Geometric Topology
Topologie géométrique
(Org: **Ryan Budney** (Victoria) and/et **Andy Nicas** (McMaster))

THOMAS BAIRD, Memorial University, St. John's, Newfoundland

Representation varieties of non-orientable surface groups

Let G be a Lie group, Σ be a compact two manifold. When Σ is orientable, the representation variety

$$\mathcal{M}(\Sigma, G) = \mathrm{Hom}\big(\pi_1(\Sigma), G\big)/G$$

has many interesting properties and has been the subject of intense investigation for several decades. In recent years, the case of nonorientable Σ has also attracted some attention. This talk will survey our current understanding of the topology of $\mathcal{M}(\Sigma, G)$ when Σ is nonorientable.

STEVE BOYER, Département de mathématiques, Université du Québec à Montréal, PO Box 8888, Centre-ville, Montreal, QC H3C 3P8

Involutions on 3-manifolds and exceptional Dehn filling

Let M be a compact, connected, orientable, hyperbolic 3-manifold with torus boundary. Thurston proved that all but finitely many Dehn fillings of M are hyperbolic manifolds. Over the last few decades much research has been devoted to understanding the set of Dehn fillings which are exceptional, that is, non-hyperbolic. By Perelman's work, these are the fillings which contain either an essential 2-sphere or an essential torus, or are small Seifert-fibred manifolds. The exceptional fillings which are least understood are those which yield small Seifert manifolds. In this talk we describe recent progress on determining the relationship between this family of fillings and those which contain essential tori. In particular we show that for generic M, this relationship satisfies the main conjectures in the subject. We also show that in the non-generic case, M admits an orientation preserving involution with quotient a simple manifold like a ball or solid torus. This allows us to convert the exceptional filling problem into a problem about links in the 3-sphere or a lens space, which can then be analysed using classical methods.

This talk reports on joint work with Cameron Gordon and Xingru Zhang.

RYAN BUDNEY, University of Victoria

Splicing of knots

In dimension 3, splicing is how one generates knots such as Whitehead doubles and connect-sums. I will show that the splicing operation for knots in any dimension has an operadic formulation. There are several consequences, for example let K denote the space of "long" embeddings of the real numbers R into R^3 such that the embeddings agree with a fixed linear embedding outside of a fixed ball. K admits an action of "the splicing operad". Moreover K is free with respect to this action, with free generating space the space of torus and hyperbolic knots. The splicing operad has a relatively simple homotopy-type as well, which I will describe.

VIRGINIE CHARETTE, Université de Sherbrooke, Sherbrooke, QC

Proper affine deformations of surface groups

Let Σ be a hyperbolic surface whose fundamental group is Schottky, such as the three-holed sphere or the once-punctured torus. Then $\pi_1(\Sigma)$ admits proper representations into the group of affine isometries of Minkowski 3-space, a remarkable fact first proved by Margulis. In joint work with Todd Drumm and Bill Goldman, we proved that the space of such proper representations, for the three-holed sphere, is entirely determined by a measure of signed Lorentzian displacement on the three boundary components. Moreover, each such action admits a fundamental domain, allowing us to offer a topological description of the quotient. We will discuss this result, and perhaps some work in progress on the one-holed torus.

KIYOSHI IGUSA, Brandeis University, Waltham, MA
Hatcher handles and the rigidity conjecture

The rigidity conjecture says that the fiberwise smooth structure of a topological manifold bundle with closed even dimensional fibers is stably rationally unique. Sebastian Goette and I have just completed our work on the construction of all rational stable smooth structures on all smooth bundles with closed odd dimensional manifold fibers. We use Hatcher handles which are based on Hatcher's elegant geometric construction of exotic smooth structures on disk bundles. This talk will explain the construction and statements for odd dimensional fibers and the evidence we have for the nonexistence of exotic smooth structures for even dimensional fibers.

BRIAN MUNSON, Wellesley College, 106 Central Street, Wellesley, MA 02481, USA
Derivatives of the identity and link maps

I will discuss a connection between the derivatives of the identity functor in the Goodwillie calculus of functors and Koschorke's invariants of link maps. This bridges the gap between Johnson's description of the derivatives of the identity functor, and Koschorke's higher-order invariants of link maps in Euclidean space, which are generalizations of Milnor's invariants of classical links. The result may be viewed as a generalization of Koschorke's invariants as well as a stable-range description, in terms of bordism, of the derivatives of the identity evaluated at spheres. We employ a multivariable generalization of the manifold calculus of Goodwillie–Weiss to organize the result.

JOHN OLSEN, University of Rochester
Three Dimensional Manifolds All of Whose Geodesics Are Closed

The existence of closed geodesics and the geometry of manifolds all of whose geodesics are closed are among the classical problems in geometry. One famous problem is the Berger Conjecture, which states that, on a simply connected manifold all of whose geodesics are closed, the geodesics have the same least period. I will give an introduction to the topic and mention known results. I will explain a possible approach via Morse Theory on the free loop space, and present some results on the Morse Theory in dimension three, where the conjecture is still open. If time permits, I will sketch a proof of the main theorem, which states that the energy function is perfect for S^1-equivariant Morse Theory with rational coefficients for the cohomology.

HUGO PARLIER, University of Toronto, Toronto, Canada
Curves on surfaces with large topology

Surfaces of large genus are intriguing objects. Their geometry has been studied by finding geometric properties that hold for all surfaces of the same genus, and by finding families of surfaces with unexpected or extremely geometric behavior. The talk will discuss short pants decompositions on surfaces. Specifically, the talk will focus on two contrasting results. The first, joint with F. Balacheff and S. Sabourau, about how to find short pants decompositions on punctured spheres, and the second with L. Guth and R. Young about how to construct closed surfaces via random constructions with shortest pants decompositions relatively long.

ALEXANDRA PETTET, University of Michigan
$\mathrm{Out}(F)$ *and its relatives*

The outer automorphism group $\mathrm{Out}(F)$ of a free group of finite rank shares many properties with linear groups and the mapping class group $\mathrm{Mod}(S)$ of a surface, although the techniques for studying $\mathrm{Out}(F)$ are often quite different from the latter two. Motivated by analogy, I will present some results about $\mathrm{Out}(F)$, previously well-known for the mapping class group, and highlight some of the features in the proofs which distinguish it from $\mathrm{Mod}(S)$.

This is joint work with Matt Clay.

LIAM WATSON, UCLA, 520 Portola Plaza, Los Angeles, CA

L-spaces and left orderability

L-spaces are three manifolds that arise naturally in the study of Heegaard Floer homology: these are manifolds with Heegaard Floer homology that is as simple as possible, or, Heegaard Floer homology lens spaces. A theorem of Ozsváth and Szabó establishes that L-spaces do not admit co-orientable taut foliations, and this fact suggests that one should search for an alternative characterization of these spaces (that is, a characterization that does not reference Heegaard Floer homology). Examples suggest that there is a correspondence between L-spaces and three manifolds with fundamental group that cannot be left-ordered. This talk will discuss how this correspondence is in fact a characterization when restricting to Seifert fibered spaces, that is, a Seifert fibered three manifold Y is an L-space if and only if the fundamental group of Y cannot be left-ordered. Another large class of L-spaces is provided by two-fold branched covers of the three-sphere, branched over an alternating link. In agreement with this correspondence, it is possible to prove that the two-fold branched cover of an alternating link has non-left-orderable fundamental group.

This is joint work with Steven Boyer and Cameron Gordon.