Abstracts for the Geometric Topology Workshop

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A core dump on the stable homology of $Aut(F_n)$

Abstract

Recent exciting work of Madsen, Tillmann, and Weiss on the stable homology of the mapping class group has reignited interest in the analgous question for the automorphism group of the free group. One basic problem in the subject is that there does not seem to exist a suitable (integral version of the) Mumford conjecture in this setting. I will present a conjectural framework which is rather nice from a geometrical point of view.

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On the coherence of coherent-by-cyclic groups

Abstract

A group G is called coherent, if any finitely generated subgroup of G is finitely presented. Examples of coherent groups include fundamental groups of 3-manifolds, fundamental groups of graphs of groups with coherent vertex groups and Noetherian edge groups, most one-relator groups with torsion. Cyclic extensions of coherent groups are not necessarily coherent. We prove that cyclic extensions of coherent hyperbolic groups are coherent. This is a joint work with D. Wise.

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Fibrator Properties of Manifolds determined by their Fundamental Groups

Abstract

This represents joint work with Y. Kim. We say that a manifold N is homotopically determined by π_1 if every map $N \to N$ which induces a π_1-isomorphism is a homotopy equivalence. Pretty clearly aspherical manifolds have this property. It is useful because such a closed manifold N is a PL fibrator if and only if it is a codimension-2 PL fibrator (N is a PL fibrator if every PL map $p : M \to B$ from a PL manifold M to a polyhedron B such that each point preimage, in some sense, is a copy of N necessarily is an approximate fibration). Here are two sets of conditions implying that a connected sum $N_1 \# N_2$ of closed, orientable n-manifolds is homotopically determined by π_1: (1) N_1 is homotopically determined by $\pi_1, \pi_{n-1}(N_1) \cong 0, \beta_1(N_1) > 0$ and N_2 is such that $N_1 \# N_2$ is a hopfian manifold; (2) N_1 is aspherical and N_2 is such that $N_1 \# N_2$ is a hopfian manifold. Although a manifold having free fundamental group definitely is not homotopically determined by π_1, we also prove that an orientable n-manifold N is a PL fibrator if $N = (S^1 \times S^{n-1}) \# N'$, where $\pi_1(N') \neq 1$ is a hopfian group and where $\pi_i(N') = 0$ for

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Almost periodic flows and hyperbolic 3-manifolds

Abstract

Let M be a closed hyperbolic 3-manifold. Then M does not admit an almost periodic flow with a closed flow line.

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On the topology and geometry of L^2_Z.

Abstract

The space L^p_Z of integer-valued functions is a closed line-free subgroup of L^p. The group L^2_Z, which topologically is itself just L^p, has some interesting geometric properties.

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The fundamental groups of subsets of closed surfaces inject into their first shape groups

Abstract

Joint research with Andreas Zastrow, University of Gdansk, Poland Abstract: We show that for every subset X of a closed surface M and every x in X, the natural homomorphism from the fundamental group of X (based at x) to the first shape homotopy group of X (based at x) is injective. In particular, it follows that if X is a proper compact subset of M, then the fundamental group of X (based at x) is isomorphic to a subgroup of the limit of an inverse sequence of finitely generated free groups.

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Compactifying Manifolds with Boundary

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Actions of mapping class groups on rings

Abstract

We consider the actions of braid groups and of some subgroups of mapping class groups on polynomial rings and on certain quotients of polynomial rings called trace rings. Applications include (i) actions of these groups on various topological spaces, including spheres; (ii) certain operators that determine geometric intersection numbers of curves.

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BNS Invariants and the Initial Tree

Abstract

The Bieri-Neumann-Strebel invariant of a finitely generated group G is subset of $H^1(G, R)$ which captures information as to which normal subgroups of G with abelian quotient are finitely generated. Ken Brown has characterized the invariant in terms of abelian actions on trees. When G is finitely presented, we can construct a sequence of complexes whose limit is the largest tree associated to a particular homomorphism in $H^1(G, Z)$. Although this sequence is infinite in general, we will see that there is actually a tree in the sequence which contains the necessary information for determining if the homomorphism is in the invariant.

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Finite Split Extensions of Right-Angled Coxeter Groups

Abstract

(joint work with Mauricio Gutierrez and Kim Ruane) We consider sequences of the form $1 \to W \to G \to K \to 1$ where W is a right-angled Coxeter group, K is a finite group, such that the sequence admits a splitting. Based on a construction of Serre, we show that G acts geometrically on a CAT(0) space.

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Hyperbolic 5-manifolds of finite volume

Abstract

The classification of a certain class of orientable hyperbolic 5-manifolds of finite volume will be discussed. The fundamental group of each of these manifolds is isomorphic to a torsion-free subgroup of minimal index in the right-angled Coxeter group corresponding to a certain 5-dimensional right-angled hyperbolic polytope with 16 sides. Each of these manifolds has either 10 or 12 cusps and volume 28zeta(3) where zeta(s) is the Riemann zeta function. One of these manifolds has a group of symmetries of order 16 that acts freely on the manifold. The orbit space of this action is an orientable hyperbolic 5-manifold with two cusps and volume 7zeta(3)/4. Reasons will be discussed why this hyperbolic 5-manifold is a good candidate for a noncompact hyperbolic 5-manifold of minimum volume.

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The 3D Resolution Conjecture: Ideas and Notions

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Do tame ends of manifolds have semi-stable second homotopy groups?

Abstract

We continue an earlier study of ends of non-compact manifolds, in particular, to obtain generalizations of Siebenmann's famous collaring theorem that may be applied to inwardly tame manifolds having non-stable fundamental group systems at infinity. Guilbault established a useful generalization to collaring that he calls *pseudo-collaring* and investigated necessary and sufficient conditions for a non-compact manifold to have a pseudo-collar at infinity. More recently, Guilbault and Tinsley have shown that the condition of inward tameness implies that any such manifold with compact boundary has stable homology (in all dimensions) and semistable fundamental group at each of its ends. However, they gave an example to show that inwardly tame manifolds need not possess fundamental group systems at infinity that are perfectly semistable, a necessary condition for a non-compact manifold to have a pseudo-collar. In this talk, we investigate a condition on the second homotopy group system at infinity and outline the construction of an example that would show it is not a consequence of inward tameness and perfect semistability. This condition, though weaker than that of semistability of the second homotopy group, arises naturally out of Guilbault's original construction.

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The Croke and Kleiner boundaries really are distinct

Abstract

Croke and Kleiner described a family of CAT(0) spaces $\{X_\alpha | 0 < \alpha \leq \frac{\pi}{2}\}$, each admitting an action by the same group G. They showed that at least two of these spaces are non-homeormorphic, so that G has at least two distinct boundaries. We present a new proof of the fact that all of these spaces are topologically distinct, so that G has uncountably many boundaries. This proof replaces an earlier, flawed attempt at the same result.

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On Psuedo n-manifolds

Abstract

Triangulable n-manifolds can be represented by a finite collection of k n-dimensional polyhedra, together with a face pairing on their boundaries. We let a pseudo n-manifold be a finite collection of k n-dimensional polyhedra, together with a face pairing on their boundaries. We wish to explore the asymptotic behaviors of pseudo n-manifolds as $k \to \infty$.

In order to explore these behaviors, we first must put a restriction on the types of polyhedra we allow. Let $T_{n,k}$ be a random pseudo n-manifold containing k n-simplexes. Let $P_{conn}(n,k)$ denotes the probability that $T_{n,k}$ is connected. We show that $lim_{k\to\infty} P_{conn}(n,k) = 1$ if $n \geq 2$ and 0 otherwise. In other words, as long as $n \geq 2$, a random pseudo n-manifold will be connected with probability 1. We then extend this result to other polyhedra.

We also explore the case when $n = 1$ and find that while in general $T_{1,k}$ is not connected, it has very few components in relation to k.

Other natural questions arise, which I will mention. This exploration came as a result of an observation by Jim Cannon that most pseudo 3-manifolds are not manifolds. The main conjecture is that with probability 0 a pseudo 3-manifold is actually a manifold. This is in stark constrast to the well know classification of 2-manifolds, which shows that every pseudo 2-manifold is a manifold.

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On the (Non-)Uniqueness of Cartesian Products of surfaces

Abstract

(joint work with J. Malesic, D. Repovs and W. Rosicki) The question that was settled in this research project was the following: Under what conditions can X_1, X_2, Y_1 and Y_2 satisfy that $X_1 \times X_2$ is homeomorphic to $Y_1 \times Y_2$. For closed surfaces this question has been long time ago settled by Borsuk in that way, that any closed four-manifold can have (up to homeomorphism and up to the order of factors) at most one such decomposition. In the case, when one permits the 4-manifold and the surfaces to have boundary, there are exceptions from an according uniqueness statement. However, a theorem can be given that restricts these exceptions to precisely those cases, where one of the surfaces itself is a Cartesian product that has the unit-interval I as a factor.