Schedule, Titles and Abstracts

Schedule

	Tuesday 26	Wednesday 27	Thursday 28	Friday 29
9:00-10:00		R. Friedman	B. Harbourne	
10:00 -11:00		F. Catanese	R. Pardini	A. Zanardini
11:00-11:30		Coffe Break	Coffe Break	Coffe Break
11:30-12:30		M. Teicher	J. Roé	A. F. Lopez
12:30 -15:30		Lunch	Lunch	
15:30 -16:00	Opening			
16:00-17:00	O. Dumitrescu	E. Postinghel	N. Shepherd Barron	
17:00 -17:30	Coffe Break	Coffe Break	Coffe Break	
17:30-18:30	A. Calabri	T. Dedieu	Paola Frediani	

Titles and Abstracts

• On plane Cremona transformations of small degree (Alberto Calabri)
A plane Cremona transformation is a birational map of the projective plane in itself and it is defined by three homogeneous polynomials, with no common factor, of the same degree. We will review the properties of the algebraic variety parametrizing plane Cremona transfomations of fixed degree. Let us say that two plane Cremona transformations f, g are equivalent if there exist two automorphisms a, b of the plane such that $g = a \circ f \circ b$. A description of equivalence classes of cubic planar Cremona transformations has been given by Cerveau and Déserti in 2013, but it is incomplete. We will give a fine and complete classification of equivalence classes of cubic planar Cremona transformations and we will see how to classify equivalence classes of quartic planar Cremona transformations. This is joint work with Nguyen Thi Ngoc Giao.

• On the moduli space of surfaces of general type with $p_g = q = 2$ (Fabrizio Catanese)
While the classification of surfaces of general type with $p_g = q$ is very simple to state for $p_g = q = 3$ or greater (only 3 cases), for $p_g = q = 2$ is an intriguing and open chapter of surface theory. I will speak on recent results, joint with Massimiliano Alessandro and Edoardo Sernesi.

For these surfaces, apart from the elementary cases where the Albanese image is a curve, respectively when K^2 attains its minimal value 4, we have examples with $K^2 = 5, 6, 7, 8$ and with degree d of the Albanese map in the set $\{2, 3, 4, 6\}$, as shown for instance by Penegini's examples of components given by surfaces isogenous to a product (this is the only case where degree d=6 is attained). A component of their moduli space is said to be of the main stream if the map associating to a surface S its Albanese surface $A = Alb(S)$ has image of dimension 3 (hence the component dominates a component of the moduli space of Abelian surfaces). I shall illustrate the status of the classification, and I will then show very simple equations for some components of the main stream, named CHPP, PP4, AC3 surfaces, the letters standing for the names of several authors: Chen-Hacon, Penegini-Polizzi, Alessandro-Catanese (here $K^2 = 5, 6, 6$, $d = 3, 4, 3$).

I shall then describe joint work with Edoardo Sernesi, concerning the branch curve of an Abelian surface with a polarization of type $(1, 3)$: this enables to show the existence of the family AC3.

I shall then describe how these components, in view of the Fourier Mukai transform, can be characterized via some assumption on the Albanese map.

• Extensions of hyperelliptic curves (Thomas Dedieu)
An extension of a curve $C \subset \mathbb{P}^N$ is a surface $S \subset \mathbb{P}^{N+1}$ such that C is a hyperplane section

of S (or, more generally, an r-dimensional variety $Y \subset \mathbb{P}^{N+r-1}$ such that C is a linear section of Y). I will explain how extensions can be studied using ribbons over C, i.e., non-reduced schemes supported on C with the same shape as the first-infinitesimal neighbourhood of C in a surface extension. For a linearly normal hyperelliptic curve C of genus g and degree $d \geq 2g+3$, I will give the classification of surface extensions of C, and the dimension of the projective space parametrizing ribbons over C. We will then see that every ribbon over C can indeed be realized as the first-infinitesimal neighbourhood of C in an extension if and only if $d = 2g+3$. In this case there exists a universal extension of C, i.e., an extension Y of C of large dimension such that every surface extension of C is a linear section of Y.

This is part of a more general program developed together with Ciro Ciliberto. I will concentrate on the hyperelliptic case which is fun to play around with.

• **On 2D TQFT and infinite dimensional Frobenius Algebra (Olivia Dumitrescu)**
Topological Quantum Field Theories (TQFT) were introduced by Atiyah and Segal as a mathematical formalism to interpret ideas from quantum physics. It is well known that finite dimensional Frobenius Algebra classify TQFT of dimension 2. I will discuss a generalization of the set of 2D TQFT axioms to classify infinite dimensional Frobenius Algebras, as well as super Frobenius Algebras. I will discuss the relation to Cohomological Quantum Field theories through the ribbon graphs formalism. This introductive talk, combining ideas from topology and algebra, is based on work in progress with William Davis (UNC).

• **Second fundamental form and higher Gaussian maps (Paola Frediani)**
We will show a relation between higher even Gaussian maps of the canonical bundle on a smooth projective curve of genus at least 4 and the second fundamental form of the Torelli map. This generalises a result obtained by Colombo, Pirola and Tortora on the second Gaussian map and the second fundamental form. As a consequence, we get an estimate for the rank of higher even Gaussian maps.

• **Deformations of Calabi-Yau varieties with log canonical singularities (Robert Friedman)**
The deformation theory of normal complex surfaces with either simple elliptic or cusp singularities was extensively studied in the 1980s, with a view both toward understanding when these singularities are locally smoothable as well as toward relating global smoothings of such surfaces with degenerations of K3 surfaces. The goal of this talk is to survey some of these results and to outline recent joint work with Radu Laza which points to higher dimensional generalizations.

• **Roots from Rick to Recent Research (Brian Harbourne)**
I will provide an overview of how root systems and their Dynkin diagrams have arisen, starting

with work of Rick Miranda and ending with recent work on unexpected hypersurfaces in projective space and geproci sets in projective 3-space.

• Varieties with Ulrich twisted normal, conormal or tangent bundles (Angelo F. Lopez)
As is well known, it is a conjecture that any smooth variety X in $\mathbb{P}^N$ carries an Ulrich vector bundle. Then a natural question arises: consider the bundles usually associated to X in $\mathbb{P}^N$. When are they Ulrich up to twist? Aside from trivial examples, it is easy to see that only $N_X(-k)$ or $N_X^*(k)$ or $T_X(k)$ can be Ulrich for some integer k. For the first two, we will give an almost complete answer. As for the third one, the problem appears to be more difficult and we will present only some partial results. Work in collaboration with D. Raychadhury, A. Casnati and V. Antonelli.

• Stable I-surfaces of index 2 and generalized spin curves of genus 2 (Rita Pardini)
An I-surface is a complex projective surface with $K^2 = 1$, $h^2(\mathcal{O}) = 2$ and ample canonical class. Gorenstein stable I-surfaces are hypersurfaces of degree 10 in $\mathbb{P}(1,1,2,5)$. In order to study 2-Gorenstein I-surfaces we introduce generalized Gorenstein spin curves, namely pairs (C, L) where C is a Gorenstein curve with ample canonical class and L is a torsion free rank 1 sheaf on C with $\chi(L) = 0$ admitting a generically injective map $L \otimes L \longrightarrow \omega_C$. We obtain a complete classification of such pairs with C reduced of genus 2 and derive from it the classification of stable I-surfaces of index 2 with a reduced canonical curve. This is joint work in progress with S.Coughlan, M.Franciosi and S.Rollenske.

• Log Fano blow-ups of mixed products of projective spaces and their effective cones (Elisa Postinghel)
While a classification of log Fano blow-ups of products of copies of $\mathbb{P}^n$ in points in general position and a description of their cones of divisors are available, following work of Mukai, Castravet and Tevelev, Araujo and Massarenti, little is known for blow-ups of mixed products. In this talk I will present some results for blow-ups of $\mathbb{P}^m \times \mathbb{P}^n$ in this direction, based on joint work with T. Grange and A. Prendergast-Smith.

• On the boundary of the Mori cone of general blowups of the plane (Joaquim Roé)
Let $X_n \to \mathbb{P}^2$ be the blowup of the plane at n points in very general position. If n¿9, the shape of the Mori cone of X_n is expected to have a simple description as a consequence of the Segre-Harbourne-Gimigliano-Hirschowitz conjecture, but relatively little has actually been proven. We will report on recent progress in this direction. This is joint work with C. Ciliberto and R. Miranda.

• A bilinear relation on elliptic surfaces (Nicholas Shepherd Barron)
On a Jacobian elliptic surface there are differentials of the second kind that form a basis of

the primitive cohomology. We give a formula for their cup product which is analogous to the classical bilinear relation on curves. This leads to an explicit orthonormal basis of the primitive cohomology.

• **Numbers in the Brain- Can I read your thoughts? (Mina Teicher)**
Unlocking The mystery of the brain is one of the most intriguing challenges of the 21st century. Trying to reveal the real model of brain activity is a target of many mathematicians and physicists, computational neuroscientists, world wide.

In the talk I'll start with a short introduction on what is currently known on the brain, and the challenges of contemporary neuroscience. I shall then focus on two breakthroughs:
1) Using recordings from primates, we disprove the long standing model of firing rate and proved that brain activity is subject to synchronization.
2) We proved using MEG recording from humans that there is a theoretical concept of a number in the brain . More over, we built a classification metric and identify different numbers in recording of brain activity, and using it to determine what number one is thinking on. This was never done before!

I shall also elaborate on work in progress, to differentiate between math gifted students and regular students , from recordings of their brain activity. (not to worry, I will not apply it on the audience...). Later, to differentiate from brain recordings, if one is more talented to algebra or to geometry!

• **GIT for linear systems of hypersurfaces (Aline Zanardini)**
In this talk I will present a possible approach to the problem of classifying linear systems of hypersurfaces (of a fixed degree) in some projective space up to projective equivalence via geometric invariant theory (GIT). In particular, I will discuss some relevant geometric examples. This is based on joint work with Masafumi Hattori.