

INdAM Intensive research period
Perspectives in Lie Theory

Program of activities

Session 3: Algebraic topology, geometric and combinatorial group theory

Period: February 8 – February 28, 2015

All talks will be held in Aula Dini, Palazzo del Castelletto.

Monday, February 9, 2015

- 10:00- 10:40, registration
- 10:40, coffee break.
- 11:10- 12:50, Vic Reiner, *Reflection groups and finite general linear groups*, lecture 1.
- 15:00- 16:00, Michael Falk, *Rigidity of arrangement complements*
- 16:00, coffee break.
- 16:30- 17:30, Max Wakefield, *Kazhdan-Lusztig polynomial of a matroid*
- 17:30- 18:30, Angela Carnevale, *Odd length: proof of two conjectures and properties* (young seminar).

Tuesday, February 10, 2015

- 9:50-10:40, Ulrike Tillmann, *Homology of mapping class groups and diffeomorphism groups*, lecture 1.
- 10:40, coffee break.
- 11:10- 12:50, Karen Vogtmann, *On the cohomology of automorphism groups of free groups*, lecture 1.
- 15:00- 16:00, Tony Bahri, *New approaches to the cohomology of polyhedral products*
- 16:00, coffee break.
- 16:30- 17:30, Alexandru Dimca, *On the fundamental group of algebraic varieties*
- 17:30- 18:30, Nancy Abdallah, *Cohomology of Algebraic Plane Curves* (young seminar).

Wednesday, February 11, 2015

- 9:00- 10:40, Vic Reiner, *Reflection groups and finite general linear groups*, lecture 2.
- 10:40, coffee break.
- 11:10- 12:50, Ulrike Tillmann, *Homology of mapping class groups and diffeomorphism groups*, lecture 2
- 15:00- 16:00, Karola Meszaros, *Realizing subword complexes via triangulations of root polytopes*
- 16:00, coffee break.
- 16:30- 17:30, Matthias Lenz, TBA.
- 17:30- 18:30, Ana-Maria Brecan, *Schubert slices in the combinatorial geometry of flag domains* (young seminar).

Thursday, February 12, 2015

- 9:40- 10:40, Kang-Ju Lee, *Simplicial Tree Numbers of Matroid Complexes* (young seminar)
- 10:40, coffee break.
- 11:10- 12:50, Karen Vogtmann, *On the cohomology of automorphism groups of free groups*, lecture 2.
- 15:00- 16:00, Ivan Marin, *Report on the BMR conjectures*
- 16:00, coffee break.
- 16:30- 17:30, Masahiko Yoshinaga, Worpitzky partition, Eulerian polynomial and Linnel arrangements
- 17:30- 18:30, Ivan Martino, TBA (young seminar).

Friday, February 13, 2015

- 9:50-10:40, Ulrike Tillmann, *Homology of mapping class groups and diffeomorphism groups*, lecture 3
- 10:40, coffee break.
- 11:10- 12:50, Vic Reiner, *Reflection groups and finite general linear groups*, lecture 3.

Monday, February 16, 2015

- 9:40- 10:40, Misha Feigin, *V-systems*
- 10:40, coffee break.
- 11:10- 12:50, Karen Vogtmann, *On the cohomology of automorphism groups of free groups*, lecture 3.
- 15:00- 16:00, Alex Fink, TBA (young seminar)
- 16:00, coffee break.
- 16:30- 17:30, Clément Dupont *Bi-arrangements of hyperplanes and Orlik-Solomon bi-complexes* (young seminar)

Workshop: Combinatorics and Algebraic Topology of Configurations – February 17-20, 2015

Tuesday, February 17, 2015

- 9:30-10:10, Toshitake Kohno, *Conformal blocks and homological representations of braid groups*
- 10:10, coffee break.
- 10:40- 11:20, Mario Marietti, *Special matchings and Kazhdan-Lusztig polynomials*
- 11:30-12:10, Bruno Benedetti, *Balinski's theorem for subspace arrangements*
- 14:30-15:10, Luis Paris, *Convexity of parabolic subgroups in Artin groups*
- 15:10, coffee break.
- 15:40-16:20, Mentor Stafa, Spaces of commuting elements in Lie groups (young seminar).

Wednesday, February 18, 2015

- 9:30-10:10, Emanuele Delucchi, TBA
- 10:10, coffee break.
- 10:40-11:20, Mattias Franz, TBA

Thursday, February 19, 2015

- 9:30-10:10, Federico Ardila, TBA
- 10:10, coffee break.
- 11:30-12:10, Takuro Abe, *Freeness and geometry of line arrangements*
- 14:30-15:10, Caroline Klivans, TBA
- 15:10, coffee break.
- 15:40-16:20, Christin Bibby TBA (young seminar).

Friday, February 20, 2015

- 9:30-10:10, Andrew Berget, TBA
- 10:10, coffee break.
- 10:40- 11:20, Alexander Engstrom, TBA
- 11:30-12:10, Andrzej Weber, *Characteristic classes for Schubert varieties and torus action*
- 14:30-15:10, Eric Babson, TBA
- 15:10, coffee break.
- 15:40-16:20, Thomas Brady, TBA

Monday, February 23, 2015

- 9:30-10:30, Fatemeh Mohammadi, Divisors on graphs, orientations and system reliability (young seminar)
- 10:30, coffee break 11:00- 12:00, Alejandro Adem, TBA
- 14:30- 15:30, Sonja Riedel, TBA (young seminar)
- 15:30, coffee break.
- 16:00- 17:00, Biplab Basak, *Minimal crystallizations of 3-and 4-manifolds* (young seminar)

Tuesday, February 24, 2015

- 9:30- 10:30, Sergey Yuzvinsky, *The higher topological complexity of subcomplexes of products of spheres*
- 10:30, coffee break
- 11:00- 12:00, Alexandru Suciu, TBA
- 14:30- 15:30, Mike Davis, *The action dimension of right-angled Artin groups.*

Wednesday, February 25, 2015

- 9:30- 10:30, Pavle Blagojevich, TBA
- 10:30, coffee break
- 11:00- 12:00, Stefan Papadima, *Arithmetic properties of homology jump loci*
- 14:30- 15:30, Elia Saini, TBA (young seminar)
- 15:30, coffee break

Thursday, February 26, 2015

- 9:30- 10:30, Eva Maria Feichtner, TBA
- 10:30, coffee break
- 11:00- 12:00, Suyoung Choi, *The cohomology ring of small covers and its torsion*
- 14:30- 15:30, Simona Settepanella, TBA
- 15:30, coffee break.

Friday, February 27, 2015

- 9:30- 10:30, Afshin Goodarzi, TBA
- 10:30, coffee break
- 11:00- 12:00, Graham Denham, TBA

Abstracts

Minicourses

Victor Reiner (University of Minnesota)

Reflection groups and finite general linear groups

Abstract: Many results in the combinatorics and invariant theory of reflection groups have q -analogues for the finite general linear groups $GL_n(\mathbb{F}_q)$. These lectures will discuss several examples, and open questions arising in this context.

Ulrike Tillmann (University of Oxford)

Homology of mapping class groups and diffeomorphism groups

Abstract: Mapping class groups and diffeomorphism groups of manifolds play an important role in geometry and topology. We will discuss recent advances in the understanding of their homology exploring homotopy theoretic methods.

Karen Vogtmann (U. of Warwick, UK and Cornell University, USA)

On the cohomology of automorphism groups of free groups

Abstract: Automorphism groups of free groups bear similarities to both lattices in Lie groups and to surface mapping class groups. In this minicourse we will explore the cohomology of these groups using tools from both topology and representation theory.

Seminars

Takuro Abe (Kyoto University)

Freeness and geometry of line arrangements

Abstract: Freeness of line arrangements in the projective plane is intensively studied, and related to geometry and combinatorics of line arrangements. We will show that the freeness of line arrangements are related to Betti numbers of complexified complements, intersection points of lines and so on.

Alejandro Adem (University of British Columbia)

TBA

Federico Ardila (San Francisco State University)

TBA

Eric Babson (University of California at Davis)

TBA

Tony Bahri (Rider University)

New approaches to the cohomology of polyhedral products

Abstract: I shall describe geometric and algebraic approaches to the computation of the cohomology of polyhedral products arising from homotopy theory. A report on joint work with Martin Bendersky, Fred Cohen and Sam Gitler.

Bruno Benedetti (Free University Berlin)

Balinski's theorem for subspace arrangements

Abstract: A graph is called " R -connected" if between any 2 vertices one can find R vertex-disjoint paths. For example, the graph of a polygon is 2-connected. More generally, Balinski's theorem says that the graph of every d -dimensional polytope is d -connected.

Hartshorne's connectedness theorem says that arithmetically Cohen-Macaulay schemes are connected in codimension one. We show a quantitative version of this result: If X is an arithmetically Gorenstein subspace arrangement, then the dual graph of X is r -connected, where r is precisely the Castelnuovo-Mumford regularity. In the very special case when X is the Stanley-Reisner variety of the boundary of a polytope, this recovers Balinski's theorem.

If time permits, we also discuss a very recent extension to dual graphs of projective curves, which is work in progress with Matteo Varbaro and Barbara Bolognese (Northeastern).

Andrew Berget (Western Washington University)

TBA

Pavle Blagojević (Free University Berlin / Mathematical Institute SASA Belgrade)

TBA

Thomas Brady (Dublin City University)

TBA

Suyoung Choi (Ajou University)

The cohomology ring of small covers and its torsion

Abstract: In this talk, we compute cohomology rings of small covers for coefficient ring \mathbb{Q} or \mathbb{Z}/q , where q is an odd integer. In particular, we compute Betti numbers of small covers corresponding to a hypergraph. As an application, for any given odd integer $q > 1$, we construct a real toric manifold whose cohomology ring has a q -torsion.

Mike Davis (Ohio State University)

The action dimension of right-angled Artin groups

Abstract: The action dimension of a discrete group Γ is the smallest dimension of a contractible manifold which admits a proper action of Γ . Associated to any flag complex L there is a right-angled Artin group, A_L . We compute the action dimension of A_L for many L .

Emanuele Delucchi (University of Bremen)

TBA

Graham Denham (University of Western Ontario)

TBA

Alex Dimca (Université Nice Sophia-Antipolis)

On the fundamental group of algebraic varieties

Abstract: We report on recent results relating the syzygies involving the partial derivatives of a homogeneous polynomial f to the geometry of the projective hypersurface $f = 0$ and the associated Milnor fiber $f = 1$.

Alexander Engstrom (Aalto University)

TBA

Michael Falk (Northern Arizona University)

Rigidity of arrangement complements

Abstract: We recall the application of resonance varieties in distinguishing homotopy types of complements of complex line arrangements, and illustrate a new application whereby one reconstructs the underlying matroid from the fundamental group or cohomology ring of the complement. As an example we show the fundamental group of the complexified non-Pappus pseudo-line arrangement is not isomorphic to the fundamental group of any complex hyperplane arrangement complement. The method amounts to a combinatorial framing argument that begs generalization. This is joint work with Emanuele Delucchi.

Eva Maria Feichtner (University of Bremen)

TBA

Misha Feigin (University of Glasgow)

V-systems

Matthias Franz (University of Western Ontario)

TBA

Afshin Goodarzi (Royal Institute of Technology)
TBA

Caroline Klivans (Brown University)
TBA

Toshitake Kohno (Graduate School of Mathematical Sciences, the University of Tokyo)
Conformal blocks and homological representations of braid groups

Abstract: We show that specializations of the homological representations of braid groups are equivalent to the monodromy of the KZ equation with values in the space of null vectors in the tensor product of Verma modules when the parameters are generic. Here the representations of the solutions of the KZ equation by hypergeometric integrals due to Schechtman, Varchenko and others play an important role. By this construction we recover quantum symmetry of the monodromy of KZ connection due to Drinfel'd and myself by means of the action of the quantum groups on twisted cycles. In the case of special parameters corresponding to conformal field theory, we give a description of twisted cycles.

Matthias Lenz (University of Oxford)
TBA

Mario Marietti (Universit Politecnica delle Marche)
Special matchings and Kazhdan-Lusztig polynomials

Abstract: We show how the combinatorial concept of special matching can be used to compute the parabolic Kazhdan-Lusztig polynomials of doubly laced Coxeter groups and of dihedral Coxeter groups. In particular, for this class of groups including all Weyl groups, we generalize to the parabolic setting certain results of Brenti, Caselli, and myself. As a consequence, the parabolic Kazhdan-Lusztig polynomial indexed by u and v depends only on the poset structure of the lower Bruhat interval $[e, v]$ and on which elements of that interval are minimal coset representatives.

Ivan Marin (Université de Picardie-Jules Verne)
Report on the BMR conjectures

Abstract: During the nineties, M. Broué, G. Malle and R. Rouquier proposed a series of conjectures in order to generalize the classical setting of real reflection groups (Coxeter groups, Artin groups, Hecke algebras) to complex reflection groups. I will report on the state-of-art concerning these conjectures, including recent progress by G. Pfeiffer and myself on the one hand, by my student E. Chavli on the other hand.

Carola Meszaros (Cornell University)
Realizing subword complexes via triangulations of root polytopes

Abstract: Subword complexes are simplicial complexes introduced by Knutson and Miller to illustrate the combinatorics of Schubert polynomials and determinantal ideals. They proved that any subword complex is homeomorphic to a ball or a sphere and asked about their geometric realizations. We show that a family of subword complexes can be realized geometrically via triangulations of root polytopes. This implies that a family of β -Grothendieck polynomials are special cases of reduced forms in the subdivision algebra of root polytopes. Based on joint work with Laura Escobar.

Stefan Papadima (IMAR)
Arithmetic properties of homology jump loci

Abstract: I will discuss connections between the algebraic monodromy action in characteristic zero and homology jump loci in positive characteristic

Luis Paris (Universit de Bourgogne)
Convexity of parabolic subgroups in Artin groups

Simona Settepanella (Hokkaido University)
TBA

Alexandru Suciu (Northeastern University)
TBA

Max Wakefield (United States Naval Academy)
Kazhdan-Lusztig polynomial of a matroid

Andrzej Weber (University of Warsaw)
Characteristic classes for Schubert varieties and torus action

Masahiko Yoshinaga (Hokkaido University)
Worpitzky partition, Eulerian polynomial and Linial arrangements

Abstract: We will formulate a generalization of the classical Worpitzky identity in terms of partition of coweight lattice points and generalized Eulerian polynomial introduced by Lam and Postnikov. This can be applied to express characteristic polynomials of the Linial arrangements. Then we will discuss a conjecture by Postnikov and Stanley on the location of zeros of the characteristic polynomials. This talk is based on [arXiv:1501.04955](https://arxiv.org/abs/1501.04955)

Sergey Yuzvinsky (University of Oregon, Eugene)
The higher topological complexity of subcomplexes of products of spheres

Abstract: Topological complexity $TC(X)$ of a topological space X was introduced by M. Farber about 10 years ago as a specialization of the Schwarz genus depending only on the homotopy type of X . About 5 years ago, Yu. Rudyak generalized Farber's definition to obtain higher (s -th) topological complexity $TC_s(X)$ for $s \geq 2$ that coincides with $TC(X)$ for $s = 2$.

For X being the complement of a complex arrangement of hyperplanes there were previous attempts to calculate $TC(X)$. They were successful for particular classes of arrangements such as Coxeter infinite series (Farber and Y.) and generic arrangements (Y., Cohen and Pruidze). In a recent paper by Gonzalez and Grant, TC_s was computed (for an arbitrary s) for the Coxeter series of type A .

In the talk we will give a simple combinatorial condition on arrangements that allows us to calculate TC_s for all complex reflection arrangements. Also we exhibit new upper and lower bounds for TC_s for arbitrary arrangement complements. If time allows we will discuss TC_s for generic arrangements.

Young seminars

Nancy Abdallah (Université Nice Sophia-Antipolis)
Cohomology of Algebraic Plane Curves

Biplab Basak (Indian Institute of Science, Bangalore)
Minimal crystallizations of 3- and 4-manifolds

Christin Bibby (University of Oregon)
TBA

Ana-Maria Brecan (Jacobs University Bremen)
Schubert slices in the combinatorial geometry of flag domains

Angela Carnevale (Università di Roma Tor Vergata)
Odd length: proof of two conjectures and properties

Clément Dupont (MPIM Bonn)
Bi-arrangements of hyperplanes and Orlik-Solomon bi-complexes

Alex Fink (Queen Mary University of London)
TBA

Kang-Ju Lee (Seoul National University)
Simplicial Tree Numbers of Matroid Complexes

Ivan Martino (University of Fribourg)
TBA

Fatemeh Mohammadi (University of Osnabrück)
Divisors on graphs, orientations and system reliability

Sonja Riedel (University of Bremen)
TBA

Elia Saini (Université de Fribourg (CH))
TBA

Mentor Stafa (Tulane University)
Spaces of commuting elements in Lie groups