed as algebraic varieties. In this expository talk we will explain the main goals of phylogenetics, introduce evolutionary Markov models on trees, and show how algebraic varieties arise in this context. Moreover, we will see how an in-depth geometric study of these varieties leads to improvements on phylogenetic reconstruction methods. We shall illustrate these improvements by showing results on simulated and real data and by comparing them to widely used methods in phylogenetics.

Christian Peskine (Jussieu) - 3:00pm

Complete intersections of 2 hyperquadrics in $\mathbb{P}^5(\mathbb{C})$ and their Fano varieties (once more)

We return (once more) to the complete intersection of 2 hyperquadrics in $\mathbb{P}^5$ and to its Fano variety of lines (embedded in $G(1,5)$). Both have been widely studied, but we explore (once more) the splendid complexity of their geometry, via ramifications and tangencies, with a special interest for (the well known) configurations of 2×16 lines and of 2×16 (genus 2) curves. The central role of "virtual" hyperplane sections of the Fano variety, and in particular of the curve of "ramified lines", is explained. The "Plucker" and "virtual" decomposed hyperplane sections associated to one of the exceptional 96 lines are explored. They explain how to project linearly the Fano variety as a $(2:1)$ cover of a 3-quadratic (resp. a Kummer, a Weddle) surface and as a $(4:1)$ cover of a Del Pezzo surface.

In this construction we see several special linear systems of hypercubics and hyperquartics in the Plucker space. They allow us to describe explicitely the square endomorphism (degree 16) of the Fano variety and the induced covering of degree 32 of the Weddle surface.

This example is part of a work in progress (common with D. Avritzer and L. Koelblen) concerning "inner projections of intersections of hyperquadrics".

Craig Huneke (Virginia) - 4:30pm

Unfinished Business: Problems on Local Cohomology

In the Fall of 1961, Grothendieck gave a seminar on the theory of local cohomology groups of sheaves on preschemes, with notes taken by Robin Hartshorne, and published in Springer's Lecture Notes in Mathematics in 1967. It may be the 40th anniversary of the "book", but it is about the 50th anniversary of these notes!

Local cohomology quickly became a powerful new tool. Papers by Hartshorne, Ogus, Speiser, Peskine and Szpiro in the late 1960s and early 1970s studied the vanishing of local cohomology and its structure.

In this talk we will present some of the unfinished business of understanding the structure of local cohomology. Research in the past few years by many authors have broadened our knowledge of this still active subject.

Abstracts – Sunday, March 25

Lectures are 60 minutes and take place in Lecture Center C4

Karen Smith (Michigan) - 10:30am
Non-Commutative Resolutions of Singularities for Toric Varieties

Fix a local or graded commutative ring R, for example a local ring of a point on a variety. A well-known result of Serre states that R is regular (that is, the corresponding point on the variety is smooth) if and only if R has finite global dimension, that is, if and only if every finitely generated R-module has finite projective dimension. This suggests that finite global dimension might be thought of as a proxy for non-singularity for non-commutative rings as well. One nice example of a non-commutative ring associated to R is the ring of differential operators $D(R)$ on R. If R is regular, this ring of differential operators has finite global dimension, so is "non-singular." But might there be some non-regular rings R which also have the property that $D(R)$ has finite global dimension? In this talk, we explain why coordinate rings of toric varieties always have non-singular rings of differential operators (at least in characteristic p). This result follows from a more general (and characteristic independent) investigation of endomorphism rings of finitely generated modules over coordinate rings of toric varieties, which culminates in a canonical construction of a non-commutative resolution of singularities (in the sense of Michel Van den Bergh) as well as a necessary and sufficient condition under which this resolution is crepant. This is joint work with Eleonore Faber and Greg Muller.

David Eisenbud (Berkeley) - 11:00am
Correspondence Scrolls

Rational normal scrolls appear often in algebraic geometry, both as extremal examples and as frameworks on which to build more complicated constructions. For example, some kinds of degenerate K3 surfaces arise this way, and shed some light on the failure in positive characteristic of Green's Conjecture on canonical curves. I'll describe these examples, and a much larger family of constructions to which they belong, from recent joint work of mine with Frank-Olaf Schreyer and Alessio Sammartano.