Pacific Institute *for the* Mathematical Sciences

GEOMETRIC AND TOPOLOGICAL ASPECTS OF THE REPRESENTATION THEORY OF FINITE GROUPS

Program

July 27 - August 5, 2016

Summer School: July 27-30
Workshop: August 1-5

The University of British Columbia
Earth Sciences Building (ESB)
2207 Main Mall, Vancouver

NATIONAL SECURITY AGENCY
UNITED STATES OF AMERICA

Universität Bielefeld

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PIMS

Booklet Contents

Pacific Institute *for the* Mathematical Sciences

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Getting Started

Get connected: Select the "ubcvisitor" wireless network on your wireless device. Open up a web browser, and you will be directed to the login page.

FAQs

Q: Where do I check in on the first day?

Check- in and package pick up can be done in the Atrium.

Q: Where are the sessions?

All Summer School Sessions are in ESB 2012

Workshop Sessions are in ESB 1012 and 1013

You will find a copy of the building floor on page 3 and a campus map at the end of the program.

Q: Will the program change?

Program changes and updates will be announced at each session.

Q: When should I wear my badge?

Please wear your name badges at all times on site so that PIMS Staff recognize you as a guest.

Q: Where can I go for help on site?

If you need assistance or have a question during the conference, please feel free to talk to one of the organizers.

Q: Where can I get refreshments and meals?

For snacks or quick meals, please view the list of UBC eateries attached at the end of the program. Coffee breaks are provided each day of the summer school and workshop.

Q: Where can I get directions for campus and the building?

You will find a copy of the building floor on page 4 and a campus map at the end of the program.

Q: Where can I get a cab to pick me up from the Venue?

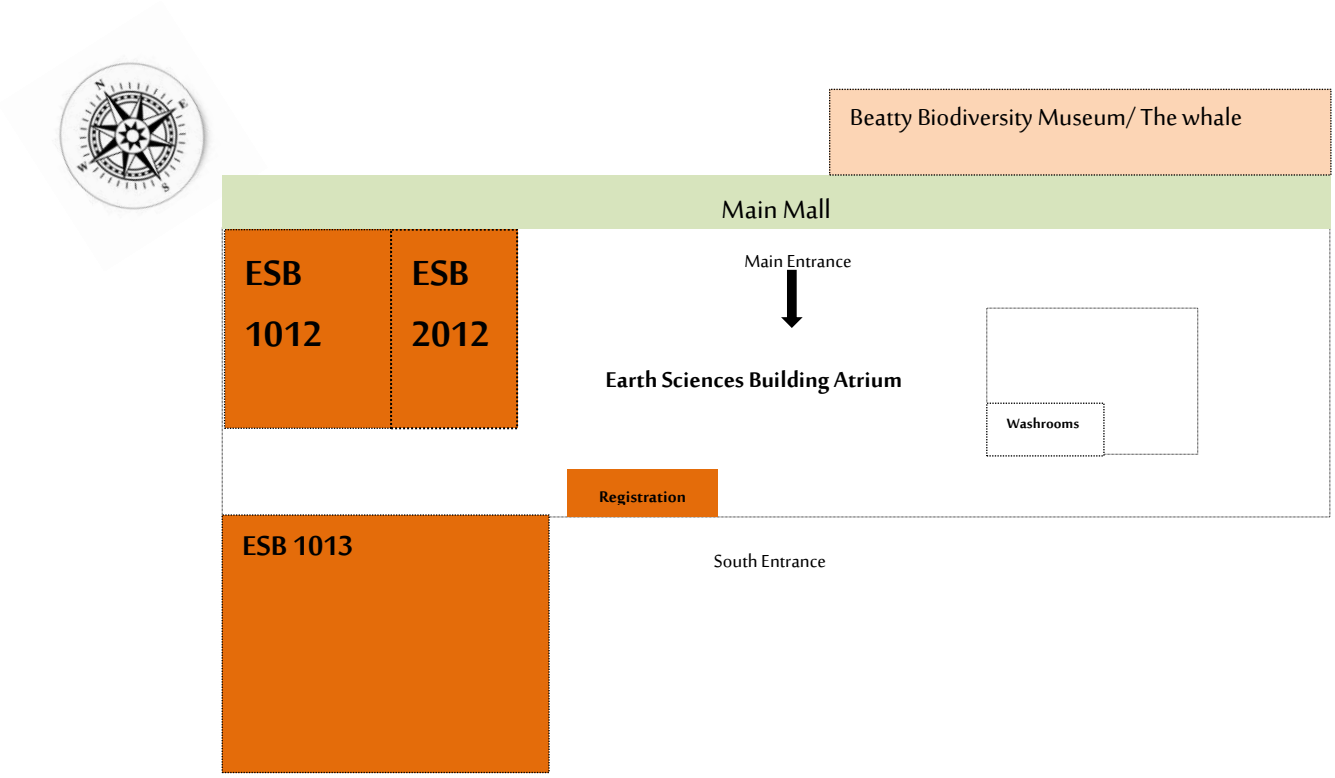
You can call Yellow Cab (604-681-1111) and request to be picked up at the intersection of West Mall and Bio. Sciences Road. Use the south entrance and walk straight down to the intersection.

There will be photography throughout this event. PIMS' event photography is used across a variety of our communications platforms including web, print and electronic promotional materials. If, for any reason, you wish not to have your photo taken or used in this manner, please contact the event organizers.

Meeting Room Guide:

All Summer School Sessions: **July 27- 30 in ESB 2012**

All Workshop Sessions: **Aug 1- 5 in ESB 1012 and 1013**



** Not drawn to scale. See detailed UBC map on the last page.

General Travel Directions:

Airport to UBC: Easiest by taxi (25min, around $30). By public transport, take the Canada Line (rail) to Broadway-City Hall station. From Broadway-City Hall station, cross Broadway and Cambie streets to get to the #99 UBC bus stop in front of London Drugs. Cost: approximately $6-8CAD. Journey time: Circa more than 1 hour

UBC Bus Loop to Earth Science Building (ESB) 2207 Main Mall: A quick 10min walk. See UBC map. Head west past the student union building, cross East Mall and get onto Main Mall. Turn left (South) on Main Mall and Earth Science Building will be on your right after a few minutes. It is a large new building, and is on Main Mall directly across from the Beatty Biodiversity Centre and prominent blue whale skeleton.

Public Transit: Feel free to search and plan your public transport rides by visiting http://www.translink.ca/, where directions, ticket costs and bus schedules are indicated. **Parking at UBC**: https://parking.ubc.ca/find-parking . **UBC Map** http://www.maps.ubc.ca/PROD/images/pdf/ubcmap.pdf and also on the last page of this schedule.

Summer School: Schedule

Course Speakers

1. **Eric Friedlander, University of Southern California, U.S.A.**
   Rational cohomology and supports for linear algebraic groups
2. **Jesper Grodal, University of Copenhagen, Denmark.**
   Endotrivial modules for finite groups via homotopy theory
3. **Radha Kessar, City University, London, U.K.**
   Local representation theory
4. **Peter Symonds, University of Manchester, U.K.**
   Endo-trivial modules for infinite groups

Time/ Day	Wed June 27	Thur June 28	Fri June 29	Sat June 30
8:30am-8:50am	**Check-in (ESB Atrium) & PIMS Welcome**			
9:00am-10:15am	**Prof. Radha Kessar** Local representation theory	**Prof: Jesper Grodal** Endotrivial modules for finite groups	**Prof. Radha Kessar** Local representation theory	**Prof.Jesper Grodal** Endotrivial modules for finite groups
Coffee Break (ESB 2012 Lobby)				
10:45am-12:00pm	**Prof: Jesper Grodal** Endotrivial modules for finite groups	**Prof. Radha Kessar** Local representation theory	**Prof: Jesper Grodal** Endotrivial modules for finite groups	**Prof. Radha Kessar** Local representation theory
Lunch (See List of UBC Eateries)				
2:00pm-3:15pm	**Prof. Eric Friedlander** Rational cohomology and supports for linear algebraic groups	**Prof. Peter Symonds** Endotrivial Modules for Infinite Groups	**Prof. Eric Friedlander** Rational cohomology and supports for linear algebraic groups	**Prof. Peter Symonds** Endotrivial Modules for Infinite Groups
Coffee Break (ESB 2012 Lobby)				
3:45pm-5:00pm	**Prof. Peter Symonds** Endotrivial Modules for Infinite Groups	**Prof. Eric Friedlander** Rational cohomology and supports for linear algebraic groups	**Prof. Peter Symonds** Endotrivial Modules for Infinite Groups	**Prof. Eric Friedlander** Rational cohomology and supports for linear algebraic groups
Evening Events	**5:00pm- 6:30pm** Welcome Reception and Networking Event: **(ESB Atrium)**			

Summer School: Course Readings

The summer school speakers have prepared a list of readings for the course. Please review the below courses readings an preparation material.

Eric Friedlander, University of Southern California, U.S.A

Rational cohomology and supports for linear algebraic groups

Linear algebraic groups and rational representations

1. J. Humphreys, Linear Algebraic Groups, GTM 1975
2. J. Jantzen, Representations of Algebraic Groups, MSM 2003

Frobenius kernels

3. W. Waterhouse, Introduction to Affine Group Schemes, GTM 1979
4. F-Suslin, Cohomology of finite group schemes over a field,Invent. Math 1997

1-parameter subgroups and support varieties

5. Suslin-F-Bendel, Infinitesimal 1-parameter subgroups and cohomology & Support varieties for infinitesimal group schemes, JAMS 1997.
6. Friedlander, Support varieties for rational representations,Compos. Math 2015

Cohomological calculations

7. F-Parshall, On the cohomology of algebraic and related finite groups, Invent. Math 1982
8. Suslin-F-Bendel, ibid

Jesper Grodal, University of Copenhagen, Denmark.

Endotrivial modules for finite groups via homotopy theory

In my 4 lectures I'll show how to use homotopy theory to determine groups of endotrivial modules for G a finite group, in particular those endotrivial modules which restrict to a trivial module direct sum a projective on a Sylow p-subgroup. We will start from from basics, and end with a solution to a conjecture of Carlson--Thevenaz and calculations for e.g., the Monster. We'll try to have plenty of concrete examples and calculations throughout, and see a number of classical concepts from algebraic topology applied to a problem in representation theory. An approximate outline is listed below:

Lecture 1: Endotrivial and Sylow-trivial modules -- an overview.

New concepts (also to be talked about during exercises?): kG-modules, categories and functors, orbit categories, cohomology of spaces and categories, limits over arbitrary indexing categories.

Lecture 2: Subgroup complexes and coefficient systems

New concepts: nerves of categories, subgroup complexes, coefficient systems, Thomason's theorem, Rickard's theorem, the Steinberg complex.

Lecture 3: Fundamental groups and fusion systems

New concepts: Fundamental groups of categories, manipulations with nerves, fusion systems, Alperin's fusion theorem.

Lecture 4: Homology decompositions and the Carlson-Thevenaz conjecture

New concepts: The isotropy spectral sequence.

Radha Kessar, City University, London, U.K.

Local representation theory

Some familiarity with the basics of representation theory of finite groups and finite dimensional associative algebras would be helpful. Suggested background reading:

1. J.L Alperin and R. B Bell, Groups and Representations , GTM 162, Springer 1995
2. J. Thevenaz, G-algebras and modular representation theory, OUP, 1994, Chapter 1.

For a more expanded version, a good source is:

3. C. Curtis and I. Reiner, Methods of representation theory, Wiley 1982.
4. H. Nagao and Y. Tsushima, Representations of finite groups, Academic Press, 1989, Chapters 1 and 2

For a quick immersion into modular representation theory, there is:

5. (e) J. L Alperin, Local Representation Theory, CUP 1986. Chapters 1, 2 and 3

Peter Symonds, University of Manchester, U.K.

Endotrivial Modules for Infinite Groups

Prerequisites:

- First of all, a basic knowledge of homological algebra: chain complexes, projective and injective resolutions and constructions involving them. We won't mention the derived category or spectral sequences except in passing, but a basic understanding of the former would provide some context for what we do.
- You will also want to know what a triangulated category is and why the stable category of the modular group ring of a finite group (or, more generally, of a Frobenius algebra) and various categories of chain complexes are triangulated.
  There are many texts on this, e.g.
  1. Happel, Triangulated categories and and the representation theory of finite dimensional algebras.
  2. Weibel, Introduction to homological algebra.
- Some very basic theory about the (modular) representations of groups will also be needed. Tensor product, Hom, induction (and coinduction for infinite groups). There are many books on this (and another course in this summer school).

Background:

- We will only need some basic facts about endotrivial modules for finite groups and we will go over them. But if you want to know what can be done, there is a survey article by Thevenaz in Geck, Testermann and Thevenaz, Group representation theory.
- We won't say much about the cohomology of groups, but it provided the motivation for much of this work. If you are keen, it would be good to skim enough of KS Brown, Cohomology of Groups to be able to follow Chapter X. Actually, what we will do is closer to Ikenaga, Homological dimension and Farrell Cohomology, J Algebra 1984.
- Finally, if you know anything about Gorenstein projective modules, that will provide some context. I can't think of any sources close to what we need that are not rather technical. Possibly Enochs and Jenda, Relative homological algebra.

Workshop: Schedule

Monday Aug 1: ESB 1012

8:30am - 9:00am	Arrival and Package Pick up
9:00am - 9:15am	Opening Remarks and Welcome from PIMS
9:15am- 10:15am	**Markus Linckelmann, City University, London** On the Hochschild cohomology of block algebras of finite groups.
10:15am - 10:45 am	Coffee break (ESB Atrium)
10:45am - 11:45am	**Beren Sanders, University of Copenhagen** Adams isomorphism as a generalized Wirthmüller isomorphism
11:45am -- 2:00pm	Lunch (**Aug 1 is a statutory holiday in BC, review the open eateries on campus on page 15 and at the end of this schedule)
2:00pm - 3:00pm	**Justin Lynd, University of Montana** Automorphisms of linking systems
3:00pm - 3:30pm	Coffee break (ESB Atrium)
3:30pm - 4:30pm	**Frauke Bleher, University of Iowa** Deformation rings of endo-trivial modules of 2-groups
4:30pm - 5:15pm	**Jon F Carlson, University of Georgia** The Work of Dave Benson

Tuesday Aug 2: ESB 1012

9:15am - 10:15am	**Paul Balmer, University of California, Los Angeles** Transposing etale topology to modular representation theory
10:15am - 10:45 am	Coffee break (ESB Atrium)
10:45am - 11:45am	**Akhil Mathew, Harvard** Nilpotence and descent in equivariant cohomology theories
11:45am - 2:00pm	Lunch (See list of eateries after the program schedule)
2:00pm - 3:00pm	**Peter Webb, University of Minnesota** Canonical Mackey functors
3:00pm - 3:30pm	Coffee break (ESB Atrium)
3:30pm - 4:30pm	**Ran Levi, University of Aberdeen** The Loop space of a p-local group
6:00pm	**Group Dinner**: Sage Bistro. 6331 Crescent Rd, **Please ensure you have registered for this event by Monday August 1 at 2:00pm**

Wednesday Aug 3: ESB 1012

9:00am - 10:00am **Robert Guralnick, University of Southern California, Los Angeles**
Globally Irreducible Weyl Modules

10:00am - 10:30 am Coffee break (ESB Atrium)

10:30am - 11:30am **Greg Stevenson, University of Bielefeld:**
Relative stable categories of finite groups

11:30am - 12:30pm **Sarah Witherspoon, Texas A & M:**
Support Varieties for Hopf Algebras

12:30pm Free Afternoon

Thursday Aug 4: ESB 1013 & ESB 1012

Morning Session: ESB 1013

9:15am - 10:15am **Luchezar Avramov, University of Nebraska- Lincoln**
Homology over short Gorenstein rings and representations of Kronecker quivers

10:15am -10:45am Coffee break (ESB Atrium)

10:45am -11:45 am **Birge Huisgen-Zimmermann, University of Carlifornia, Santa Barbara**
Generic representation theory of quivers with relations

11:45am - 2:00pm Lunch (See list of eateries after the program schedule)

Afternoon Session: ESB 1012

2:00pm - 3:00pm **Paul Sobaje, University of Georgia**
Tilting modules for algebraic groups and their decompositions over Frobenius kernels

3:00pm - 3:30pm Coffee break (ESB Atrium)

3:30pm - 4:30pm **Mark Walker, University of Nebraska-Lincoln**
Adams operations for matrix factorizations

Friday Aug 5: ESB 1012

9:15am - 10:15am **Henning Krause, University of Bielefeld:**
Local duality for representations of finite group schemes

10:15am -10:45am Coffee break (ESB Atrium)

10:45am -11:45 am **Daniel Nakano, University of Georgia, Athens:**
On the existence of mock injective modules for algebraic groups

11:45am - 2:00pm	Lunch (See list of eateries after the program schedule)
2:00pm - 3:00pm	**Burt Totaro, University of Carlifornia, Los Angeles** Tightening the bounds: detection theorems for the cohomology and Chow ring of a finite group
3:00pm - 3:30pm	Coffee break (ESB Atrium)
3:30pm - 4:30pm	**Alejandro Adem,UBC** Homotopy Group Actions and Group Cohomology
4:30pm - 4:45pm	**Closing remarks from the organizers and Event Evaluation Surveys** Participants attending the Representation Thoery Workshop are required to fill in the event survey on the PIMS webpage or online here: https://goo.gl/H3QWyP

Workshop: Titles and Abstracts

Alejandro Adem, UBC

Homotopy Group Actions and Group Cohomology

Let G denote a finite group and X a CW-complex. A homotopy group action is defined as a homotopy class of maps BG --> BAut(X). In this talk we will analyze these actions using techniques from group cohomology. We will show how they relate to geometric actions and how they can be used to construct new examples. In particular we will discuss applications to a conjecture of Benson and Carlson about free group actions on products of spheres. This is joint work with Jesper Grodal.

Luchezar Avramov, University of Nebraska- Lincoln

Homology over short Gorenstein algebras and representation of Kronecker quivers

The talk concerns graded modules M over a commutative graded self-injective algebra R with Hilbert series $1+es+s^2$ over some field. The main results completely characterize the possible tables of graded Betti numbers of such modules. Those M that satisfy $M_i=0$ for $i \neq 0,1$ are precisely the representations of the Kronecker quiver Q with e arrows, and each point of view provides specific information on M. The talk is based on joint work with Courtney Gibbons and Roger Wiegand.

Paul Balmer, University of California, Los Angeles

Transposing etale topology to modular representation theory

Commutative separable ring objects (dubbed "tt-rings") appear in several interesting settings: as Bousfield localizations, as etale extensions in algebraic geometry, and as restriction to subgroups in several equivariant settings. Recently, Neeman established that the algebro-geometric example is "sharp", in that every such "tt-rings" in the derived category of a scheme precisely comes from the etale topology. In stable categories of finite groups, the same question is open: Do we know all tt-rings? Or is there an exotic etale topology in representation theory? We shall explain some progress on this question, which is joint work with Jon Carlson.

Frauke Bleher, University of Iowa

Universal deformation rings of endo-trivial modules of 2-groups

Let k be a field of positive characteristic p, and let G be a finite p-group. Alperin showed that every endo-trivial kG-module V lifts to an endo-trivial module over a complete discrete valuation ring of characteristic 0 with residue field k. If $p=2$ and G is either dihedral, semi-dihedral or generalized quaternion, I will generalize this result by determining the universal deformation ring $R(G,V)$ for all endo-trivial kG-modules V. One new technique is to use the action of the outer automorphism group of G on the deformations of V to determine the structure of $R(G,V)$. This is joint work with T. Chinburg and R. Soto.

Birge Huisgen-Zimmermann, University of Carlifornia, Santa Barbara

Generic representation theory of quivers with relations

Instead of shooting for a complete classification of the indecomposable modules with any fixed dimension vector over a finite dimensional algebra (a hopeless objective), one adopts the following strategy to attain a more modest goal: Namely, (1) one tries to determine the irreducible components of the algebraic varieties parametrizing these modules, and (2), one targets the ``generic

structure" of the modules encoded by each of the components (a module property is ``generic" for a component if it is shared by all modules in some dense open subset). We will outline the origins and present status of the theory. Then we will focus on a specific class of algebras and illustrate recent results with examples.

Robert Guralnick, University of Southern California, Los Angeles

Globally Irreducible Weyl Modules

Let G be a subgroup of GL(n,Z). We want to consider the problem of when the image of G is absolutely irreducible modulo p for all primes p. This reduction map was considered by Minkowski to get bounds for finite subgroups of GL(n,Q). Thompson showed that there was a close connection between this problem and quadratic forms. We will discuss this problem for the case that G are the Z-points of a simple Lie group for some irreducible representation. Dick Gross suggested the correct answer and we will discuss the proof of his suggestion. This is joint work with Skip Garibaldi and Dan Nakano.

Henning Krause, University of Bielefeld:

Local duality for representations of finite group schemes

Given a finite group scheme, its modular representations enjoy a Gorenstein property which implies a "local duality" for the representations supported at a point of the projective variety of the cohomology ring. To explain this new type of duality is the aim of my talk. All this is based on recent work with D. Benson, S. Iyengar, and J. Pevtsova.

Ran Levi, University of Aberdeen

The Loop space of a p-local group

The homotopy type of the loop space on the p-complete classifying space of a finite group was studied by myself and a few other researchers since the early 90s. The homology of such loop spaces is of particular interest from the homotopy theoretic point of view, as it exhibits a rather rigid behaviour, yet not very well understood. From the algebraic point of view, works of Benson-Greenlees-Iyengar suggest the loop space homology of p-completed classifying spaces provides interesting examples of much more general phenomena. In his 2009 paper “An algebraic model for chains on $\Omega BG^\wedge_p$” Benson showed that the homology can be defined purely algebraically through what he named a “squeezed resolution” for the group in question.

The theory of p-local finite and compact groups allows one to study homotopy theoretic and algebraic properties of p-completed classifying spaces in a very general context, and where a genuine group is not necessarily available. Thus the question that arises naturally is whether one can construct an analog of a squeezed resolution for p-local groups. The answer to this question turns out to be positive in a more general sense. In an ongoing project with Broto and Oliver we show that for any small category $\mathcal{C}$ satisfying certain conditions, the homology of the loop space of its p-completed nerve can be understood algebraically by means of a squeezed resolution. In this talk I will present the construction of squeezed resolutions in this context and discuss some of their properties. I will also relate this to a number of interesting homotopy theoretic questions.

Markus Linckelmann, City University, London

On the Hochschild cohomology of block algebras of finite groups.

Modular representation theory of finite groups is driven by conjectures which can be loosely divided into three classes: structural conjectures, numerical conjectures, and finiteness conjectures. The latter can be rephrased as saying that there should be only very `few' Morita equivalence classes of algebras over fields, or more generally, over complete discrete valuation rings, which can occur as indecomposable direct factors of finite group algebras. Just how `few' remains largely unclear. We descibe in this talk some methods, most of which revolve around the use of Hochschild cohomology, whose goal is to provide critera for `excluding' classes of algebras as candidates for being block algebras.

Justin Lynd, University of Montana

Automorphisms of linking systems

There has been interest recently in the connections between automorphisms of fusion systems, of their associated linking systems, and of the finite groups realizing them (when such groups exist).Determination of the connection between group automorphisms and linking system automorphisms are important for Aschbacher's program for classifying certain classes of simple fusion systems at the prime 2. Comparison between the automorphism groups of fusion systems and their associated linking systems has importance for various group-like constructions in fusion systems, such as the defining of extensions, and it seems also to be related to the problem of defining the centralizer of a fusion subsystem.

I'll revisit joint works with G. Glauberman on the existence and uniqueness of centric linking systems within this context, and describe some additional (more preliminary) work arising out of it.

Akhil Mathew, Harvard

Torus actions on stable module categories and applications

A circle action on a category is equivalent to the data of a natural automorphism of every object. For example, there is a circle action on the category of representations of a group G for every central element of the group given by the action by that element. We study a homotopy coherent version of this circle action on the stable module category of a finite group. As a result, we give a new approach to the classical theorem of Dade describing the Picard group of the stable module category for abelian p-groups and a slight variation of the Benson-Iyengar-Krause classification of localizing subcategories based on the theory of Galois extensions of structured ring spectra due to Rognes.

Daniel Nakano, University of Georgia, Athens:

On the existence of mock injective modules for algebraic groups

Let G be an affine algebraic group scheme over an algebraically closed field k of characteristic $p>0$, and let G_r denote the r-th Frobenius kernel of G. Motivated by recent work of Friedlander, we investigate the class of mock injective G-modules, which are defined to be those rational G-modules that are injective on restriction to G_r for all $r\geq 1$. In this talk we provide necessary and sufficient conditions for the existence of non-injective mock injective G-modules, thereby answering a question raised by Friedlander. Furthermore, we investigate the existence of non-injective mock injectives with simple socles. Interesting cases are discovered that show that this can occur for reductive groups, but will not occur for their Borel subgroups. This is joint work with William Hardesty and Paul Sobaje.

Beren Sanders, University of Copenhagen:

Adams isomorphism as a generalized Wirthmüller isomorphism

In a recent paper, joint with Paul Balmer and Ivo Dell'Ambrogio, we made a general study of the existence and properties of adjoints to an arbitrary coproduct-preserving tensor-triangulated functor between rigidly-compactly generated tensor triangulated categories. One of the highlights of this work was the recognition that such a functor has a left adjoint if and only if it satisfies Grothendieck-Neeman duality, in which case there is a Wirthmüller isomorphism between its left and right adjoint (twisted by the relative dualizing object). In particular, this work provided a purely formal canonical construction of the classical Wirthmüller isomorphism in equivariant stable homotopy theory.

In this talk, I will review aspects of the above story before explaining how the Adams isomorphism can also be obtained purely formally by an extension of the theory. The main punch-line is that every such functor -- even one which does not have a left adjoint -- gives rise to a "Wirthmüller type" isomorphism (properly understood). This construction generalizes the Wirthmüller isomorphism of the earlier paper, and includes the Adams isomorphism as a special case.

Paul Sobaje, University of Georgia

Tilting modules for algebraic groups and their decompositions over Frobenius kernels

Let G be a simple and simply connected algebraic group over an algebraically closed field of prime characteristic. A question, which has remained unresolved for some time, is whether or not every projective indecomposable module for G_1, the first Frobenius kernel of G, has some structure as a G-module. Donkin has further conjectured that certain tilting modules for G should provide such a G-structure. Donkin's conjecture is known to hold when $p \ge 2h-2$, where h is the Coxeter number of G, or if $G=SL_3$.

In this talk, we will look at recent progress on the general problem of lifting the G_1-PIMs to G. We will also discuss Donkin's tilting module conjecture, and its relationship to other conjectures involving good filtration G-modules and their restriction to G_1.

Greg Stevenson, University of Bielefeld:

Relative stable categories of finite groups

A few years ago Benson, Iyengar, and Krause introduced an analogue of the stable module category for representations of a finite group over any commutative ring. I will discuss some recent progress on understanding the structure of these categories, with a focus on the cases where the coefficient ring is either self-injective or regular (based on joint work with Baland, and Baland and Chirvasitu).

Burt Totaro, University of Carlifornia, Los Angeles

Tightening the bounds: detection theorems for the cohomology and Chow ring of a finite group

Henn-Lannes-Schwartz showed that computing the cohomology of a finite group G reduces to computations in degree at most the "topological nilpotence degree" of G. It turns out the same is true for the Chow ring of a finite group, which maps to the cohomology ring. We show that the topological nilpotence degree is small: at most twice the dimensions of a faithful complex representation of G. Examples suggest that even better bounds may be true.

Mark Walker, University of Nebraska-Lincoln

Adams operations for matrix factorizations

This is joint work with Michael Brown, Claudia Miller, and Peder Thompson. A hyper-surface ring is a ring that can be expressed as the quotient of a regular (commutative and Noetherian) ring by a principal ideal. An example of such a ring that is of interest in representation theory is the group ring of an elementary abelian p-group with coefficients in a field of characteristic p. Matrix factorizations give a concrete model for the stable module category of hypersurface rings. In this talk, I describe how to build a good theory of Adams operations for the Grothendieck group of matrix factorizations. The method for constructing such operations used, for example, by Gillet and Soule in a slightly different context is unavailable for matrix factorizations. Instead, we use an idea that goes back to Atiyah, and which has also been used by Benson, that involves only considering cyclic power operations. As an application of this theory, we prove a conjecture due to H. Dao, which represents an analogue for matrix factorizations of the Serre vanishing conjecture.

Peter Webb, University of Minnesota

Canonical Mackey functors

Mackey functors encode the representation theory of a finite group, as well as the restriction, induction and conjugation information between representations. They are well-suited for applications in local representation theory and canonical constructions with Mackey functors have the potential to give insight into representation theory. I will describe the Mackey functors constructed by analogy with the canonical (tilting) modules for Schur algebras. I will also describe the cohomological Mackey functors of maximal finite projective dimension.

Sarah Witherspoon, Texas A & M:

Support Varieties for Hopf Algebras

The theory of support varieties for modules of finite groups has been generalized to finite dimensional self-injective algebras under some finiteness assumptions. Finite dimensional Hopf algebras, such as group algebras, restricted Lie algebras, and small quantum groups, are self-injective. One asks: which properties of support varieties for finite group representations are true more generally? In this talk, we will give an overview of the theory of varieties for modules of self-injective algebras. We will focus on the tensor product property for Hopf algebras, that is, that the variety of a tensor product of modules is the intersection of the varieties. We will give examples of Hopf algebras constructed from finite groups for which the tensor product property does not hold. Some of these examples were found in work with Benson, and more recently were put into a general context with other examples in work with Plavnik.

The following campus dining options are available on Aug 1 Statutory holiday:

UBC Food Services across campus:

- Harvest (limited hours): http://www.food.ubc.ca/place/harvest/

The Nest:

- Upper Case : http://www.ams.ubc.ca/foodanddrink/uppercase/
- Pie R Squared: http://www.ams.ubc.ca/foodanddrink/piersquared/

UBC Village: Directions here

- A number of eateries are available in this location, including Sushi restaurants, Macdonald's, A&W, Blenz and various food outlets at the Village basement.
- Mahoney and Sons at UBC http://mahonyandsons.com/ubc-location.html

On-Campus Dining
at the University of British Columbia

Student Union Building (1)

Subway Mon – Fri 7:30am-2pm

Starbucks Mon – Fri 7:30am-6pm, Sat 8:30am-3pm

University Village (2)

University Village has many take out and dine in options; diner-style breakfasts, coffee shops, pizza by the slice, bubble tea, a full-service sushi restaurant, a small grocer selling fresh produce and assorted goods, as well as an international food court

Blenz Coffee	Booster Juice	Mio Japan	Granville Island Produce
McDonalds	Pearl Fever Tea House	FreshSlice Pizza	One More Sushi
Only U Café	Starbucks	Pita Pit	Vera's Burger Shack
Subway	Red Burrito	Well Tea	5 Tastes Chinese Bistro
Suga Sushi Japanese	Oven Fresh Bakery	A&W	International Food Court

Wesbrook Village (3)

Wesbrook Village, located on south campus, offers shops, services and homes within a quaint, pedestrian-friendly setting, with access to Pacific Spirit Park and all the amenities of the UBC campus.

Save-On-Foods
Large grocery store with a deli and small café

Chef Hung Taiwanese Beef Noodle
Noodles, soups, rice dishes, and sides

Jugo Juice
Fresh fruit smoothies

BierCraft
Craft pub with a French-inspired Bistro menu.

Menchie's Frozen Yogurt
Frozen yogurt and sorbet bar

Togo Sushi
Fresh sushi made to order

Blenz
Coffee shop

Doughgirls Comfort Kitchen + Bakeshop
Fresh made bread and pastries.

m.ubc.ca

UBC Campus Food Trucks

Hungry Nomad
The original UBC food truck!

Roaming Bowl
Fresh made Asian noodle and rice bowls

The Dog House
The home of the West Coast hot dog

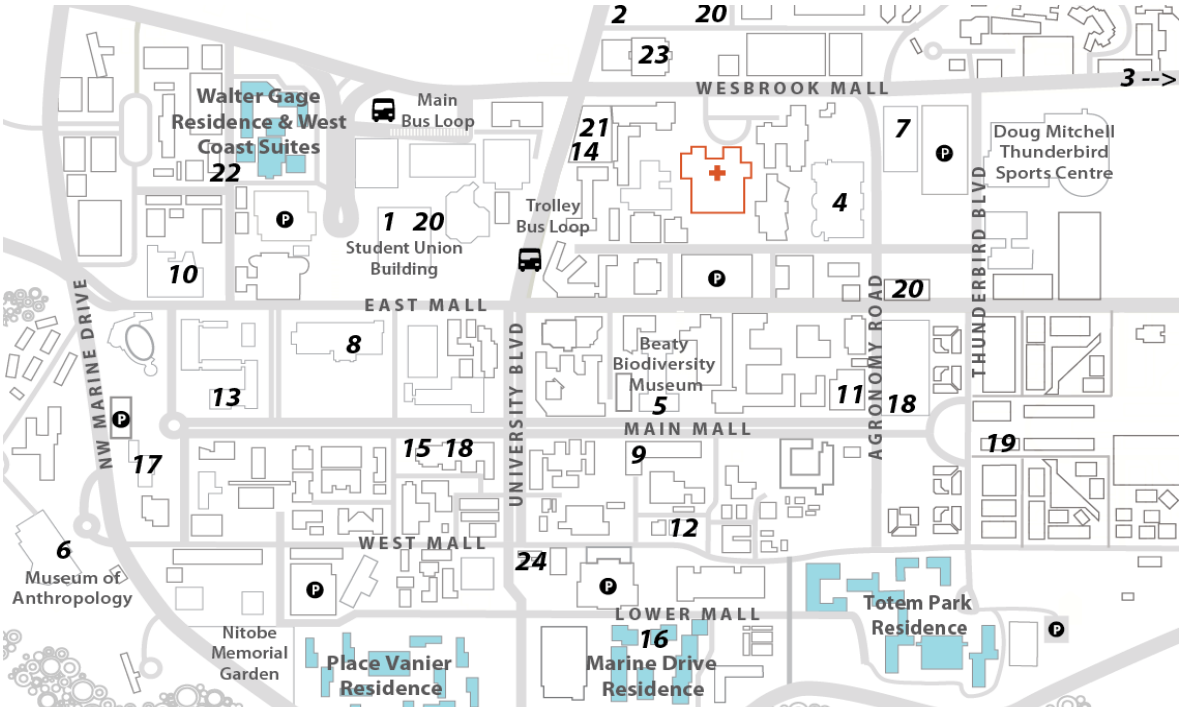
The Nest

The Nest, located on the new University Square beside the Student Union Building, will offer AMS owned and operated restaurants and shops for the summer of 2015!

Perch
Uppercase
Pier^2 Pizza
Flip Side
Qoola Frozen Yogurt Bar
Peko Sushi
Palate
The Pit
Grand Noodle Emporium
The Delly

On-Campus Dining

at the University of British Columbia



Full-Service Restaurants

Mahoney & Sons Public House (14)
Irish-style pub serving salads, appetizers, pizzas, and a sampling of classic pub fare

The Point Grill (16)
Burgers and sandwiches, salads, local seafood, and an outdoor patio to enjoy the sun

Triple O's (15)
Dine in or take out - breakfast sandwiches, beef, chicken, and veggie burgers, and milkshakes

Sage (17)
Healthy, modern West Coast cuisine paired with breathtaking views.

Mercante (24)
Authentic Cucina Italiana, stone oven Italian pizza, salads, pasta, soups and desserts

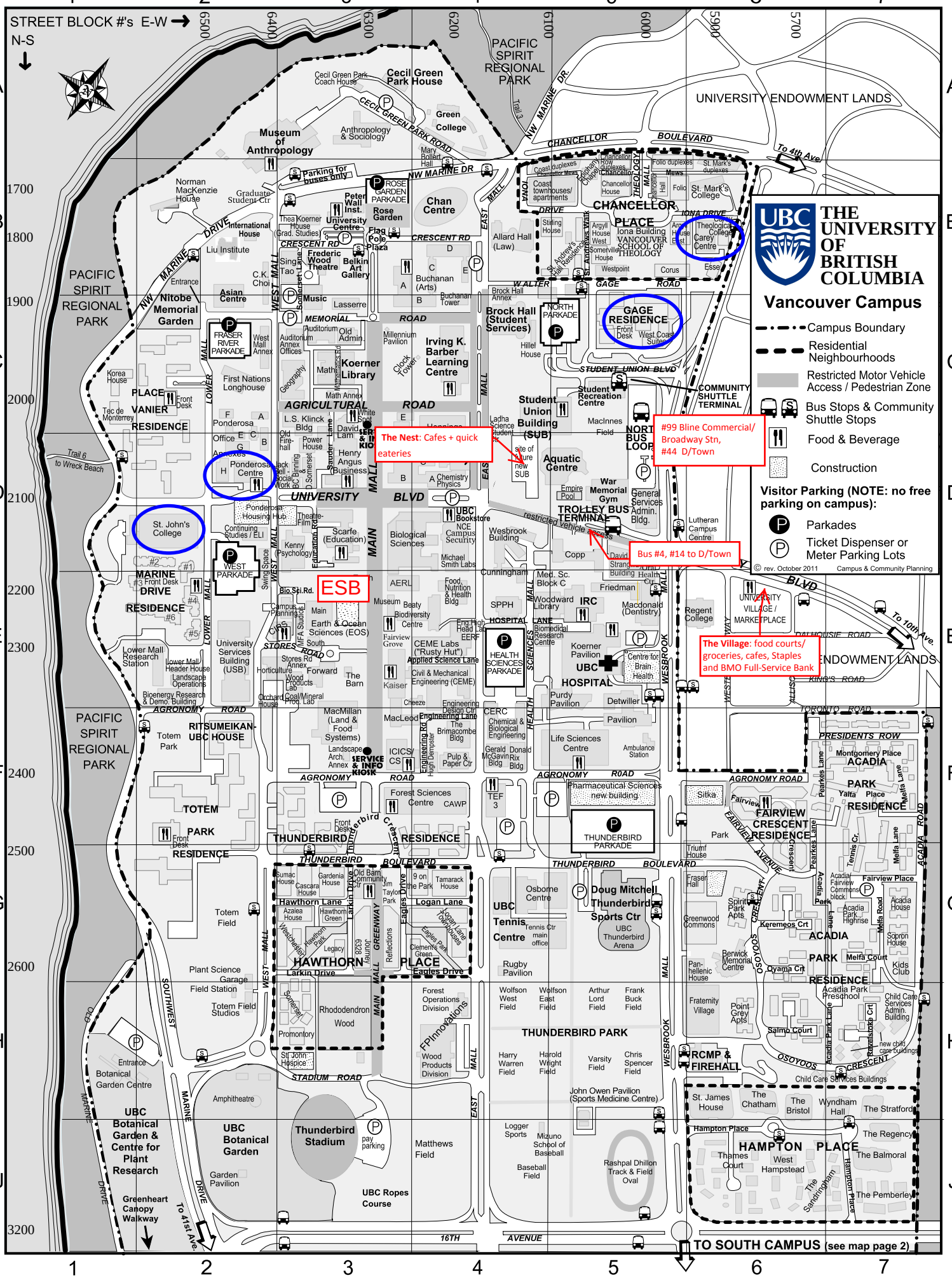
Coffee Shops

Tim Hortons (18)
Bean Around the World (19)
Starbucks (20)
The Boulevard Coffee Roasting Co (21)
Great Dane Coffee (22)
The Well Café (23)

Quick-Service Cafés

These cafés, located in convenient spots across campus, offer a range of snacks and lunch items, including soups, sandwiches, salads, and a variety of hot dishes

Caffe Perugia (4)
Niche Café (5)
Café MOA (6)
Pharmacy Café (7)
Ike's Café (8)
Magma Café (9)
Law Café (10)
Reboot Café (11)
The Loop Café (12)
Stir It Up Café (13)


STREET BLOCK #'s E-W
N-S
PACIFIC SPIRIT REGIONAL PARK
UNIVERSITY ENDOWMENT LANDS
Cecil Green Park House
Museum of Anthropology
Chan Centre
CHANCELLOR PLACE
GAGE RESIDENCE
Brock Hall (Student Services)
Koerner Library
Irving K. Barber Learning Centre
Student Union Building (SUB)
Aquatic Centre
ESB
UBC HOSPITAL
HEALTH SCIENCES PARKADE
THUNDERBIRD PARKADE
Doug Mitchell Thunderbird Sports Ctr
UBC Tennis Centre
Thunderbird Stadium
UBC Botanical Garden & Centre for Plant Research
RCMP & FIREHALL
HAMPTON PLACE
ACADIA PARK RESIDENCE
FAIRVIEW CRESCENT RESIDENCE
TOTEM PARK RESIDENCE
HAWTHORN PLACE
THUNDERBIRD PARK
RITSUMEIKAN-UBC HOUSE
TROLLEY BUS TERMINAL
COMMUNITY SHUTTLE TERMINAL
The Nest: Cafes + quick eateries
#99 Bline Commercial/ Broadway Stn, #44 D/Town
Bus #4, #14 to D/Town
The Village: food courts/ groceries, cafes, Staples and BMO Full-Service Bank
TO SOUTH CAMPUS (see map page 2)
THE UNIVERSITY OF BRITISH COLUMBIA
Vancouver Campus
Campus Boundary
Residential Neighbourhoods
Restricted Motor Vehicle Access / Pedestrian Zone
Bus Stops & Community Shuttle Stops
Food & Beverage
Construction
Visitor Parking (NOTE: no free parking on campus):
Parkades
Ticket Dispenser or Meter Parking Lots
© rev. October 2011 Campus & Community Planning

Map Directory

Site or Building Name & Address	Grid
Abdul Ladha Science Student Ctr, 2055 East Mall	D4
Acadia/Fairview Commonsblock, 2707 Tennis Cres	G7
Acadia House, 2700-2720 Acadia Rd	G7
Acadia Park Residence	F/H-6/7
Acadia Park Highrise, 2725 Melfa Rd	G7
Acadia Park Preschool, 2750 Acadia Park Lane	H7
Allard Hall [Faculty of Law], 1822 East Mall	B4
Anthropology & Sociology Bldg, 6303 NW Marine Dr	A3
Aquatic Centre, 6121 University Blvd	D5
Aquatic Ecosystems Research Lab (AERL), 2202 Main Mall	E3
Asian Centre, 1871 West Mall	B2
Auditorium (a.k.a. "Old Auditorium"), 6344 Memorial Rd	C3
Auditorium Annex Offices, 1924 West Mall	C3
Barn (daycare), 2323 Main Mall	E3
B.C. Binning Studios (formerly Hut M-17), 6373 University Blvd	D3
Beaty Biodiversity Centre & Museum, 2212 Main Mall	E3/4
Belkin (Morris & Helen) Art Gallery, 1825 Main Mall	B3
Berwick Memorial Centre, 2765 Osoyoos Cres	G6
Bioenergy Research & Demonstration Bldg., 2337 Lower Mall	E2
Biological Sciences Bldg [Science Faculty office], 6270 University Blvd	D3
Biomedical Research Ctr, 2222 Health Sciences Mall	E4
Biotechnology Laboratory, 2125 East Mall	D4
Bollert (Mary) Hall, 6253 NW Marine Dr	A4
Bookstore, 6200 University Blvd	D4
Botanical Garden Centre/Gatehouse, 6804 SW Marine Dr	H1
Botanical Garden Pavilion (enter at Gatehouse, 6804 SW Marine Dr)	J2
Botan. Gard. Greenhses/ Workshops, 6088 S. Campus Rd	South Campus
Brimacombe Building, 2355 East Mall	F4
BROCK HALL: Student Services & Welcome Centre, 1874 East Mall	**C4**
Brock Hall Annex, 1874 East Mall	C4
Buchanan Building (Blocks A, B, C, D, & E) [Arts], 1866 Main Mall	B3/4
Buchanan Tower, 1873 East Mall	C4
C.K. Choi Building for the Institute of Asian Research, 1855 West Mall	B2
Campus & Community Planning, 2210 West Mall	E3
Campus Security, 2133 East Mall	D4
Carey Centre, 5920 Iona Drive	B6
Carey Theological College, 1815 Wesbrook Mall	B6
CAWP (Centre for Advanced Wood Processing), 2424 Main Mall	F4
Cecil Green Park Coach House, 6323 Cecil Green Park Rd	A3
Cecil Green Park House, 6251 Cecil Green Park Rd	A3
CEME — *see Civil & Mechanical Engineering Building*	
Centre for Comparative Medicine, 4145 Wesbrook Mall	South Campus
Centre for Interactive Research on Sustainability (CIRS), 2260 West Mall	E3
CERC (Clean Energy Research Ctr), 2360 East Mall	F4
Chan Centre for the Performing Arts, 6265 Crescent Rd	B4
Chancellor Place neighbourhood	B5
Chemical & Biological Engineering Bldg, 2360 East Mall	F4
Chemistry A Block - Chemistry Physics Building, 6221 University Blvd	D4
Chemistry B,C,D & E Blocks, 2036 Main Mall	D3
Child Care Services Administration Bldg, 2881 Acadia Rd	H7
Child Care Services Bldgs, Osoyoos Cresc and Revelstoke Crt	H7
CIRS — *see Centre for Interactive Research on Sustainability...*	
Civil & Mechanical Engineering Bldg (CEME), 6250 Applied Science Lane	E4
Civil & Mechanical Eng. Labs ("Rusty Hut"), 2275 East Mall	E4
Coal & Mineral Processing Lab, 2332 West Mall	E3
Continuing Studies Bldg [English Language Institute], 2121 West Mall	D2
Copp (D.H.) Building, 2146 Health Sciences Mall	D5
Cunningham (George) Building [Pharmaceutical Sc.], 2146 East Mall	E4
David Lam Learning Centre, 6326 Agricultural Rd	C3
David Lam Management Research Ctr, 2033 Main Mall	C3
Donald Rix Building, 2389 Health Sciences Mall	F4
Doug Mitchell Thunderbird Sports Centre, 6066 Thunderbird Blvd	G5
Dorothy Somerset Studios (formerly Hut M-18), 6361 University Blvd	D3
Earth Sciences Building (ESB) under construction, 2207 Main Mall	E3
Earth & Ocean Sciences (EOS) - Main and South, 6339 Stores Rd	E3
Earthquake Engineering Research Facility (EERF), 2235 East Mall	E4
Engineering High Head Room Lab, 2225 East Mall	E4
English Language Institute (E.L.I.) — *see Continuing Studies Building*	
Environmental Services Facility, 6025 Nurseries Rd	South Campus
Fairview Crescent Residence, 2600-2804 Fairview Cres	F6
Fire Department, 2992 Wesbrook Mall	H6
First Nations Longhouse, 1985 West Mall	C2
Flag Pole Plaza (Main Mall & Crescent Rd)	B3
Food, Nutrition and Health Bldg, 2205 East Mall	E4
Forest Sciences Centre [Faculty of Forestry], 2424 Main Mall	F4
Forward (Frank) Building, 6350 Stores Rd	E3
FPInnovations (Forest Operations & Wood Products), 2601/2665 E. Mall	H4
FPInnovations (Pulp & Paper Division), 3800 Wesbrook Mall	South Campus
Fraser Hall (public rental housing), 2550 Wesbrook Mall	G6
Fraternity Village, 2880 Wesbrook Mall	H6
Frederic Wood Theatre, 6354 Crescent Rd	B3
Friedman Bldg, 2177 Wesbrook Mall	E5
Gage Residence, 5959 Student Union Blvd	C5
General Services Administration Bldg (GSAB), 2075 Wesbrook Mall	D5
Geography Building, 1984 West Mall	C3
Gerald McGavin Building, 2386 East Mall	F4
Graduate Student Centre — *see Thea Koerner House*	
Green College, 6201 Cecil Green Park Rd	A4
Greenheart Canopy Walkway, Botanical Garden, 6804 SW Marine Dr	H1
Greenwood Commons (public rental housing), 2660 Wesbrook Mall	G6
Hampton Place neighbourhood	H/J-6/7
Hawthorn Place neighbourhood	G/H3
Hebb Building, 2045 East Mall	D4
Hennings Building, 6224 Agricultural Rd	C4
Henry Angus Building [Sauder School of Business], 2053 Main Mall	D3
Hillel House - The Diamond Foundation Centre for Jewish Campus Life, 6145 Student Union Blvd	C4
Horticulture Building/Greenhouse, 6394 Stores Rd	E2/3
Hugh Dempster Pavilion, 6245 Agronomy Rd	F4
ICICS/CS (Institute for Computing, Information & Cognitive Systems/Computer Science), 2366 Main Mall	F4
Instructional Resources Centre (IRC), 2194 Health Sciences Mall	E5
International House, 1783 West Mall	B2
In-Vessel Composting Facility, 6035 Nurseries Road	South Campus
Irving K. Barber Learning Centre, 1961 East Mall	C4
Jack Bell Building for the School of Social Work, 2080 West Mall	D3
John Owen Pavilion & Allan McGavin Sports Medicine Centre, 3055 Wesbrook Mall	H5
Kaiser (Fred) Building [Faculty of Applied Science], 2332 Main Mall	E3
Kenny (Douglas T) Building, 2136 West Mall	D3
Kids Club, 2855 Acadia Rd	G7
Klinck (Leonard S.) Bldg, 6356 Agricultural Rd	C3
Koerner (Walter C.) Library, 1958 Main Mall	C3
Landscape Architecture Annex, 2371 Main Mall	F3
Lasserre (Frederic) Building, 6333 Memorial Rd	C3
Law, Faculty of — *see Allard Hall*	
Leon and Thea Koerner University Centre, 6331 Crescent Rd	B3
Life Sciences Centre, 2350 Health Sciences Mall	F5
Liu Institute for Global Issues, 6476 NW Marine Dr	B2
Lower Mall Header House, 2269 Lower Mall	E2
Lower Mall Research Station, 2259 Lower Mall	E2
Macdonald (J.B.) Building [Dentistry], 2199 Wesbrook Mall	E5
MacLeod (Hector) Building, 2356 Main Mall	F3
MacMillan (H.R.) Bldg [Faculty of Land & Food Systems], 2357 Main Mall	F3
Marine Drive Residence (Front Desk in Bldg #3), 2205 Lower Mall	E2
Material Recovery Facility, 6055 Nurseries Rd	South Campus
Mathematics Annex, 1986 Mathematics Rd	C3
Mathematics Building, 1984 Mathematics Rd	C3
Medical Sciences Block C, 2176 Health Sc. Mall	E4
M.F.A. Studios (formerly B.C. Binning MFA Studios), 6363 Stores Rd	E3
Michael Smith Laboratories, 2185 East Mall	D4
Museum of Anthropology (MOA), 6393 NW Marine Dr	A2/3
Music Building, 6361 Memorial Rd	B/C3
Networks of Ctrs of Excellence (NCE), 2125 East Mall	D4
Nitobe Memorial Garden, 1895 Lower Mall	B/C2
Nobel Biocare Oral Heath Centre (David Strangway Bldg), 2151 Wesbrook Mall	E5
Norman MacKenzie House, 6565 NW Marine Dr	B2
NRC Institute for Fuel Cell Innovation, 4250 Wesbrook Mall	South Campus
Old Administration Building, 6328 Memorial Rd	C3
Old Auditorium — *see Auditorium*	
Old Barn Community Centre, 6308 Thunderbird Blvd	G3
Old Firehall, 2038 West Mall	D3
Orchard House, 2336 West Mall	E2
Osborne (Robert F.) Centre/Gym, 6108 Thunderbird Blvd	G4
Panhellenic House, 2770 Wesbrook Mall	G6
Peter Wall Institute for Advanced Studies, 6331 Crescent Rd	B3
Place Vanier Residence, 1935 Lower Mall	C/D2
Plant Ops Nursery/Greenhouses, 6029 Nurseries Rd	South Campus
Plant Science Field Station & Garage, 2613 West Mall	H2
Point Grey Apartments, 2875 Osoyoos Cresc	H6
Police (RCMP) & Fire Department, 2990/2992 Wesbrook Mall	H6
Ponderosa Centre, 2071 West Mall	D2
Ponderosa Office Annexes: A, B, & C, 2011-2029 West Mall	C/D2
Ponderosa Office Annexes: E to H, 2008-2074 Lower Mall	C/D2
Power House, 2040 West Mall	D3
Pulp and Paper Centre, 2385 East Mall	F4
Ritsumeikan-UBC House, 6460 Agronomy Rd	F2
Rose Garden	B3
Roy Barnett Recital Hall - in Music Building	
Rugby Pavilion, 2584 East Mall	G4
Scarfe (Neville) Building [Education], 2125 Main Mall	D3
School of Population & Public Health (SPPH), 2206 East Mall	E4
Simon K.Y. Lee HKU-UBC House — Bldg #1, Marine Drive Residence	E2
Sing Tao Building, 6388 Crescent Rd	B3
Sopron House, 2730 Acadia Rd	G7
South Campus Warehouse, 6116 Nurseries Rd	South Campus
Spirit Park Apartments, 2705-2725 Osoyoos Cresc	G8
St. Andrew's Hall/Residence, 6040 Iona Dr	B5
St. John's College, 2111 Lower Mall	D2
St. Mark's College, 5935 Iona Dr	B6
Staging Research Centre, 6045 Nurseries Rd	South Campus
Stores Road Annex, 6368 Stores Rd	E3
Student Recreation Ctr, 6000 Student Union Blvd	C5
Student Union Bldg (SUB), 6138 Student Union Blvd	C4
TEF3 (Technology Enterprise Facility 3), 6190 Agronomy Rd	F4
Thea Koerner House [Faculty of Graduate Studies], 6371 Crescent Rd	B3
Theatre-Film Production Bldg, 6358 University Blvd	D3
Thunderbird Residence, 6335 Thunderbird Cresc	F3/4
Thunderbird Stadium, 6288 Stadium Rd	J3
Thunderbird Winter Sports Ctr — *see Doug Mitchell Thunderbird Sports...*	
Totem Field Studios, 2613 West Mall	H2
Totem Park Residence, 2525 West Mall	F/G2
TRIUMF, 4004 Wesbrook Mall	South Campus
Triumf House (TRIUMF Visitor's Residence), 5835 Thunderbird Blvd	G6
UBC Bookstore, 6200 University Blvd	D4
UBC Farm, 6182 Wesbrook Mall	South Campus
UBC Hospital, 2211 Wesbrook Mall	E5
UBC Tennis Centre, 6160 Thunderbird Blvd	G4
UBC Thunderbird Arena (in Doug Mitchell Centre), 2555 Wesbrook Mall	G5
University Centre (Leon & Thea Koerner), 6331 Crescent Rd	B3
University Neighbourhoods Association, 5923 Berton Ave	South Campus
University Services Building (USB), 2329 West Mall	E2
Vancouver School of Theology, 6000 Iona Drive	B5
Walter H. Gage Residence, 5959 Student Union Blvd	C5
War Memorial Gymnasium, 6081 University Blvd	D5
Wayne & William White Engineering Design Ctr, 2345 East Mall	E4
Wesbrook Bldg, 6174 University Blvd	D4
Wesbrook Place neighbourhood	South Campus
Wesbrook Village shopping centre	South Campus
West Mall Annex, 1933 West Mall	C2
West Mall Swing Space Bldg, 2175 West Mall	D2
Wood Products Laboratory, 2324 West Mall	E3
Woodward IRC, 2194 Health Sciences Mall	E4/5
Woodward Library, 2198 Health Sciences Mall	E4/5

SOUTH CAMPUS MAP

Campus & Community Planning
www.planning.ubc.ca

Note:
Local traffic only along Wesbrook Mall on South Campus

Map Information

Need help finding your way on campus? Call the Campus & Community Planning MapInfo Line at 604-827-5040, M-F, 8:30-4:30

Or use the online searchable colour map at www.maps.ubc.ca