Monday

9:15 a.m. Coffee & bagels

10:00 a.m. ***Welcoming address***
Joan Birman, Barnard College, Columbia University

10:20 a.m.
Topology of Ending Lamination Space
David Gabai, Princeton
The Ending lamination space is a naturally defined space associated to a surface of negative Euler characteristic that is important in hyperbolic geometry and geometric group theory. We will discuss recent progress on characterizing the topology of these beautiful and mysterious spaces.

11:30 a.m.
Galois and his groups
Peter M. Neumann, Oxford
There are many myths about Évariste Galois and his groups. A by-product of my work to produce a bilingual edition of his mathematical writings has been some new insights into what went on in his mind, and how his concept of group came to be understood and disseminated in the second half of the 19th Century. There are difficult historical questions in this area, and I hope to interest an audience in some of them.

12:30 p.m. Lunch break

2:00 p.m.
Essential triangulations of manifolds
J Hyam Rubinstein, Melbourne
Joint with C Hodgson, H Segerman and S Tillmann.

A one vertex triangulation of a closed manifold is called essential if every edge loop is essential. It is strongly essential if no two edge loops are homotopic keeping the vertex fixed. For compact orientable 3-manifolds with tori boundary, an ideal triangulation of the interior is essential if no edge is homotopic into the boundary tori and strongly essential if no two edges are homotopic, keeping their ends on the boundary. We give three constructions of essential and strongly essential triangulations for closed 3-manifolds with non zero $\mathbb{Z}_2$ homology, for Haken 3-manifolds which are closed or have tori boundaries and for closed Riemannian manifolds with no conjugate points. It is easy to see that geometric triangulations of hyperbolic manifolds are always strongly essential and this is the main motivation for their study.

3:15 p.m.
Veering triangulations admit strict angle structures
Craig Hodgson, Melbourne
(Joint work with Rubinstein, Segerman, Tillmann.)

A basic question in 3-dimensional topology is to relate the combinatorics of a triangulation of a 3-manifold to the geometry of the manifold. In particular, given an ideal triangulation of a cusped hyperbolic 3-manifold we would like to know whether the triangulation are geometric, i.e. realized by positively oriented ideal hyperbolic tetrahedra.

I will describe a new class of "veering triangulations", which includes the veering taut triangulations of Agol, and sketch a proof that each veering triangulation admits a strict angle structure. This is a first step in trying to show that these triangulations are geometric via the volume maximization approach of Rivin and Casson.

4:15 p.m. Coffee

4:45 p.m.
The Margulis lemma for properly convex projective manifolds
Stephan Tillmann, Queensland
In hyperbolic geometry for every dimension, there is a Margulis constant $\mu > 0$ with the following property: If Γ is a discrete group of isometries of hyperbolic space generated by isometries, all of which move a fixed point p a distance at most μ, then Γ is virtually abelian. In joint work with Daryl Cooper and Darren Long, we prove the Margulis lemma under the weaker hypothesis of a properly convex real projective manifold. In this talk, I will sketch the proof of this new version of the lemma.

Tuesday

9:15 a.m. Coffee & bagels

10:00 a.m.
Distinguishing residually finite groups by their finite quotients
Alan Reid, UT Austin
By definition, a residually finite group has a large supply of finite quotient groups. A natural question is to what extent this collection of finite quotients "determines" the group. For example, an old, and basic question is, if G is a residually finite group with the same collection of finite quotient groups as a free group F of rank r, is G isomorphic to F? This talk will discuss this question for various classes of groups G as well as some other related questions.

11:15 a.m.
Representation theory and homological stability
Benson Farb, Chicago

In this talk I will explain some recent work with Tom Church. The story begins when we were working out some cohomology computations for a problem in geometric topology. Hints of a pattern emerged, but we struggled to find a way to describe it. We finally developed a language to do this, and called the phenomenon "representation stability".

As we began to look more broadly we started to see representation stability in many different areas of mathematics: from group cohomology to the topology of configuration spaces to classical representation theory to flag varieties to Lie algebras to algebraic combinatorics. We have been able to apply representation stability to prove theorems and make new predictions in these directions (some since proved by others). Many conjectures remain.

My goal in this talk will be to explain representation stability through examples and applications. I will also explain how Church, Jordan Ellenberg and I are applying this theory in order to compute and explain various combinatorial statistics in number theory. I will try to make this talk accessible to first-year graduate students.

12:15 p.m. Lunch break

2:00 p.m.
Lipschitz Geometry of Complex Singularities
Lev Birbrair, Ceara

I am going to answer the following questions:

1. Why the Lipschitz Geometry of Singularities of Complex Surfaces exists?
2. Why it is nontrivial?
3. How this stuff is related to 3-topology, to real algebraic geometry and to Lipschitz Geometry of Real Surfaces.

This lecture contains some joint works with Walter Neumann, Anne Pichon and Alexandre Fernandes.

3:15 p.m.
The thick-thin decomposition of a normal complex surface
Anne Pichon, Luminy

This is a joint work with Lev Birbrair and Walter Neumann.

We study the geometry of a normal complex surface X in a neighbourhood of a singular point $p \in X$. It is well known that for all sufficiently small $\epsilon > 0$ the intersection of X with the sphere S^{2n-1}_ϵ of radius ϵ about p is transverse, and X is therefore locally "topologically conical," i.e., homeomorphic to the cone on its link $X \cap S^{2n-1}_\epsilon$. However, as shown by Birbrair and Fernandez, (X, p) need not be "metrically conical", i.e. bilipschitz equivalent to a standard metric cone, and in fact, it was shown by Birbrair, Fernandez and Neumann that it rather rarely is.

We describe the decomposition of a normal complex surface singularity into its "thick" and "thin" parts. The former is essentially metrically conical, while the latter shrinks rapidly in thickness as it approaches the origin. The thin part is empty if and only if the singularity is metrically conical.

4:15 p.m. Coffee

4:45 p.m.
Rational homology disk smoothings and log-terminal singularities
Jonathan Wahl, UNC

Does a given compact 3-manifold bound a rational homology disk (or QHD), i.e., a 4-manifold with no non-trivial rational homology? This problem is not completely solved even for lens spaces. The algebro-geometric analogue is to determine normal surface singularities with a smoothing whose Milnor fibre is a QHD. We showed in the early '80s that for cyclic quotient singularities (whose links are lens spaces), these smoothings occur exactly for type $p^2/pq-1$ $(0 < q < p, (p, q) = 1)$. We found other examples, both published and unpublished; all were weighted homogeneous rational singularities, and included 3 triply-infinite families, each based on one of the spherical triples (3, 3, 3), (2, 4, 4), and (2, 3, 6).

The search for symplectic fillings of 3-manifolds attracted interest of symplectic topologists in the last decade, motivated by Seiberg-Witten theory and "rational blow-down" of Fintushel-Stern. A 2008 paper of Stipsicz, Szabó, and Wahl (SSW) gave strong restrictions on the possible resolution dual graphs of such singularities. A recent paper of Bhupal-Stipsicz used (SSW) to prove that for star-shaped resolution graphs (i.e., weighted homogeneous singularities), our old list of examples with QHD smoothings is complete.

This list of surface singularities is not known to arise in any other context. Recent work yields the surprising result that for each example, one may choose the total space of the smoothing (a 3-dimensional singularity) to be a log-terminal singularity. This is a very restrictive class of singularities which arises naturally in Mori theory, for study of questions about higher-dimensional non-singular projective varieties. The result implies that the smoothings themselves are "Q-Gorenstein", an important property of smoothings first studied by Kollár and Shepherd-Barron in 1988.

Wednesday

9:15 a.m. Coffee & bagels

10:00 a.m.
Arithmetic properties of 3-dimensional quantum invariants
Don Zagier, MPIM Bonn

We will discuss various arithmetic and modularity properties of quantum invariants of knot and link complements, 3-manifolds, and knotted graphs.

11:15 a.m.
Gromov-Witten invariants of P^1 and Eynard-Orantin invariants.
Paul Norbury, Melbourne

Eynard and Orantin have recently defined invariants of any compact Riemann surface equipped with two meromorphic functions, as a tool for studying enumerative problems in geometry. I will descibe how these invariants bring new insight into the well-studied problem of the Gromov-Witten invariants of P^1.

12:15 p.m. Lunch break

2:00 p.m.
Random rigidity in the free group
Danny Calegari, CalTech

We prove a rigidity theorem for the geometry of the unit ball in the stable commutator length norm spanned by k random elements of the commutator subgroup of a free group of fixed big length n; such unit balls are C^0 close to regular octahedra. A heuristic argument suggests that the same is true in all hyperbolic groups. This is joint work with Alden Walker.

3:15 p.m.
Efficient position for curves
Saul Schleimer, Warwick

Given a pair of curves on a surface, there is a single best relative position for them: namely, the one that minimizes intersection number. Given a curve and a train track the question is more subtle—the curve may be carried, may "hit efficiently" (be transverse in a topologically nice way), or neither. We will give a complete analysis, an algorithm, and applications. This is joint work with Howard Masur and Lee Mosher.

4:15 p.m. Coffee & computer demonstration

4:45 p.m.
Quasi-isometric classification of 3-manifold groups
Jason Behrstock, CUNY Lehman

Any finitely generated group can be endowed with a natural metric which is unique up to maps of bounded distortion (quasi-isometries). A fundamental question is to classify finitely generated groups up to quasi-isometry. Considered from this point of view, fundamental groups of 3-manifolds provide a rich source of examples. Surprisingly, a concise way to describe the quasi-isometric classification of 3-manifolds is in terms of a concept in computer science called "bisimulation." We will describe this classification and a geometric interpretation of bisimulation. This is joint work with Walter Neumann.

7:00 p.m. Banquet, the James Room, Barnard Hall

Thursday

9:15 a.m. Coffee & bagels

10:00 a.m.
Some early papers by Walter Neumann
Matthias Kreck, HIM Bonn

I would like to report about some of the earlier papers by Walter which deal with questions like fibrations over the circle or cutting and pasting invariants. In addition I want to add some new results and report about application of Walter's results in the last years.

11:15 a.m.
Complete flat 3-manifolds
Bill Goldman, Maryland

This talk will survey examples of geometric structures in dimension 3, and in particular complete affine 3-manifolds. The most interesting examples (due to Margulis and Drumm) have free fundamental group and closely relate to hyperbolic geometry on 3-manifolds. This talk will discuss their geometry and classification.

12:15 p.m. Lunch break

2:00 p.m.
The Quest for the First Volume String
Bob Meyerhoff, Boston College

The figure-eight knot complement and its sibling are the one-cusped hyperbolic 3-manifolds of minimum volume, and this volume is the limit (from below) of a sequence of volumes of closed hyperbolic 3-manifolds. It would be thrilling to identify every one of the hyperbolic 3-manifolds with volumes in this sequence. However, it seems as if we are rather far away from solving this problem. But the following similar problem might be considerably more tractable: Identify the entire collection of one-cusped hyperbolic 3-manifolds whose volumes form the sequence of (one-cusped) volumes approaching the volume of the minimum volume 2-cusped hyperbolic 3-manifolds.

The most natural approach to this problem is via area bounds for the maximal cusp torus in a 1-cusped hyperbolic 3-manifold. Here, we would expect the following dichotomy: either a 1-cusped manifold M is obtained by Dehn surgery on a simple 2-cusped manifold (e.g., a Mom manifold), or the maximal cusped torus for M has unexpectedly large area (dare we hope for area 6?). Further along the path dictated by this approach we would find ourselves desperate to develop tools for finding volume outside the cusp in our 1-cusped manifolds.

This work in progress is joint with D. Gabai and N. Thurston.

3:15 p.m.
Chern-Simons theory and hyperbolic volume
Christian Zickert, Berkeley
We give a simplicial formula for the Chern-Simons invariant of a flat $SL(n, C)$-connection (with unipotent holonomy near the boundary) on a compact 3-manifold. Concrete computations reveal the striking new phenomenon that the imaginary part is often (conjecturally always) an integral linear combination of volumes of hyperbolic manifolds. The formula makes uses of the extended Bloch group, an object introduced by Walter. This is joint work with Stavros Garoufalidis and Dylan Thurston.

4:15 p.m. Coffee

4:45 p.m.
Volume bounds for twisted torus links
Abhijit Champanerkar, CUNY Staten Island
Twisted torus knots and links are given by twisting adjacent strands of a torus link. They are geometrically simple and contain many examples of the smallest volume hyperbolic knots. Many are also Lorenz links. In this talk we will discuss the geometry of twisted torus links and related generalizations. We will give upper bounds on their hyperbolic volume and exhibit many families of twisted torus knots with interesting properties. This is joint work with David Futer, Ilya Kofman, Walter Neumann and Jessica Purcell.

Friday

9:15 a.m. Coffee & bagels

10:00 a.m.
Maps between subgroups of mapping class groups
Martin Bridson, Oxford

I shall describe recent work with Alexandra Pettet and Juan Souto in which we explore maps between subgroups of mapping class groups. In particular we prove that (except in low genus) the abstract commensurator of each of the Andreadakis-Johnson subgroups is the ambient mapping class group.

11:15 a.m.
Canonical decompositions of 3-manifolds and groups.
Gadde Swarup, Melbourne

We describe some developments stemming from a joint paper with Walter Neumann in 1997: "Canonical decompositions of 3-manifolds". The additional ingredients come from the work of Peter Scott on 'interestion numbers'. Most of the work was done with Peter Scott and more recently with Vincent Guirardel.

12:15 p.m. Lunch break

2:00 p.m.
CAT(0)-groups, horosperical limit sets and early Tropical Geometry
Robert Bieri, Frankfurt

Starting point is the invariant $\Sigma^0(G; A) \subseteq Hom(G, \mathbb{R})$, defined when G is a finitely generated group and A a finitely generated G-module. Recall that a homomorphism $\chi : G \to \mathbb{R}$ is in $\Sigma^0(G; A)$ if and only if A is finitely generated over $\{g|\chi(g) > 0\}$. Mind you: THIS IS NOT THE MORE POPULAR GEOMETRIC INVARIANT $\Sigma_{G'} = \Sigma^1(G)$ that Walter Neumann, Ralph Strebel and I came up with in 1987, and which has recently been used to classify fundamental groups of Kaehler manifolds. No, even though $\Sigma^0(G; A)$ does occur as a very special case of the (less important) invariant Σ'_A in the BNS-paper of 1987, it is really only the humble 0-dimensional companion of its noble 1-dimensional brother. Though in the hunt for information in higher dimensions, $\Sigma^0(G; A)$ was woefully neglected.

I will talk on joint work with Ross Geoghegan: One can regard $\Sigma^0(G; A)$ as a subset of the sphere at infinity of the Euclidean G-space $\mathbf{E} = G_{ab} \otimes \mathbb{R}$, and we aim to extend the scope and range of applications by replacing **E** by an arbitrary proper CAT(0)-metric space **M**. We find two invariants $^\circ\Sigma^0(M;A) \subseteq \Sigma^0(M;A)$, both of them generalizing $\Sigma^0(G;A)$. By specialization it turns out that our invariants relate the Groebner Fan of tropical Geometry with horospherical limit sets of discrete groups of Moebius transformations on hyperbolic n-space and (probably) with the spherical building of $SL_n(\mathbb{Q})$.

3:15 p.m.
The Hanna Neumann Conjecture
Igor Mineyev, UIUC

The Hanna Neumann Conjecture asserts a specific upper bound on the rank of the intersection of two finitely generated subgroups in a free group. Walter Neumann proposed a strengthened version of the Hanna Neumann Conjecture (SHNC). We will present two proofs of SHNC: one using the Murray-von Neumann (!) dimension of Hilbert modules, and the other purely in terms of group actions on graphs. The first proof is less technical and allows for generalizations to complexes. The second proof is more explicit for the original SHNC and does not use analysis. The same argument proves more general statements about groups acting on left-ordered complexes. We will also discuss trees, flowers, forests, gardens, and leafages.

4:15 p.m. Coffee

4:45 p.m.
Residually nilpotent groups
Gilbert Baumslag, CCNY

Let G be a group and let $x_1, x_2, \ldots$ be elements of G. The commutator $x_1^{-1}x_2^{-1}x_1x_2$ of x_1 and x_2 is denoted by $[x_1, x_2]$. If H and K are subgroups of G, $gp([h,k] : h \in H, k \in K)$ is denoted by $[H,K]$. The *lower central series*

$$G = \gamma_1(G) \geq \gamma_2(G) \cdots$$

of G is defined inductively by setting $\gamma_{n+1}(G) = [\gamma_n(G), G]$ and the sequence

$$G/\gamma_2, G/\gamma_3(G), \ldots, G/\gamma_n(G), \ldots$$

is called the lower central sequence of G. G is termed residually nilpotent if $\bigcap_{n=1}^{\infty} \gamma_n(G) = 1$. The groups G and H are said to have the same lower central sequences if $G/\gamma_n \cong H/\gamma_n(H)$ for every n.

In 1935 Wilhelm Magnus proved that free groups are residually nilpotent and that an n-generator group ($n < \infty$) with the same lower central sequence as a free group of rank n is free. There are, however, finitely generated residually nilpotent groups with the same lower central series as free groups which are not free. The question is then whether finitely generated groups with the same lower central series have anything in common. In recent, ongoing joint work of mine with Roman Mikhailov and Kent Orr, we have proved that various residually nilpotent groups with the same lower central series are closely related, even isomorphic. The object of this talk is to describe some of this work.

Speakers

Gilbert Baumslag
City College, City University of New York
gilbert.baumslag@gmail.com

Jason Behrstock
Lehman College, City University of New York
jason.behrstock@gmail.com

Robert Bieri
Johann Wolfgang Goethe-Universität, Frankfurt
bieri@math.uni-frankfurt.de

Lev Birbrair
Universidade Federal Do Ceara, Brazil
birb@ufc.br

Martin Bridson
University of Oxford
bridson@maths.ox.ac.uk

Danny Calegari
California Institute of Technology
dannyc@its.caltech.edu

Abhijit Champanerkar
College of Staten Island, City University of New York
abhijit@math.csi.cuny.edu

Benson Farb
University of Chicago
farb@math.uchicago.edu

David Gabai
Princeton University
gabai@princeton.edu

Bill Goldman
University of Maryland
wmg@math.umd.edu

Craig Hodgson
University of Melbourne
C.Hodgson@ms.unimelb.edu.au

Matthias Kreck
Hausdorff Research Inst. for Mathematics, Bonn
kreck@HIM.uni-bonn.de

Bob Meyerhoff
Boston College
meyerhog@bc.edu

Igor Mineyev
University of Illinois at Urbana-Champaign
mineyev@math.uiuc.edu

Peter Neumann
University of Oxford
peter.neumann@queens.ox.ac.uk

Paul Norbury
University of Melbourne
pnorbury@ms.unimelb.edu.au

Anne Pichon
Institut de Mathématiques de Luminy
pichon@iml.univ-mrs.fr

Alan Reid
University of Texas at Austin
areid@math.utexas.edu

Hyam Rubinstein
University of Melbourne
rubin@ms.unimelb.edu.au

Saul Schleimer
University of Warwick
s.schleimer@warwick.ac.uk

Gadde Swarup
University of Melbourne
anandaswarupg@gmail.com

Stephan Tillmann
University of Queensland
tillmann@maths.uq.edu.au

Jonathan Wahl
The University of North Carolina at Chapel Hill
jmwahl@email.unc.edu

Don Zagier
Max Planck Institute for Mathematics, Bonn
Don.Zagier@mpim-bonn.mpg.de

Christian Zickert
University of California, Berkeley
zickert@math.berkeley.edu

Organizers

Jason Behrstock
Lehman College, City University of New York
jason.behrstock@gmail.com

Abhijit Champanerkar
College of Staten Island, City University of New York
abhijit@math.csi.cuny.edu

Ilya Kofman
College of Staten Island, City University of New York
ikofman@math.csi.cuny.edu

Philip Ording
Medgar Evers College, City University of New York
pording@mec.cuny.edu

Stephan Tillmann
University of Queensland
tillmann@maths.uq.edu.au