Schedule for the Sunday Morning AARMS Research Session:

All talks are held in Rowe Building room 1020

A. Introductory overview talks

8:30–9:10: Yorck Sommerhäuser (Memorial)
Current developments in Hopf algebra theory

9:15–9:55: Peter Selinger (Dalhousie)
Monoidal categories and their graphical languages

10:00-10:30 Coffee Break

B. Research talks

10:30–10:55: Mikhail Kotchetov (Memorial)
Hopf algebras and gradings

11:00–11:25: Julien Ross (Dalhousie)
The ZX-calculus

11:30–11:55: Mitja Mastnak (Saint Mary's)
Bialgebra coverings and transfer of structure

12:00–12:25: Jonathan Gallagher (Dalhousie)
Introduction to differential categories

Abstracts:

Speaker: Jonathan Gallagher

Title: Introduction to differential categories

Abstract: This talk will introduce cartesian differential categories. Intuitively, cartesian differential categories provide an axiomatization of categories of smooth maps between vector spaces: in particular, they axiomatize the total derivative used in multivariable calculus. We will give the axiomatization of a cartesian differential category, and highlight these axioms in the example of multivariable calculus. We will then investigate other, related examples. One class of examples comes from a related notion called a monoidal differential category: we will introduce them and show how they give rise to cartesian differential categories. Finally, we will cover some things that can be done with differential categories, including setting up

tangent structure, the fibration of bundles, differential cohomology, the state construction, and more.

Speaker: Mikhail Kotchetov

Title: Hopf algebras and gradings

Abstract: It is well known that gradings and actions by a finite abelian group are equivalent, provided that the ground field contains sufficiently many roots of unity. The correspondence between gradings and actions is best understood in terms of Hopf algebras, which also allow us to remove restrictions on the ground field. In this talk, we will review the relevant concepts and discuss examples where this approach led to a complete classification of gradings on many classical algebras.

Speaker: Mitja Mastnak

Title: Bialgebra coverings and transfer of structure

Abstract: The talk is based on joint work with A. Lauve. I will introduce the bicategory of bialgebras with coverings (which can be thought of as coalgebra-indexed families of morphisms), and provide a motivating application to the transfer of formulas for primitives and antipode. I will also mention a generalization of Nichols' result on bialgebra quotients of Hopf algebras (which gives conditions on when the resulting bialgebra quotient is a Hopf algebra).

Speaker: Julien Ross

Title: An introduction to the ZX-calculus

Abstract: The ZX-calculus is a graphical language which provides a simple yet powerful way of reasoning about quantum processes. In the ZX-calculus, a quantum process is represented by a diagram constructed from a set of basic generators. The ZX-calculus is equipped with rewrite rules which can be used to equate diagrams. In a sequence of recent breakthroughs, the ZX-calculus was shown to be complete: if two

diagrams denote the same process then the rules of the ZX-calculus can be used to reduce one diagram to the other. The completeness of the ZX-calculus paves the way for applications in quantum computer science such as quantum circuit optimization. In this talk, I will introduce the ZX-calculus, survey recent results, and discuss open problems.

Speaker: Peter Selinger

Title: Monoidal categories and their graphical languages

Abstract: I will give an overview of the definitions of various flavors of monoidal categories and their associated graphical languages. These categories form a veritable "zoo", including such specimens as planar, spacial, braided, balanced, and symmetric monoidal categories, pivotal, autonomous, tortile, and compact closed categories, as well as traced and dagger monoidal categories. Just like in a real zoo, the diversity can be overwhelming, but we can impose some order on the chaos by introducing a suitable taxonomy.

Speaker: Yorck Sommerhäuser

Title: Current developments in Hopf algebra theory

Abstract: A Hopf algebra is an algebra for which it is possible to form the tensor product of two representations. For that, one needs an additional structure element, the so-called coproduct. In the talk, we will first give a more precise definition of a Hopf algebra. We will then discuss from which sources the concept arose historically and what the current research problems are.