Topology
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(Org: **Dale Rolfsen** (UBC))

ALEJANDRO ADEM, Department of Mathematics, UBC
On spaces of homomorphisms

In this lecture we describe properties of $\mathrm{Hom}(Q, G)$, where Q is a suitable discrete group and G is a Lie group.

KRISTINE BAUER, University of Calgary, Calgary, AB T3l 2W9
The topological Lie operad

The classical Lie operad is an operad of modules whose algebras are Lie algebras. Algebras which have the homotopy type of a Lie algebra are called strongly homotoply Lie algebras (or sometimes L_∞-algebras), and there is another operad which detects these. We construct a topological version of the L_∞ operad, whose algebras are topological spaces.

STEVEN BOYER, UQAM

IAN HAMBLETON, McMaster University, Hamilton, ON
Free actions on products of spheres

Which finite groups G can act freely and smoothly on a product of spheres $S^n \times S^n$? In the talk we will present old and new results on this problem—the answer is not yet known.

GABRIEL INDURSKIS, UQAM, Dept. de mathématiques, Case postale 8888, succursale Centre-Ville, Montréal, QC H3C 3P8
On the character varieties of manifolds obtained from the Whitehead link exterior by Dehn filling

A well-known method due to Riley characterizes the p-reps of the fundamental group of the exterior of a 2-bridge knot by the roots of a one-variable polynomial. (A p-rep of such a group is a representation with values in $\mathrm{SL}(2, C)$ which is parabolic on the peripheral subgroup.) We describe how to generalize this method to find the p-reps for all Dehn fillings on one boundary component of the Whitehead link exterior in terms of the filling slope. This is done by taking a "detour" through the eigenvalue variety of the unfilled manifold and using elimination theory to find a polynomial whose roots characterize the p-reps of the filled manifold. As an application, we determine the minimal Culler–Shalen norm for all such fillings and use this to make some statements about the structure of their character varieties.

RICK JARDINE, University of Western Ontario
Cocycle categories

This talk defines and gives applications of cocycle categories. The path components of such categories define morphisms in homotopy categories arising in a variety of algebraic and geometric settings. Applications in non-abelian cohomology theory, including the homotopy classification of gerbes, will be displayed.

RICHARD KANE, University of Western Ontario
Invariant Theory and Lie Groups

The $\mathrm{mod}\, p$ cohomology of a Lie group is a Hopf algebra, *i.e.*, both an algebra and a coalgebra. It is well known, going back to the work of Borel and Chevaley in the 1950's, that the rational cohomology of a connected Lie group G and of its classifying space BG can be determined from a knowledge of the invariant theory of the Weyl group of G. This same result holds in $\mathrm{mod}\, p$ cohomology provided p is not a torsion prime for G (p is a torsion prime if p torsion appears in the integral cohomology of G). Kac and Peterson introduced the concept of generalized invariants of a Weyl group and demonstrated that generalized invariants determine the $\mathrm{mod}\, p$ cohomology of G when p is a torsion prime. We will consider the relation between the generalized invariants of G and the coalgebra structure of the $\mathrm{mod}\, p$ cohomology of G.

ROBION KIRBY, Univ. of California, Berkeley, CA 94720-3840
Singular Lefschetz fibrations

Auroux, Donaldson and Katzarkov have shown that smooth 4-manifolds with near symplectic forms are singular Lefschetz pencils. I will discuss this work and attempts to extend it to other 4-manifolds.

This is joint work with David Gay.

ELENA KUDRYAVTSEVA, University of Calgary, Dept. of Math. and Stat., Calgary, AB T2N 1N4
On coincidence points of mappings of the torus into a surface

For an arbitrary pair of continuous maps (f, g) of the 2-torus T into an arbitrary surface S, the Wecken property for the coincidence problem is proved. This means that there exist homotopic maps f', g' such that each Nielsen class of coincidence points of (f', g') consists of one point and has a non-vanishing index. Moreover, every non-vanishing index is equal to ± 1, and every non-vanishing semi-index of Jezierski is equal to 1, if S is neither the sphere nor the projective plane.

Joint work with S. Bogatyi and H. Zieschang.

VICTOR NUNEZ, Cimat
Classical drawings of branched coverings

Given a branched covering $\varphi\colon S^3 \to (S^3, k)$, it is an interesting and very difficult problem to determine the link type of $\varphi^{-1}(k) \subset S^3$. If k is drawn in an n-bridge presentation, that is, if there is a 3-ball $B \subset S^3$ such that k is the union of n properly embedded arcs in B and n arcs on ∂B, it is tempting to try to recover $\varphi^{-1}(k)$ from a drawing of $\varphi^-1(B)$—an abstract drawing, not an embedding of $\varphi^{-1}(B)$ in S^3. It is well known that, if $\varphi^{-1}(B)$ is also a 3-ball, this is possible. If $\varphi^{-1}(B)$ is a handlebody of positive genus, an arbitrary drawing of $\varphi^{-1}(B)$ is generally misleading.

We give a description of how to embed $\varphi^{-1}(B)$ in S^3 in the general case, and, therefore, a complete criterion to recover the link type of $\varphi^{-1}(B)$ from an embedding of $\varphi^{-1}(B)$ in S^3. We also give some applications.

DORETTE PRONK, Dalhousie University
The Orbifold Construction

Orbifolds were originally defined as differentiable manifolds with singularities that can be described as quotients of an open subset of Euclidean space by the action of a finite group. Orbifolds have proved their usefulness in various contexts and today we have analytic, algebraic, topological, and differentiable orbifolds. This leads us to ask the following questions:

- what kind of results are applicable to all orbifolds?

- in what kind of categories can one define orbifolds?
- is there an orbifold construction?
- is there a natural class of orbifold morphisms?

We will begin to answer these questions from an abstract categorical view point, but we will also describe some of the concrete geometrical consequences.

This is joint work with Robin Cockett from the University of Calgary.

ANTONIO RAMIREZ, University of British Columbia, 1984 Mathematics Rd., Vancouver, BC V6T 1Z2
Open-closed string topology

The area of string topology began with a construction by Chas and Sullivan of previously undiscovered algebraic structure on the homology $H_*(LM)$ of the free loop space of an oriented manifold M. Among other results, Chas and Sullivan showed that $H_*(LM)$, suitably regraded, carries the structure of a graded-commutative algebra. The product pairing was subsequently extended by Cohen and Godin into a form of topological quantum field theory (TQFT). Open-closed string topology, first sketched by Sullivan, arises when considering spaces of paths in M with endpoints constrained to lie on given submanifolds (the so-called D-branes). In this talk, I describe a way to extend the TQFT structure of string topology into an analogue of TQFT which incorporates open strings. The method of construction is homotopy theoretic, and it makes use of constrained mapping spaces from fat B-graphs (which I define) into the ground manifold M.

DALE ROLFSEN, UBC, Vancouver, BC V6T 1Z2
Ordering knot groups

Classical knot groups are known to be right-orderable, by a theorem of Howie and Short. This means that the elements of the group may be given a strict total ordering which is invariant under right multiplication. Some knot groups can be given an ordering which is invariant under multiplication on both sides; the figure-eight is an example, as shown by B. Perron and the speaker. Others, such as torus knot groups, do not enjoy a 2-sided ordering. For most knots, the question of the existence of 2-sided orderings is still open. I will discuss this problem, including some new techniques, the conjecture that all knot groups are virtually orderable, and why we should care about the question.

LAURA SCULL, UBC
The Equivariant Fundamental Groupoid

I will discuss a Seifert–Van Kampen Theorem for the equivariant fundamental groupoid.

DONALD STANLEY, University of Regina, Department of Mathematics, College West 307.14, Regina, Saskatchewan
Refining Poincaré Duality

We refine Poincaré duality by showing that closed manifolds satisfy Poincaré duality at the chain level. More precisely we prove that every commutative differential graded algebra whose cohomology is a simply-connected Poincaré duality algebra is quasi-isomorphic to one whose underlying algebra is simply-connected and satisfies Poincaré duality in the same dimension. We apply our result to the study of CDGA models of configuration spaces on a closed manifold.

JENS VON BERGMANN, University of Calgary
Compactness for Moduli Spaces of $\mathcal{H}$-Holomorphic Maps

We prove compactness of the moduli space of $\mathcal{H}$-holomorphic maps with varying complex structure on the domain into a certain subclass of stable almost contact mansifolds. The compactness statement differs from that for J-holomorphic maps as one needs a compactification of the domains that is different from Deligne-Mumford and one needs to fix the homotopy class of maps rather than just the homology class. This result is needed for the compactness of the moduli space of pseudoholomorphic maps into folded symplectic manifolds and its possible generalization to all contact manifolds is the missing link in Hofer's scheme to prove the Weinstein conjecture.

GENEVIEVE WALSH, University of Texas at Austin, Dept. of Math., Austin, Texas 78712
Which knots are great?

A great circle link is a link of geodesic circles in S^3. We say that a knot is *great* if its complement is commensurable with the complement of a great circle link. All great circle link complements are fibered. Therefore, if a knot is great, its complement is virtually fibered. Provably great knots include: two-bridge knots, spherical Montesinos knots, and torus knots. We will discuss these knots and speculate on the greatness of other knots.

LIAM WATSON, UQAM mathématiques, Montréal, QC H3C 3P8
Tangle surgery and the Jones polynomial

Eliahou, Kauffman, and Thistlethwaite have given examples of non-trivial links (with 2 or more components) that have trivial Jones polynomial. However, it is still unknown if there is a non-trivial knot with Jones polynomial 1. As this question remains open, I will present a construction for producing pairs of prime knots with the same Jones polynomial that uses machinery similar to that of Eliahou, Kauffman, and Thistlethwaite.

PETER ZVENGROWSKI, University of Calgary
Recent Progress in the Span of Smooth Manifolds

The span of a smooth manifold M is a classical invariant, defined as the maximal number of (pointwise) linearly independent tangent vector fields on M. We shall also consider the related concepts of stable span and immersion codimension. Some recent progress (with D. Crowley) showing that these invariants can depend on the smoothness structure of M will be described, as well as some recent progress (with J. Korbaš and P. Sankaran) related to the span of a specific family of manifolds, the projective Stiefel manifolds $X_{n,r}$.

In the former case we shall give examples of manifolds in dimension 15 and higher where the span, stable span, and immersion codimension can be different for different smoothness structures. In the latter case we shall show how various techniques can be applied, in particular the ring structure in (complex) K-theory, to obtain refined estimates of the span of $X_{n,r}$.