Titles & Abstracts

Tom Baird (Memorial): Classifying spaces of twisted loop groups

Abstract: Given a Lie group G and an automorphism $\sigma \in G$, the twisted loop group $L_\sigma G$ is the group of continuous paths $\gamma : [0,1] \to G$ such that $\gamma(1) = \sigma(\gamma(0))$. Note that if σ is the identity, then $L_\sigma G$ is the usual (continuous) loop group LG. These groups arise in various places in gauge theory and representation theory.

In this talk, I will explain how to derive formulas for cohomology ring of the classifying space, $H^*(BL_\sigma G)$ when G is compact and connected, and σ has finite order modulo inner automorphisms. The method of proof can be used more generally to calculate the equivariant cohomology of compact Lie group actions with 'constant rank stabilizers'.

Peter Bubenik (Cleveland State): Topological Data Analysis and Representation Theory

Abstract In the past decade there has been an increasing appreciation the ability of topology to assemble local data to give global summaries of the 'shape of data'. In the standard setting one starts with a filtered topological space, applies homology with coefficients in a field, and gets a sequence of vector spaces and linear maps. More generally one starts with a diagram of topological spaces and obtains a diagram of vector spaces. I will introduce and summarize some of this work and show how difficult problems in representation theory lie at the heart of the subject.

Eddy Campbell (New Brunswick): Invariant Theory of $GL_n(F) \times F^*$

Abstract: This talk is about the relationship between recent joint work with Chuai, Shank and Wehlau to older joint work with Paul.

In the late 80's, Paul and I investigated a "twisted" action of the Steenrod algebra on polynomial algebras over fields of order $q = p^s$. These twisted actions are naturally associated to the action of the group of units of F_q on a polynomial algebra on s generators. The setting led to results in unstable homotopy theory by Harris, Hunter and Shank, to joint work with Hughes, Pappalardi and Selick and to joint work with Harris and Wehlau in invariant theory.

Shank, Wehlau and I recently studied the invariant theory of 3-dimensional representations of elementary Abelian subgroups of order a power of p, a prime. In this context, we found an action of $GL_n(F_q) \times F_1^*$ on a polynomial algebra $F_q[x_1, \cdots, x_n]$. The invariant

theory of this group action is related to the actions just described, but somewhat more difficult to analyze.

Steve Halperin (Maryland): Rational homotopy theory for non-nilpotent spaces

Abstract: The techniques introduced by Sullivan in 1972 can be applied to the study of non-nilpotent spaces and their fundamental groups. I will sketch the general framework and then outline the steps in the proof of

Theorem (Félix, Halperin, Thomas) Let Γ be the Malcev completion of the fundamental group of a finite dimensional connected Sullivan CW-complex X. Then

1. The subgroup, K, generated by all the normal solvable subgroups of Γ is a Malcev complete nilpotent group.
2. The lower central series $K = K^1 \supset \cdots \supset K^r \supset \cdots$ satisfies

$$\Sigma_r \dim K^r/K^{r+1} \leq \dim X.$$

Megumi Harada (McMaster): The cohomology of Hessenberg varieties and representations of the symmetric group

Abstract: Hessenberg varieties are subvarieties of the full flag variety of nested sequences of subspaces in $\mathbb{C}^n$, and they appear in many areas of mathematics, including but not limited to: geometric representation theory, combinatorics, Schubert calculus, and the study of quantum cohomology. Special cases of Hessenberg varieties are: Springer varieties, Peterson varieties, and certain toric varieties associated to Weyl group orbits. In this talk, we will discuss a relation between cohomology rings of regular nilpotent Hessenberg varieties (e.g. Peterson varieties) and regular semisimple Hessenberg varieties (e.g. the toric varieties associated with Weyl chambers) in terms of representations of a symmetric group. We will also discuss a relation between our work and a conjecture of Shareshin and Wachs in combinatorics. This is joint work with Hiraku Abe, Tatsuya Horiguchi, and Mikiya Masuda.

Rick Jardine (Western Ontario): Path categories and algorithms

Abstract: The path category $P(K)$ of a cubical complex K is a categorical invariant which is defined much like the fundamental groupoid, except that directions of paths are not formally reversed. This construction has applications in theoretical computer science, where it gives a description of execution paths in geometric models for the behaviour of parallel processing systems.

The theory of path categories for finite cubical and simplicial complexes will be reviewed. There is an algorithm for computing the path category $P(K)$ of a finite complex K, which is based on its path 2-category. This "2-category algorithm" will be displayed, and complexity reduction methods for the algorithm will be discussed.

Patching techniques are required for addressing large computational examples. Path categories appear most naturally within Joyal's homotopy theory of quasi-categories, and Joyal's theory admits a local to global extension to categories of simplicial presheaves.

Derek Krepski (Manitoba): On surface group representations and prequantization

Abstract: Let G be a compact connected Lie group and let Σ be an oriented surface. This talk considers the space $M_G(\Sigma; C)$ of G-representations of the fundamental group of Σ (up to conjugation) satisfying prescribed boundary conditions $C = (C_1, \ldots, C_s)$ for a collection of conjugacy classes $C_j \subset G$ (i.e. representations $\rho : \pi_1(\Sigma) \to G$ with $\rho|_{S_j} \in C_j$ for each boundary component $S_j \subset \partial\Sigma$). We describe the connected components of $M_G(\Sigma; C)$ for non-simply connected simple G and discuss the obstruction to the existence of a prequantization (a complex line bundle whose curvature class coincides with the natural symplectic form on $M_G(\Sigma; C)$) when $G = PU(p)$, the projective unitary group with p prime.

Joe Neisendorfer (Rochester): What is loop multiplication anyhow?

Abstract: In the beginning we are taught that multiplication of pointed loops is just the first followed by the second. Later we learn that the cobar construction on the chains of the base is a model for the chains on the loop space, that is, this cobar construction is chain equivalent to the chains on the loop space. The cobar construction is a certain tensor algebra and has a natural multiplication of tensors. This multiplication of tensors models the multiplication induced by the multiplication of loops. But, because of the simplicity of the definition of loop multiplication, this modeling is not obvious. We interpret loop multiplication so that this modeling becomes a clear consequence of the naturality of Eilenberg-Moore methods. In contrast, we observe that, if we require that it be invariant under homological equivalence of differential coalgebras, there is no natural modeling of the comultiplication in the loop space. But, in rational homotopy theory, results of Milnor-Moore and Quillen show that there is a natural modeling of the Hopf algebra structure of the loop space.

Jim Shank (Kent): Modular invariants of elementary abelian p-groups

Abstract: Elementary abelian p-groups play an important role in algebra and topology, often proving to be a fundamental special case or providing a useful setting in which to explore complex phenomena. I will discuss the rings of invariants of modular representation of elementary abelian p-groups, paying particular attention to recent work on parameterised families of three dimensional representations.

Jie Wu (Singapore): Combinatorial approach to the exponents

Abstract: (Joint with Fred Cohen and Roman Mikhailov.) This talk will be a report of our recent progress on the combinatorial approach to the exponents of Moore spaces using Cohen's program. By working out the combinatorics of the Cohen groups, we obtain that the power map p^{r+1} on the loop space of the mod p^r Moore space $P^{2n+1}(p^r)$ projecting to the atomic piece $T^{2n+1}\{p^r\}$ is null homotopic for $p > 3$, $n > 1$ and $r > 1$. This gives a shorter proof on the exponents of Moore spaces using the Cohen groups.

For mod 2 Moore spaces, we consider the exponents of metastable homotopy. By using the Cohen group to control the obstructions to the exponent together with some special properties of $4n$-dimensional mod 2 Moore spaces, we obtain that the double loop space of $4n$-dimensional mod 2 Moore space has exponent 4 up to the range below 4 times the connectivity. In particular, there is no $\mathbb{Z}/8$-torsion in the metastable homotopy groups of $4n$-dimensional mod 2 Moore spaces.