İzmir Algebraic Geometric Topology Days

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
08:30-09:00	Registration				
09:00-10:00	B. Akyar Møller	A. Degtyarev	T. Etgü	S. Ünver	B. Özbağcı
10:20-11:20	J. L. Dupont	A. Degtyarev	T. Etgü	S. Ünver	B. Özbağcı
11:40-12:40	J. L. Dupont	İ. U. Türkmen	Ö. Kişisel	K. Aker	Ö. Ünlü
LUNCH BREAK					
14:00-15:00	S. Altınok Bhupal	M. Tosun	B. Coşkunüzer	M. Uludağ	Ö. Ünlü
15:20-16:20	S. Altınok Bhupal	M. Tosun	B. Coşkunüzer	M. Uludağ	M. Pamuk A. Beyaz
16:40-17:10	S. Altınok Bhupal		B. Coşkunüzer		
	Opening cocktail (17:10)		Welcome dinner (19:30)		

Kürşat Aker — A field guide to projective spaces

Bedia Akyar Møller — Vector bundles and characteristic classes

Selma Altınok Bhupal — An introduction to algebraic geometry

Ahmet Beyaz — Gromov-Witten invariants

Barış Coşkunüzer — Hyperbolic manifolds

Alexander Degtyarev — Introduction to singular complex plane curves

Johan L. Dupont — Simplicial gerbes and a generalization of Abel's theorem on linear equivalence of divisors

Tolga Etgü — From Morse theory to Heegaard-Floer theory

Özgür Kişisel — Toric varieties

Mehmetçik Pamuk — 4-Manifolds with free or surface fundamental group

Burak Özbağcı — Topology of contact 3-manifolds

Meral Tosun — On resolution of singularities of surfaces

İnan Utku Türkmen — Introduction to Hodge theory

A. Muhammed Uludağ — Hypergeometric galois actions

Özgün Ünlü — 1) Free froup actions on manifolds
2) Group actions on products of spheres (joint with Ergün Yalçın)

Sinan Ünver — Mixed tate motives over dual numbers

A Field Guide to Projective Spaces

Dr. Kürşat Aker

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These lectures notes are designed as an hands-on field guide to lead the reader through a garden of mathematical ideas, techniques, and objects, with projective spaces at its center. Although they are important in their own right, a through understanding of projective spaces and their variants, how they are constructed and how they can be related to other varieties could really help anyone who feels lost in a sea of algebraic geometry. In the notes, the requirements are kept to a minimum, but more sophisticated ideas, techniques and objects are intertwined with the rest.

Keywords: projective spaces, weighted projective spaces, projective bundles.

References

[1] J. Harris, *Algebraic geometry: A first course*, Springer, 1995.

[2] R. Hartshorne, *Algebraic geometry*, Springer 1997.

[3] H. Schenck, *Computational algebraic geomety*, Cambridge University Press, Cambridge, 2003.

[4] M. Reid, *Graded rings, more chapters*, `http://www.warwick.ac.uk/~masda/surf/`

[5] M. Reid, *Rational scrolls, chapters on algebraic surfaces*, `http://front.math.ucdavis.edu/9602.5006`

Vector Bundles and Characteristic Classes

Assist. Prof. Dr. Bedia Akyar Møller

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The target of the talk is to give characteristic classes with real (and complex) coefficients by using the classical Chern-Weil Theory and the bundle theory. It is assumed that you have met the definitions of differential forms, the de Rham complex, the de Rham cohomology group, Lie groups, the de Rham theorem, the simplicial de Rham complex. I will start giving principal G (Lie group) bundles, connections in principal G-bundles and after that I will mention Chern-Weil theory. At the end of the talk I am planning to give some examples of characteristic classes.

Keywords: : bundle theory, curvature, Chern-Weil theory, characteristic classes.

References

[1] J. W. Milnor and J. D. Stasheff, *Characteristic classes*, Annals of Math. Studies **76**, Princeton University Press, Princeton, 1974.

[2] J. L. Dupont, *Curvature and characteristic classes*, Lecture Notes in Mathematics **640**, Springer–Verlag, Berlin–New York, 1978.

[3] J. L. Dupont, *Fibre bundles and Chern-Weil theory*, LNS **69**, Dept. of Math., University of Aarhus, Aarhus, 2003.

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[8] F. Warner, *Foundations of Differentiable Manifolds and Lie groups*, GTM **94**, Springer-Verlag, NewYork, 1983.

An Introduction to Algebraic Geometry

Assist. Prof. Dr. Selma Altınok Bhupal

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The purpose of this talk is to introduce some of basic notations, definitions and theorems of Algebraic Geometry. The main objects of study are algebraic varieties in affine or projective space over a fixed algebraically closed field k. To understand affine varieties we study ideals in the polynomial ring $k = [x_1, x_2, ..., x_n]$. We explain the correspondence between affine varieties and ideals. It follows from the Hilbert Nullstellensatz theorem that the correspondence between affine varieties and radical ideas will be one to one. We define the affine coordinate ring of an affine variety and prove that the krull dimension of the ring is the same as its topological dimension.

In a similar way to the case of affine varieties we will define projective varieties.

Keywords: algebraic sets, Hilbert basis theorem, Hilbert Nullstellensatz theorem, affine varieties, projective varieties.

References

[1] D. Cox, J. Little and D. O'Shea, *Ideals, varieties and algorithms. An introduction to computational algebraic geometry and commutative algebra*, Undergraduate Texts in Mathematics, Springer, New York, 1997.

[2] R. Hartshorne, *Algebraic geometry*, Graduate Texts in Mathematics **52**, Springer–Verlag, New York–Heidelberg, 1977.

[3] H. Matsumara, *Commutative ring theory*, Translated from the Japanese by M. Reid, Second edition, Cambridge Studies in Advanced Mathematics **8**, Cambridge University Press, Cambridge, 1989.

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[7] I. R. Shafarevich, *Basic algebraic geometry 2. Schemes and complex manifolds*, Second edition, Translated from the 1988 Russian edition by Miles Reid, Springer-Verlag, Berlin, 1994.

Gromov-Witten Invariants

Dr. Ahmet Beyaz

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This talk will be a brief explanation of genus 0 Gromov-Witten invariants with a couple of examples.

Keywords: : Gromov-Witten, symplectic manifold.
2000 Mathematics Subject Classification. 14N35, 14J80, 53D05.

References

[1] S. Katz, *Enumerative geometry and string theory*, Student Mathematical Library, vol. 32, American Mathematical Society, Providence, RI, 2006. IAS/Park City Mathematical Subseries. MR **MR2218550** (**2007i:**14054).

[2] D. McDuff and D. Salamon, *J-holomorphic curves and symplectic topology*, American Mathematical Society Colloquium Publications, vol. 52, American Mathematical Society, Providence, RI, 2004. MR **MR2045629** (2004m:53154).

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Hyperbolic Manifolds

Assist. Prof. Dr. Barış Coşkunüzer

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We will start with a brief introduction to hyperbolic geometry. Then, we give a survey of basic results on the classification of hyperbolic 3-manifolds in the last 20 years, and try to draw a fairly complete picture of the field.

Keywords: hyperbolic geometry, classification of hyperbolic 3-manifolds.

References

[1] W. P. Thurston, *Three-dimensional geometry and topology*, Princeton University Press, Princeton, NJ, 1997.

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[3] Y. Minsky, *End invariants and the classification of hyperbolic 3-manifolds*, Current developments in mathematics (2002), 181–217, Int. Press, Somerville, MA, 2003. `http://www.math.yale.edu/~yhm3/research/`

Introduction to Singular Complex Plane Curves

Assoc. Prof. Dr. Alex Degtyarev

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The intent of the mini-course is to give a brief and gentle introduction to such seemingly unrelated topics as singularities, Hodge theory, fundamental groups, Galois covers, $K3$-surfaces, integral bilinear forms, and Grothendieck's *dessins d'enfants*. (The particular subjects are to be chosen depending on time and/or the audience).

We choose for the background problem the computation of the fundamental group of the complement of a singular algebraic curve in the complex projection plane. We start with the basic (and pretty much the only known) approach, namely, Zariski–van Kampen theorem, and work out a few examples, showing that it is natural to expect that the group should depend on the singularities of the curve. We will also try to illustrate that this dependence is much more complicated than one might expect. Then, we will proceed in one or several of the following directions:

1. using the Hodge theory to compute the Alexander polynomial of a curve (as a relatively simple invariant of its fundamental group);

2. using the theory of $K3$-surfaces to obtain certain information about the classification and the fundamental groups of plane sextics;

3. using Grothendieck's *dessins d'enfants* to study trigonal curves in rational ruled surfaces, with applications to plane curves.

Keywords: hyperbolic geometry, classification of hyperbolic 3-manifolds.

References

[1] A. Dimca, *Singularities and topology of hypersurfaces.* Universitext. Springer–Verlag, New York, 1992.

Simplicial Gerbes and a Generalization of Abel's Theorem on Linear Equivalence of Divisors

Prof. Dr. Johan Dupont

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The notion of smooth Deligne cohomology is conveniently reformulated in terms of the simplicial deRham complex. In particular the usual Chern-Weil and Chern-Simons theory are well adapted to this framework. The construction provides representing cocycles in the usual Čech-deRham model for smooth Deligne cohomology called 'gerbes with connection' as they generalize usual Hermitian line bundles with connection. As an application we generalize Abel's classical theorem on linear equivalence of divisors on a Riemannian surface. For every closed submanifold $M^d \subset X^n$ in a compact oriented Riemannian n–manifold, or more generally for any d–cycle Z relative to a triangulation of X, we define a (simplicial) ℓ–gerbe Λ_Z, whose vanishing as a Deligne cohomology class generalizes the notion of 'linear equivalence to zero', so that Abel's theorem remains valid. We also generalize the Abel-Jacobi map.

Keywords: simplicial deRham complex, gerbes with connection, Deligne cohomology, Abel's theorem, Abel-Jacobi map.

References

[1] J.L. Dupont and F.W. Kamber, *Gerbes, simplicial forms and invariants for families of foliated bundles*, Commun. Math. Phys. **253** (2) (2005), 253–282.

[2] J.L. Dupont and F.W. Kamber, *A generalization of Abel's theorem and the Abel–Jacobi map*, Preprint 2008, http://de.arxiv.org/abs/0811.0961

From Morse Theory to Heegaard-Floer Theory

Assoc. Prof. Dr. Tolga Etgü

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We will begin by outlining classical Morse Theory, i.e., the theory of critical points of a real-valued function on a finite dimensional smooth manifold, and its relationship to the homology of the manifold via the chain complex generated by the critical points of the function with boundary operator given by the gradient flow of the function. The second part of the talk will be on Floer's generalization of Morse Theory to an infinite dimensional setting. At the end we will focus on Heegaard-Floer invariants of 3 and 4 dimensional manifolds defined by Ozsvath and Szabo.

Keywords: : smooth manifold, Morse function, Floer homology, Heegaard-Floer invariants.

References

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Toric Varieties

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An n dimensional normal algebraic variety over the complex field which is the Zariski closure of an n dimensional complex torus, and which admits an action of this complex torus extending its standard action on this dense subset is called a toric variety. Toric varieties provide an important class of examples for algebraic varieties, with some features simplified, yet other important characteristics retained. In this talk, I will introduce toric varieties, explain related combinatorial constructions, and outline some of their important appearances in literature.

Keywords: Toric varieties, fans

References

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[2] W. Fulton, *Introduction to Toric varieties*, Princeton University Press, Princeton **NJ**, 1993.

4-Manifolds with Free or Surface Fundamental Group

Dr. Mehmetçik Pamuk

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In this talk we will give a classification of topological 4-manifolds up to s-cobordism when the fundamental group of the manifold is either a free group or a surface group, by studying the group of homotopy classes of homotopy self-equivalences of such 4-manifolds.

Keywords: : 4-manifolds, homotopy self-equivalences, free group, surface group, s-cobordism.

References

[1] I. Hambleton and M. Kreck, *Homotopy Self-Equivalences of 4-manifolds, Mathematische Zeitschrift* **248**, 2004, 147–172.

[2] J. A. Hillman, *PD_4-complexes with free fundamental group*, Hiroshima Math. J. **34**, 2004, 295–306.

[3] J. A. Hillman, *PD_4-complexes with strongly minimal models*, Topology and its Applications **153**, 2006, 2413–2424.

Topology of contact 3-manifolds

Assoc. Prof. Dr. Burak Özbağcı

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This will be an expository talk on contact 3-manifolds. We will begin with fundamental definitions and results in the field with a strong emphasis on the topological aspects of the theory. We will also outline the interactions with the topology of 4-manifolds.

Keywords: contact structures, tight, overtwisted, contact surgery, open book, Lefschetz fibration, fillable.

References

[1] G. Hansjörg, *An introduction to contact topology*, Cambridge Studies in Advanced Mathematics **109**, Cambridge University Press, Cambridge, 2008.

[2] B. Ozbagci and A. Stipsicz, *Surgery on contact 3-manifolds and Stein surfaces*, Bolyai Society Mathematical Studies **13**, Springer-Verlag, Berlin; János Bolyai Mathematical Society, Budapest, 2004.

On Resolution of Singularities of Surfaces

Assoc. Prof. Dr. Meral Tosun

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Let S be a singular variety. We may obtain a non-singular variety X and a proper birational morphism $\pi : X \to S$ such that $X - Sing(S)$ remains the same. The map π is called a resolution of singularities of S or a resolution of S. For some special S a resolution can be found rather easily, for example the cases of plane curves, of toric varieties and of normal surfaces. However, this problem is a complicated question and still studied by many mathematicians. Resolution of complex curves has been obtained in the 19th century by L. Kronecker, M. Noether and A. Brill. The existence of a resolution of complex surfaces has been proved in 1935 by R.J.Walker using the method of H.W. Jung (1908) which was given for hypersurfaces. The first algebraic proof of a resolution of complex surfaces, the existence of a resolution over algebraically closed fields of characteristic zero, has been proved by O. Zariski in 1939. By some extension of O. Zariski's proof, S. Abhyankar solved the problem in 1966 for low dimensional varieties (3-dimensional case was already solved by O. Zariski in 1944) and J.De Jong in 1996 for positive characteristic. Finally, in 1964 H. Hironaka proved the existence of a resolution in characteristic zero in any dimension. The proof was powerful but difficult and by the aim of understanding his proof some other algorithmic approaches have been developed by E.Bierstone and P.Milman, O.Villamayor, S.Encinas and H.Hauser. All of these approaches are based on finding the proper birational map as a sequence of blowing ups. In these lectures, we will try to understand the process of resolution for some surfaces with singularity and the curves on the surfaces passing through the singularity. And, if time permits, we will speak on the deformation of singularities of surfaces.

Keywords: Singularity, blowing up, resolution, deformation of singularities of surfaces.

References

[1] M. Artin, *On isolated rational singularities of surfaces*, Amer. J. Math. **88** (1966), 129–166.

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[3] J. Lipman, *Rational singularities, with applications to algebraic surfaces and unique factorization*, Publ. Math. IHES **36** (1969), 195–279.

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Introduction to Hodge Theory

Res. Assist. İnan Utku Türkmen

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In the first part of the talk I will explain one of the most important and inspirational problems of algebraic geometry: The Hodge Conjecture (Classical From) briefly. In the second part I will talk about my research problem, a variant of Hodge conjecture, namely Hodge-D Conjecture.

Keywords: Hodge conjecture, Hodge-D conjecture, algebraic cycle, cycle class map, higher Chow groups, regulator

References

[1] J. D. Lewis, *A Survey of the Hodge conjecture*, Second edition. Appendix B by B. B. Gordon. CRM Monograph Series **10**, American Mathematical Society, Providence, RI, 1999.

Hypergeometric Galois Actions

Assoc. Prof. Dr. A. Muhammed Uludağ

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I will present a research project to study the action of the absolute Galois group on a class of curves originatings from the study of hypergeometric functions.

Keywords: hypergeometric function, deltahedra, Galois actions, Grothendieck-Teichmüller group, modular group, algebraic fundamental group

References

[1] P. Lochak, *Fragments of non-linear Grothendieck-Teichmüller Theory*, Woods Hole Mathematics, 225–262, Series on Knots and Everything **34**, World Scientific, 2004.

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Free Group Actions on Manifolds

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Given a compact highly connected manifold M without boundary, we will discuss the problem of what group theoretic conditions characterize the finite groups which can act freely on M. The study of this problem breaks up into two distinct aspects: (1) finding group theoretic restrictions on finite groups that can act freely on M; and (2) constructing explicit free actions of finite groups on M. In the case when M is a sphere, the problem is called the topological space form problem and both aspects of this problem have been well studied. As a natural continuation, we will also consider the case when M is a product of two equidimensional spheres and discuss some recently employed methods of constructing such actions.

Key words: finite group actions, surgery, manifolds.

References

[1] D. J. Benson and J. F. Carlson, *Complexity and multiple complexes*, Math. Z. **195** (1987), 221–238.

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Group actions on products of spheres

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The purpose of this talk is to give a feeling for the cohomological methods that are used for studying group actions on topological spaces. I will introduce some basic notions such as G-CW-complexes and prove some well known theorems on group actions on products of spheres. Finally, I will state some problems which are still open and interesting.

Keywords: Group actions, products of spheres, group extensions, free rank of symmetry, G-CW-complexes.

References

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Mixed Tate Motives over Dual Numbers

Assist. Prof. Dr. Sinan Ünver

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We will give a survey of the construction of motives and motivic cohomology and compute the motivic cohomology over the dual numbers in weight 2.

Keywords: polylogarithms, mixed Tate motives, scissors congruence class groups, Hilbert's 3rd problem.

References

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