WINTER BRAIDS VIII
School on braids and low-dimensional topology

CIRM, Marseille
5-9 February, 2018

Organizing committee:
B. Audoux (Marseille), P. Bellingeri (Caen), V. Florens (Pau),
J.B. Meilhan (Grenoble), E. Wagner (Dijon)

- Programme -

	Monday 5th	**Tuesday 6th**	**Wednesday 7th**	**Thursday 8th**	**Friday 9th**
9h00-10h00	Gay I	Amiot I	Brendle II	Amiot III	Boileau III
Coffee break					
10h30-11h30	Brendle I	Gay II	Amiot II	Boileau II	Brendle III
11h35-12h05	Liechti	Feller	Cumplido	Anghel	Ueki
Lunch					
15h-16h	Boileau I	Vera		Gay III	
Coffee break		Flash Talks			
16h30-17h	Kegel	Poster Session		Kjuchukova	
17h05-17h35	Witzel			Meier	
17h40-18h10	Kolay			Lange	

Mini courses

Claire Amiot (Univ. Grenoble Alpes)

Cluster algebras from surfaces and categorification.

In this course I will first introduce cluster algebras associated with a triangulated surface. I will then focus on representation of quivers, and show the strong link between cluster combinatorics and representation theory. The aim will be to explain additive categorification of cluster algebras in this context. All the notions will be illustrated by examples.

Michel Boileau (Univ. Aix-Marseille)

3-manifolds groups and related topics

Recent years have seen spectacular progress in the understanding of the algebraic properties of the fundamental groups of 3-manifolds. In these lectures we will present some of these results. We will start with some basic properties of 3-manifold groups related to topology. Then we will discuss the relationship with geometric properties of 3-manifolds, with an emphasis on surface subgroups. The last lecture will focus on virtual properties and profinite properties of 3-manifold groups.

Tara Brendle (Univ. Glasgow)

Congruence braid groups

This course will focus on braid groups, as viewed through the lens of a symplectic representation. We will discuss various contexts in which this representation arises, including the classical symplectic representation of mapping class groups and the Burau representation. The kernel of this representation, often referred to as the braid Torelli group, also admits a number of different definitions including an algebro-geometric description. Along the way, we will also describe generalizations of the braid Torelli group, such as the Torelli group for an arbitrary surface and braid congruence groups, and we will give a sample application to the Brunnian braid group.

David Gay (Univ. Georgia)

From Heegaard splittings to trisections; porting 3-dimensional ideas to dimension four

Trisections are to 4-manifolds as Heegaard splittings are to 3-manifolds. I will develop the foundations of the theory (why do trisections exist and how unique are they?) and then survey a range of newer extensions of the theory (submanifolds, boundaries, gluing). Throughout I will be emphasizing what we don't know and advertising open problems; with luck, maybe some will be solved by participants and we'll all know more at the end of the week!

Short talks

Cristina Anghel-Palmer (Univ. Paris 7)

A homological model for the coloured Jones polynomials

In 1991, Reshetikhin and Turaev defined a method that starts with a quan- tum group and leads to link invariants. This construction is purely algebraic and combinatorial. The coloured Jones polynomials J_N (L, q) are a family of quantum invariants constructed from the representation theory of $U_q(sl(2))$. We will describe a geometrical interpretation for the coloured Jones polynomials.
R. Lawrence defined a sequence of representations of the braid groups, using the homology of a certain covering of a configuration space. In 2012, Kohno proved a deep connection between the representations of the braid group on the highest weight spaces of $U_q(sl(2))$-modules and the Lawrence representations. Using this, we give a homological model for J_N (L, q). We prove that the coloured Jones polynomials can be described as a graded intersection pairing between two homology classes on a covering of the configuration space of the punctured disc.

Maria Cumplido Cabello (Univ. Rennes 1 / Univ. Sevilla)

Advances in the understanding of parabolic subgroups of Artin-Tits groups

Artin-Tits groups are a natural generalisation of braid groups from the algebraic point of view: In the same way that the braid group can be obtained from the presentation of the symmetric group with transpositions as generators by dropping the order relations for the generators, other Coxeter groups give rise to more general Artin-Tits groups. If the underlying Coxeter group is finite, the resulting Artin-Tits group is said to be of spherical type. Artin-Tits groups of spherical type share many properties with braid groups.
The properties of the complex of curves, and the way in which the braid group acts on it, allow to use geometric arguments to prove results in braid groups. As one cannot replicate these geometrical techniques in other Artin-Tits groups, they must be replaced by algebraic arguments if one tries to extend properties of braid groups to all Artin-Tits groups of spherical type. That is why we are interested in parabolic subgroups of Artin-Tits groups, which are defined as conjugates of a subgroups generated by a subset of the standard generators. They are the analogue of isotopy classes of simple closed curves in the puncture disk, which are the building blocks that form the complex of curves. Then, it is logical to believe that improving our understanding about parabolic subgroups will allow us to prove similar results for Artin-Tits groups of spherical type in general.
In this talk two new results about parabolic subgroups will be presented, namely that the intersection of parabolic subgroups is a parabolic subgroup and that the set of parabolic subgroups is a lattice.
Joint work with Volker Gebhardt, Juan González-Meneses and Bert Wiest.

Peter Feller (ETH Zurich)

Braids with as many full twists as strands realize the braid index

We explain how the fractional Dehn twist coefficient of braids---a rational quantity studied in mapping class group theory---can be recast in terms of a certain linear combination of (concordance) invariants of knots. This interpretation allows to provide lower bounds on the braid index of closures of braids with ``many twists''. Based on joint work with Diana Hubbard.

Marc Kegel (Univ. Köln)

The knot complement problem for Legendrian and transverse knots

The famous knot complement theorem by Gordon and Luecke states that two knots in the 3-sphere are equivalent if and only if their complements are homeomorphic. In this talk I want to discuss the same question for Legendrian and transverse knots and links in contact 3-manifolds. The main results are that Legendrian as well as transverse knots in the tight contact 3-sphere are equivalent if and only if their exteriors are contactomorphic.

Alexandra Kjuchukova (Univ. Wisconsin Madison)

Trisections of singular branched covers

Let Y be a closed oriented four-manifold which is an irregular dihedral cover of the four-sphere, branched along an oriented surface B embedded in S^4 with one cone singularity. I will describe a method to produce a trisection of Y from a singular triplane diagram of the pair (S^4,B). I will give a construction of an infinite family of three-fold dihedral covers $f_i: Y_i \to S^4$, branched along singularly embedded two-spheres whose singularities are cones on pairwise distinct knot types K_i. I will use trisections to prove that, for infinitely many among these knots K_i, the manifold Y_i is diffeomorphic to CP^2. Lastly, I will discuss a ribbon obstruction which arises in this setting. Joint work with Patricia Cahn.

Sudipta Kolay (Georgia Tech)

Braided Embeddings

The theory of braids has been very useful in the study of classical knot theory. One can hope that higher dimensional braids will play a similar role in higher dimensional knot theory. In this talk we will introduce the concept of braided embeddings of manifolds, and discuss existence, lifting and isotopy problems for braided embeddings.

Christian Lange (Univ. Köln)

Orbifolds from a metric viewpoint

In the talk we explain the concept of an orbifold and its covering space theory from a metric viewpoint. The presence of a metric makes the story less technical compared to the smooth setting. We discuss some geometric and topological questions and results related to orbifolds.

Livio Liechti (Univ. Paris 6)

A graph model for positive braid links

We discuss a model for positive braid links, given by certain graphs which are embedded in the plane and carry an acyclic orientation. By a result of Stallings, the exterior of a positive braid link has the structure of a surface bundle over the circle, where the monodromy is a product of positive Dehn twists along simple closed curves. We discuss a graph model for positive braid links, using the key observation that such a surface bundle is determined by how the curves along which we twist intersect and in which order they get twisted along. This is joint work with Sebastian Baader and Lukas Lewark.

Jeffrey Meier (Univ. Georgia)

Fibered homotopy-ribbon knots, the Generalized Property R Conjecture, and trisections

I'll describe recent work (joint with Alex Zupan) that draws connections between the study of fibered homotopy-ribbon knots in the three-sphere with the study of trisections of homotopy four-spheres, giving a new approach to the Generalized Property R Conjecture along the way. One application is the classification of fibered homotopy-ribbon disks bounded by square knots.

Jun Ueki (Univ. Tokyo)

The profinite completions of knot groups and twisted Alexander polynomials

In several occasions we can distinguish two knots by comparing the homology torsions of their finite covers. This leads us to the following question: What topological information does the profinite completions of knot groups know ?
In my talk, we study profinite rigidity of twisted Alexander polynomials of knots associated to representations over the ring *O* of *S*-integers of a number field.
We prove it under some mild conditions, and also present some inevitable finite ambiguity, by investigating the completed group ring $\widehat{O}[[t^{\widehat{\mathbb{Z}}}]]$ and some Iwasawa modules.

Anderson Vera (Univ. Strasbourg)

Johnson-Levine homomorphisms and the tree reduction of the LMO functor

The interaction between the study of 3-manifolds and that of the mapping class group (MCG) is well known. In some sense, the algebraic structure of the MCG and of its subgroups is reflected in the topology of 3-manifolds. For instance, the subgroup of homeomorphisms acting trivially in homology, known as the Torelli group, is tied to homology 3-spheres. For this family of 3-manifolds there exists a powerful (quantum) invariant called the LMO invariant, which is a further generalization of the Casson invariant and that is quite mysterious, in part because its construction is very indirect. This invariant can be extended to a topological quantum field theory from a category of cobordisms to a category of unitrivalent graphs, called the LMO functor. In this talk we show that for a special kind of cobordisms, a part of the tree-like graphs in the image by the LMO functor can be interpreted as the diagrammatic version of the Johnson-Levine homomorphisms (homomorphisms similar to the classical Johnson homomorphisms).

Stefan Witzel (Univ. Bielefeld)

The complex of boundary braids

A boundary braid in a solid cylinder is defined by the condition that certain strands stay in the boundary cylinder. I will present decomposition results for boundary braids. Specifically, the dual braid complex of braids with n strands of which k are boundary parallel decomposes as a metric direct product into the dual braid complex of braids with n-k strands and a Euclidean polyhedron. Conjecturally, the dual braid complex is CAT(0) and therefore the braid group is a CAT(0) group. By our result the dual braid complex on n strands is covered by n subcomplexes which would be CAT(0) in an inductive proof.
This is joint work with Jon McCammond and Michael Dougherty.