COE Conference

Groups, Homotopy, and Configuration Spaces

— Program and Abstracts —

July 5 – 11, 2005

Graduate School of Mathematical Sciences
The University of Tokyo

Program

July 4th

16:30 ∼ 18:00 **Registration**

July 5th

9:00 ∼ 10:00 **Registration**

10:00 ∼ 11:00 **Shigeyuki Morita** (Graduate School of Mathematical Sciecnes, The University of Tokyo)

Constructions of cycles in the moduli space of Riemann surfaces and the moduli space of graphs

11:30 ∼ 12:30 **Ralph Cohen** (Stanford University)

Moduli spaces of graphs and homology operations on loop spaces of manifolds

14:30 ∼ 15:00 **Natalia Dobrinskaya** (Moscow State University)

Configurations of manifold embeddings

15:15 ∼ 15:45 **Miguel A. Xicotencatl** (CINVESTAV, Mexico)

Orbifold string topology

16:00 ∼ 16:30 **Tetsuhiro Moriyama** (Graduate School of Mathematical Sciences, The University of Tokyo)

Configuration space and Casson invariant

17:00 ∼ 18:00 **COE Special Lecture by Fred Cohen** (University of Rochester)

A survey of recent applications of braid groups

July 6th

10:00 ∼ 11:00 **Ryan Budney** (University of Oregon)

The topology of spaces of knots in dimension 3

11:30 ∼ 12:30 **Masaaki Yoshida** (Kyushu University)

Automorphic functions for Whitehead-link-complement group

14:30 ∼ 15:00 **Jun O'Hara** (Tokyo Metropolitan University)

Conformal geometry of knots

15:15 ∼ 15:45 **Sadok Kallel** (Université de Lille 1)

Decomposing the homology of braid spaces with applications to the topology of mapping spaces

16:00 ∼ 16:30 **Carles Casacuberta** (Universitat de Barcelona)

Homotopy localization with respect to proper classes of maps

17:00 ∼ 18:00 **Work of Fred Cohen by Ran Levi** (University of Aberdeen)

18:30 ∼ 21:00 **Reception Party** (Faculty Club House)

July 7th

Please note that the 30-minutes talks begin at 14:00 on July 7th, 8th, and 9th.

10:00 ∼ 11:00 **Corrado De Concini** (Università di Roma "La Sapienza")
Toric arrangements and lattice points in convex polytopes

11:30 ∼ 12:30 **Mario Salvetti** (Università di Pisa)
On the cohomology and topology of Coxeter and Artin groups

14:00 ∼ 14:30 **Vladimir Vershinin** (Université Montpellier II)
Generalized braids and their presentations

14:40 ∼ 15:10 **Jelena Grbic** (University of Aberdeen)
The homotopy type of the complement of the coordinate subspace arrangement

15:20 ∼ 15:50 **Haruko Nishi** (Kyushu University)
A parametrisation of the Teichmüller space by polygons

16:00 ∼ 16:30 **Sergey Maksymenko** (Institute of Mathematics, NAS of Ukraine)
Homotopy type of stabilizers and orbits of Morse functions on surfaces

17:00 ∼ 18:00 **Alexander Varchenko** (University of North Carolina, Chapel Hill)
The $(\mathfrak{gl}_n, \mathfrak{gl}_k)$-duality and critical points of master functions

July 8th

10:00 ∼ 11:00 **Alexander A. Voronov** (University of Minnesota)
Configurations of points on the sphere

11:30 ∼ 12:30 **Yasuhiko Kamiyama** (University of the Ryukyus)
Configuration spaces and rational functions

14:00 ∼ 14:30 **Victor Turchin** (Université Catholique de Louvain)
Dyer-Lashof-Cohen operations in Hochschild cohomology

14:40 ∼ 15:10 **Hiroshige Kajiura** (Yukawa Institute for Theoretical Physics, Kyoto University)
Homotopy algebra of open-closed strings

15:20 ∼ 15:50 **Dmitri Millionschikov** (Moscow State University)
Deformations of nilpotent Lie algebras and nilmanifolds

16:00 ∼ 16:30 **Aniceto Murillo** (Universidad de Malaga)
Mapping spaces from the rational point of view

17:00 ∼ 18:00 **Gilles Robert** (Université Bordeaux 1)
Poincaré maps and Bol's theorem

July 9th

10:00 ∼ 11:00 **Alejandro Adem** (University of Wisconsin-Madison)
On spaces of homomorphisms

11:30 ∼ 12:30 **Stephen Theriault** (University of Aberdeen)
The odd primary H-structure of $SU(n)$ in low rank

14:00 ∼ 14:30 **Juno Mukai** (Shinshu University)
Determination of the order of the P-image by Toda brackets

14:40 ∼ 15:10 **Brayton Gray** (University of Illinois at Chiago)
Hopf invariants for mapping cones

15:20 ∼ 15:50 **Radu Stancu** (The Ohio State University)
A reduction theorem for fusion systems of blocks

16:00 ∼ 16:30 **Peter Symond** (University of Manchester)
Cohomology and fusion for groups of finite vcd

17:00 ∼ 18:00 **A. Jon Berrick** (National University of Singapore)
From braid groups to homotopy groups of spheres

July 10th

Excursion

July 11th

The 30-minutes talks begin at 14:30.

10:00 ∼ 11:00 **Daniel C. Cohen** (Louisiana State University)
Boundary manifolds of projective hypersurfaces

11:30 ∼ 12:30 **Ulrike Tillmann** (Oxford University)
Cobordism categories and their classifying spaces

14:30 ∼ 15:00 **Tilman Bauer** (Universität Münster)
On the convergence of the Eilenberg-Moore spectral sequence

15:15 ∼ 15:45 **Bilal Khan** (John Jay College, City University of New York)
Asymptotic structure and Gromov hyperbolicity of automorphisms of the free group of rank two

16:00 ∼ 16:30 **Ethan Berkove** (Lafayette College)
Stable splittings of the Bianchi groups

17:00 ∼ 18:00 **Laurence R. Taylor** (University of Notre Dame)
Cohomology of some configuration spaces and associated bundles

Abstracts

Abstracts are listed in the alphabetical order of the name of the speakers.

Alejandro Adem

On spaces of homomorphisms

Given a suitable discrete group Q and a Lie group G, we will discuss basic topological and homological properties of the space of homomorphisms $\mathrm{Hom}(Q, G)$. This is joint work with Fred Cohen.

Tilman Bauer

On the convergence of the Eilenberg-Moore spectral sequence

Ethan Berkove

Stable splittings of the Bianchi groups

The Bianchi groups are a collection of matrix groups that can be thought of as generalizations of $PSL_2(\mathbb{Z})$, which can be built out of finite groups using algebraic constructions like the amalgamated product and the HNN extension. When a Bianchi group Γ's classifying space is suspended, the space often splits into a wedge of pieces that reflect Γ's finite subgroups. In this talk, we will review previous work in this vein and produce stable splittings for various members of the Bianchi group family.

A. Jon Berrick

From braid groups to homotopy groups of spheres

This talk presents the surprising fact that encoded within Artin's braid groups one can find homotopy groups of spheres. Joint work with F. R. Cohen, Y.-L. Wong and J. Wu; to appear in JAMS.

Ryan Budney

The topology of spaces of knots in dimension 3

Let K denote the topological space of C^∞ smooth embeddings of $\mathbb{R}$ in $\mathbb{R}^3$ that restrict to a (fixed) linear inclusion outside of some (fixed) ball. We call K the space of long knots in $\mathbb{R}^3$. I will give a recursive description of the homotopy type of K, component-by-component. The path-components of K are the isotopy classes of long knots. First I'll describe an "indexing" of these components in terms of finite, labelled, rooted-trees, based on the JSJ-decomposition of 3-manifolds. Via this indexing, the homotopy type of any path-component of K can be described in terms of iterating three elementary bundle operations related to such things as: free little 2-cubes objects from homotopy theory, and 'wreath product constructions' that use natural signed symmetric representations of the isometry groups of certain hyperbolic link complements of a 'brunnian type'.

Carles Casacuberta

Homotopy localization with respect to proper classes of maps

Localizing with respect to sets of maps is a common technique in Mathematics. However, localizing with respect to proper classes of maps is more delicate, due to set-theoretical difficulties. In earlier joint work with Scevenels and Smith, we proved that, assuming the validity of a suitable large-cardinal axiom, homotopy localization exists with respect to any class of maps between simplicial sets, and any such localization is in fact determined by a single map. These results were extended to any combinatorial model category in joint work with Chorny.

We have recently proved with Gutierrez and Rosicky that, under a large-cardinal axiom, the following statements are true in the homotopy category of any combinatorial stable model category: every colocalizing subcategory is reflective, and every localizing subcategory is a coreflective cohomological Bousfield class. This gives a partial answer to a question asked by Hovey-Palmieri-Strickland. Counterexamples exist if the model category is not cofibrantly generated.

Daniel C. Cohen

Boundary manifolds of projective hypersurfaces

We study the topology of the boundary manifold of a regular neighborhood of a complex projective hypersurface. We show that, under certain Hodge theoretic conditions, the cohomology ring of the complement of the hypersurface functorially determines that of the boundary. When the hypersurface defines an arrangement of hyperplanes, the cohomology of the boundary is completely determined by the combinatorics of the underlying arrangement and the ambient dimension.

Frederick R. Cohen (COE Special Lecture)

A survey of recent applications of braid groups

This survey of applications of braid groups gives connections between spaces of representations, cohomology, homotopy, as well as certain Lie algebras as developed by T. Kohno. The mathematics represents joint work with A. Adem, R. Budney, J. Berrick, Y. Wong, and J. Wu.

Ralph Cohen

Moduli spaces of graphs and homology operations on loop spaces of manifolds

In this lecture I will show how spaces of graphs and “gradient graph flows” can be used to define (co)homology operations. In the classical case of Morse theory on a compact manifold, one obtains classical cohomology operations such as Steenrod squares. When one uses “fat” or “ribbon graphs” and Morse theory on the loop space of a manifold, one obtains string topology operations. When one uses ribbon graphs and flows of the symplectic action on the loop space of the cotangent bundle, one obtains a variation of Gromov-Witten invariants on the cotangent bundle.

Corrado De Concini

Toric arrangements and lattice points in convex polytopes

In the talk we shall introduce the notion of toric arrangement in an algebraic torus T and explain how to compute the cohomology of their complements by studying the structure of their coordinate rings as modules over the ring of differential operators on T.

Following ideas of Szenes and Vergne, applications will be given to the computation of the number of lattice points in a rational convex polytope.

Also, some amusing combinatorial on root systems will be explained. Joint with Claudio Procesi.

Natalia Dobrinskaya

Configurations of manifold embeddings

Classical results about configuration spaces determine the homotopy type of their group completion. Regarding n points as 0-dimensional manifolds we generalizes methods of McDuff and Segal to prove the n-dimensional analogous of those results which is statement about homotopy type of certain spaces of n-dimensional manifold embeddings. Among examples are spaces of self-cobordisms embeddings. Considering last example in dimension 2 we get alternative proof of homotopy part of the theorem of Madsen and Weiss.

Brayton Gray

Hopf invariants for mapping cones

The relative James construction provides a functorial Hopf invariant defined on the fiber of a pinch map. Here we give a lifting of this Hopf invariant from the fiber of one pinch map to the fiber of another. An application is made to the study of the Cohen Moore Neisendorfer splitting of the loops of a Moore space in order to understand the obstructions that come in the study of the double suspension conjecture.

Jelena Grbic

The homotopy type of the complement of the coordinate subspace arrangement

An arrangement $\mathcal{CA} = \{L_1, \ldots, L_r\}$ in $\mathbb{C}^n$ is called *coordinate* if every L_i for $i = 1, \ldots, r$ is a coordinate subspace. We describe the *unstable* homotopy type of the complement $U(\mathcal{CA}) := \mathbb{C}^m \setminus \bigcup_{i=1}^r L_i$ of a given coordinate subspace arrangement $\mathcal{CA}$ by combining the methods of classical homotopy theory and the new achievements of Toric Topology. As a corollary we obtain a new proof of the Golod result considering the rationality of the Poincaré series of certain local rings.

Hiroshige Kajiura

Homotopy algebra of open-closed strings

In work with Jim Stasheff, we define a strongly homotopy algebra associated with tree open-closed strings and call it an open-closed homotopy algebra (OCHA). It is known that in general tree open string theory is associated with an A_∞-structure and tree closed string theory is associated with an L_∞-structure. An OCHA is defined as an algebra which includes both an A_∞-algebra and an L_∞-algebra as subalgebras. We explain homotopy algebraic properties of OCHAs and their application to deformation theory of A_∞-algebras.

Sadok Kallel

Decomposing the homology of braid spaces with applications to the topology of mapping spaces

Using truncated symmetric products and variants of simplicial resolutions, we give various decomposition results for the homology of braid spaces of closed and punctured manifolds. Combining similar resolution techniques with configuration space models we completely determine the homology of spaces of maps from Riemann surfaces into complex projective spaces (this part is joint with P. Salvatore).

Yasuhiko Kamiyama

Configuration spaces and rational functions

In order to study the homology of the configuration space of unordered k-tuples of distinct points in $\mathbb{C}$, Arnold defined a space $P^l_{k,n}$ and performed an induction. Here $P^l_{k,n}$ is defined to be the space consisting of all monic polynomials $f(z)$ over $\mathbb{C}$ of degree k and such that the number of n-fold roots of $f(z)$ is at most l. In this talk, we give a description of the stable homotopy type of $P^l_{k,n}$ by relating $P^l_{k,n}$ to a space consisting of certain n-tuples of monic polynomials.

Bilal Khan

Asymptotic structure and Gromov hyperbolicity of automorphisms of the free group of rank two

Sergey Maksymenko

Homotopy type of stabilizers and orbits of Morse functions on surfaces

Let M be a smooth compact surface, orientable or not, with boundary or without it. Let also P be either the real line R^1 or the circle S^1. Then the group $\mathrm{Diff}(M)$ of diffeomorphisms of M acts on $C^\infty(M,P)$ by the rule $h \cdot f \mapsto f \circ h^{-1}$, for $h \in \mathrm{Diff}(M)$ and $f \in C^\infty(M,P)$.

Let $f : M \to P$ be a Morse function and O_f be the orbit of f under this action. We prove that $\pi_k O_f = \pi_k M$ for $k \geq 3$, and $\pi_2 O_f = 0$ except for few cases. In particular, O_f is aspherical, provided M is. Moreover, $\pi_1 O_f$ is an extension of a finitely generated free abelian group with a (finite) subgroup of the group of automorphisms of the Kronrod-Reeb graph of f.

Dmitri Millionschikov

Deformations of nilpotent Lie algebras and nilmanifolds

Milnor asked in 1977 whether a torsion-free and virtually polycyclic group Γ can be the fundamental group of a complete compact affine manifold. In 1993 Benoist constructed a finitely generated torsion-free nilpotent group of rank 11 that is not the fundamental group of any compact complete affine manifold, later Burde and Grunewald added new counter-examples of ranks 10 and 12 respectively. We will discuss the relations of the deformation theory of the positive part W^n_+ of the Virasoro algebra and possible new counter-examples for an arbitrary rank $r \geq 13$.

Shigeyuki Morita

Constructions of cycles in the moduli space of Riemann surfaces and the moduli space of graphs

In this talk, I would like to discuss various methods of constructing (co)cycles in the moduli space of Riemann surfaces and the moduli space of graphs. More precisely, I will mention three methods which make use of

1. the theory of group cohomology,
2. the natural cell decompositions of the moduli spaces and
3. the structure of the derivation algebra of surfaces via a theorem of Kontsevich.

A particular emphasis will be given on the comparison between the above two moduli spaces.

Tetsuhiro Moriyama

Configuration space and Casson invariant

In this talk, we define an invariant of the isotopy classes of diffeomorphisms between a rational homology 3-sphere by using the graph of maps. We also show that it is equal to the Casson-Walker invariant when the map is identity. By comparing the constructions of the degree one term of the Kontsevich-Kuperberg-Thurston invariant Z of rational homology 3-spheres and our invariant, we can see a direct relation between them.

The invariant Z was constructed by Kontsevich by using the configuration space integrals, and Lescop proved that the degree one term of Z coincides with the Casson-Walker invariant. Roughly speaking, the complement of the graph of a map, which is used to define our invariant, corresponds to the two-point configuration space.

Juno Mukai

Determination of the order of the P-image by Toda brackets

The purpose of this talk is to try to determine the orders of Whitehead products $[\iota_n, \alpha]$ for $n \geq k+2, k \leq 24$, where ι_n is of the identity class of an n-sphere S^n and α is an element of the 2-primary components of the k-stem of the homotopy groups of S^n. We use the classical methods of homotopy theory, i.e. mainly the results of Kervaire, Mahowald, Mimura, Nomura, Oda and Toda.

Aniceto Murillo

Mapping spaces from the rational point of view

In this talk we present basic constructions of the rational homotopy type of mapping spaces (free and pointed) based in the Brown-Szczarba approach to the Haefliger model of such spaces. This will lead to the full description of the homotopy Lie algebra structure of mapping spaces and to a manageable computation of evaluation subgroups. (Joint work with Urtzi Buijs)

Haruko Nishi

A parametrisation of the Teichmüller space by polygons

In this talk, we present a parametrizaion of the Teichmüller space of hyperelliptic curves by Euclidean polygons. There is a natural way to associate nonsingular Euclidean polygons to hyperelliptic curves. We shall introduce a notion of marked Euclidean cone manifold to extend such an association to general Euclidean polygons. Joint work with Kenichi Ohshika.

Jun O'Hara

Conformal geometry of knots

(joint work with R. Langevin (Université de Bourgogne)

I will introduce the "infinitesimal cross ratio", which is a conformally invariant complex valued 2-form on $K \times K \setminus \triangle$, where K is a knot. I will show that it can express the "energy of knots", and also give the meanings of its real and imaginary parts using the symplectic form and the semi-Riemannian structure of $S^3 \times S^3 \setminus \triangle$.

Gilles Robert

Poincaré maps and Bol's theorem

The usual Poincaré map is defined for a four-web admitting three independent Abelian relations, and gives a natural projective model of the web where the leaves are straight lines. This model thus proves that the web is associated with a quartic curve in the dual projective plane.

We shall present a generalization of this situation to the case of five-webs for which every extracted three-web carries an Abelian relation. This generalization takes into account not only the Abelian relations of the web, but also the spaces of Abelian relations of the extracted sub-webs. This way we prove the following theorem of G. Bol:

> If all extracted three-webs of a five-web admit an Abelian relation, then the web is diffeomorphic either to five pencils of straight lines, or to Bol's exceptional example.

The main tool used in the separation of cases is a careful investigation of the configuration formed by the spaces of relations of the extracted sub-webs in the space of relations of the whole web.

Mario Salvetti

On the cohomology and topology of Coxeter and Artin groups

We consider topological combinatorial constructions of orbit-spaces and $K(\pi, 1)$-spaces for Coxeter groups and Artin groups, in particular in the infinite case. We use them to perform calculations of the cohomology of these spaces.

Radu Stancu

A reduction theorem for fusion systems of blocks

Let p be a prime number. Fusion systems on finite p-groups were introduced by L. Puig and provide an axiomatic framework for studying p-fusion in finite groups. This axiomatic point of view has been very useful in determining many properties of finite groups and of the p-completion of their classifying spaces as well as in modular representation theory. As well, it underlies the theory of p-local finite groups developed by C. Broto, R. Levi and R. Oliver.

Let k be an algebraically closed field of characteristic p and G a finite group. An interesting question for fusion systems is whether they can be obtained from the local structure of a block of the group algebra kG. In this talk I present a joint work with Radha Kessar on some methods to reduce this question to the case when G is a central p'-extension of a simple group. As an application of our result, we obtain that the 'exotic' examples of fusion systems discovered by Ruiz and Viruel do not occur as fusion systems of p-blocks of finite groups.

Peter Symonds

Cohomology and fusion for groups of finite vcd

We consider various ways of proving Mislin's theorem on homomorphisms between groups that induce an isomorphism in mod-p cohomology. We then show how we can obtain a result for groups of finite virtual cohomological dimension (discrete or profinite) and ask what should be understood by fusion for such groups.

Laurence R. Taylor

Cohomology of some configuration spaces and associated bundles

We will discuss some recent work with F. Cohen on the cohomology of configuration space bundles. These are bundles associated to vector bundles but with a fibre over a point being the space of k distinct points in that fibre. The calculation of their cohomology mimics the Euclidean space case but there are some surprises especially in the equivariant structure given by the natural symmetric group actions.

Stephen Theriault

The odd primary H-structure of $SU(n)$ in low rank

$SU(n)$ has a classifying space so it is a loop space, making it homotopy associative. James and Thomas showed that a homotopy commutative Lie group must be a torus, so $SU(n)$ is not homotopy commutative. This commutativity statement is integral. We show that after localizing at an odd prime, $SU(n)$ is in fact homotopy commutative if n is less than or equal to $(p-1)(p-2)$. We then describe some consequences.

Ulrike Tillmann

Cobordism categories and their classifying spaces

I will report on recent work with Ib Madsen, Soren Galatius, and Michael Weiss in which we show that the cobordism category of $d-1$ dimensional closed, compact manifolds and their d dimensional cobordisms is the infinite loop space associated to the spectrum MO_d shifted by $d-1$ dimensions. There is a similar theorem in the oriented case.

This work was motivated by the case $d = 2$ which plays an important role in topological conformal field theory and recently led to the proof of the Mumford conjecture by Madsen and Weiss.

Victor Turchin

Dyer-Lashof-Cohen operations in Hochschild cohomology

It is already well known that Hochschild cohomology complex is endowed with an action of an operad quasi-isomorphic to the chains operad of little squares. It means in particular that Hochschild cohomology has the same operations as the homology of double loop spaces. For instance, cup-product corresponds to Pontriagyn product, Gerstenhaber bracket corresponds to the Browder operator. We will present explicit formulae for unary Hochschild cohomology operations analogous to operations ξ_1 and ζ_1 introduced by Araki-Kudo for $p = 2$ and by F. Cohen for $p > 2$.

Alexander Varchenko

The $(\mathfrak{gl}_n, \mathfrak{gl}_k)$-duality and critical points of master functions

The Bethe eigenvectors of the Gaudin model associated with a tensor product of representations of a Lie algebra are constructed using critical points of the associated master function.

The $(\mathfrak{gl}_n, \mathfrak{gl}_k)$-duality provides a situation in which the Gaudin model associated with a tensor product of k representations of $\mathfrak{gl}_n$ is isomorphic to the Gaudin model associated with a tensor product of n representations of $\mathfrak{gl}_k$. In this situation one must expect a correspondence between the critical points of the two associated master functions.

I will explain this correspondence.

Vladimir Vershinin

Generalized braids and their presentations

We consider various presentations for the generalizations of braids. Here we give two examples.

In his initial paper on braids E. Artin gave a presentation of an arbitrary braid group with two generators. The analogous presentation for the complex braid group $B(2e, e, r)$ have the generators τ_2, τ, σ, τ_2' and relations

$$\begin{cases} \tau_2\tau^i\tau_2\tau^{-i} & = \tau^i\tau_2\tau^{-i}\tau_2 \ \text{ for } \ 2 \le i \le r/2, \\ \tau^r & = (\tau\tau_2)^{r-1}, \\ \sigma\tau^i\tau_2\tau^{-i} & = \tau^i\tau_2\tau^{-i}\sigma, \ \text{ for } \ 1 \le i \le r-2, \\ \sigma\tau_2'\tau_2 & = \tau_2'\tau_2\sigma, \\ \tau_2'\tau\tau_2\tau^{-1}\tau_2' & = \tau\tau_2\tau^{-1}\tau_2'\tau\tau_2\tau^{-1}, \\ \tau\tau_2\tau^{-1}\tau_2'\tau_2\tau\tau_2\tau^{-1}\tau_2'\tau_2 & = \tau_2'\tau_2\tau\tau_2\tau^{-1}\tau_2'\tau_2\tau\tau_2\tau^{-1}, \\ \underbrace{\tau_2\sigma\tau_2'\tau_2\tau_2'\tau_2\tau_2'\dots}_{e+1 \text{ factors}} & = \underbrace{\sigma\tau_2'\tau_2\tau_2'\tau_2\tau_2'\tau_2\dots}_{e+1 \text{ factors}}\ . \end{cases}$$

In the second example we give an analogue of the Sergiescu graph presentation.

Theorem 1. *Let Γ be a planar graph with n vertices. The singular braid monoid SB_n has the presentation $\langle X_\Gamma, R_\Gamma\rangle$ where $X_\Gamma = \{\sigma_a, \sigma_a^{-1},\ x_a |\ a$ is an edge of $\Gamma\}$ and R_Γ is formed by the following six types of relations:*

- *disjointedness: if the edges a and b are disjoint, then*

$$\sigma_a\sigma_b = \sigma_b\sigma_a,\ x_a x_b = x_b x_a,\ \sigma_a x_b = x_b\sigma_a,$$

- *commutativity:*

$$\sigma_a x_a = x_a\sigma_a,$$

- *invertibility:*

$$\sigma_a\sigma_a^{-1} = \sigma_a^{-1}\sigma_a = 1,$$

- *adjacency: if the edges a and b have a common vertex, then*

$$\sigma_a\sigma_b\sigma_a = \sigma_b\sigma_a\sigma_b, \quad x_a\sigma_b\sigma_a = \sigma_b\sigma_a x_b,$$

- *nodal: if the edges a, b and c have a common vertex and are placed clockwise, then*

$$\sigma_a\sigma_b\sigma_c\sigma_a = \sigma_b\sigma_c\sigma_a\sigma_b = \sigma_c\sigma_a\sigma_b\sigma_c,$$

$$x_a\sigma_b\sigma_c\sigma_a = \sigma_a\sigma_b\sigma_c x_a, \quad \sigma_a\sigma_b x_c\sigma_a = \sigma_b x_c\sigma_a\sigma_b, \quad x_a\sigma_b x_c\sigma_a = \sigma_b x_c\sigma_a x_b,$$

- *pseudocycle: if the edges $a_1, \ldots, a_n$ form an irreducible pseudocycle and if a_1 is not the starting edge nor a_n is the end edge of a reverse, then*

$$\sigma_{a_1}\ldots\sigma_{a_{n-1}} = \sigma_{a_2}\ldots\sigma_{a_n}, \quad x_{a_1}\sigma_{a_2}\ldots\sigma_{a_{n-1}} = \sigma_{a_2}\ldots\sigma_{a_{n-1}}x_{a_n}.$$

Alexander A. Voronov

Configurations of points on the sphere

Configurations of points on the n-sphere turn out to span a bridge between the Hochschild homology of n-algebras on the one hand and free n-sphere spaces on the other. We will discuss joint results with Martin Markl, which generalize the classical $n = 1$ case, due to Burghelea and Fiedorowicz.

Miguel A. Xicotencatl

Orbifold string topology

It is well known that the category of orbifolds is equivalent to the category of proper etale groupoids modulo Morita equivalences. This allows one to talk about the classifying space of an orbifold or even the loop groupoid of a representing groupoid. Moreover in the case of a global quotien $X = [M/G]$, we can follow the methods of R. Cohen and J. Jones to define a Chas-Sullivan string product on the homology of the free loop space of the classifying space of an orbifold. The resulting ring is a BV algebra and realizes the Chas-Sullivan construction in the case in which the orbifold is a manifold.

Masaaki Yoshida

Automorphic functions for Whitehead-link-complement group

The Whitehead link is known to admit a hyperbolic structure. We construct automorphic functions for the Whitehead-link-complement group, and embed the quotient space to a Euclidean space.

List of Registered Participants

The following is the list of registered participants as of June 30, 2005.

- Abbaspour, Hossein (Ecole Polytechnique)
- Adem, Alejandro (University of Wisconsin-Madison)
- Aguade, Jaume (Universitat Autonoma de Barcelona)
- Akita, Toshiyuki (Department of Mathematics, Hokkaido University)
- Asuke, Taro (Graduate School of Mathematical Sciences, The University of Tokyo)
- Bauer, Kristine (University of Calgary)
- Bauer, Tilman (Universität Münster)
- Berkove, Ethan (Lafayette College)
- Berrick, A. Jon (National University of Singapore)
- Brunetti, Maurizio (Università di Napoli)
- Budney, Ryan (University of Oregon)
- Callegaro, Filippo (Scuola Normale Superiore di Pisa)
- Casacuberta, Carles (Universitat de Barcelona)
- Cohen, Daniel C. (Louisiana State University)
- Cohen, Fred (Universitry of Rochester)
- Cohen, Ralph (Stanford University)
- Costoya, Cristina (University of Aberdeen)
- De Concini, Corrado (Università di Roma "La Sapienza")
- Deguchi, Tetsuo (Department of Physics, Ochanomizu University)
- Dobrinskaya, Natalia (Moscow State University)
- Dung, Nguyen Viet (Institute of Mathematics, Hanoi, Vietnam)
- Feshbach, Mark (University of Minnesota)
- Foukzon, Jaykov (Israel Institute of Technology)
- Fukunaga, Eiko (Graduate School of Mathematical Sciences, The University of Tokyo)
- Futaki, Masahiro (Graduate School of Mathematical Sciences, The University of Tokyo)
- Garvin, Antonio (Universidad de Malaga)
- Gitler, Samuel (Cinvestav, Mexico)

- Gomi, Kiyonori (Graduate School of Mathematical Sciences, The University of Tokyo)
- Gray, Brayton (University of Illinois at Chiago)
- Grbic, Jelena (University of Aberdeen)
- Guest, Martin (Tokyo Metropolitan University)
- Han, Sang-Eon (Honam University)
- Hansen, Soren K (Kansas State University)
- Hattori, Akio (The University of Tokyo)
- Hemmi, Yutaka (Kochi University)
- Igusa, Kiyoshi (Brandeis University)
- Iriye, Kouyemon (Osaka Women's University)
- Ishiguro, Kenshi (Fukuoka University)
- Ishimoto, Hiroyasu (Kanazawa University)
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