

# Oral Qualifying Exam Syllabus

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## MAJOR AREA: ALGEBRAIC TOPOLOGY

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### Higher algebraic $K$ -theory for categories

Mona Merling (advisor)

I will give a presentation to the committee and be prepared to answer questions.

Rob Ghrist

#### Classifying spaces

- Simplicial sets/spaces and geometric realization
- Elementary theorems about classifying spaces (no proofs), e.g. compatibility with products, natural transformations to homotopies, adjunctions to homotopy equivalences
- Quillen's theorems A and B
- Examples: nerve of a category, classifying space of a group, two-sided simplicial bar construction, Čech complex of a map, twisted arrow category/Segal's edgewise subdivision

#### Quillen's higher algebraic $K$ -theory

- The  $+$ -construction, higher  $K$ -groups of a ring
- The  $H$ -space structure of  $BGL(R)^+$
- The  $Q$ -construction, higher  $K$ -groups of an exact category
- Comparison of  $+$ -construction and  $Q$ -construction via the  $S^{-1}S$ -construction

#### Waldhausen's higher algebraic $K$ -theory

- Waldhausen categories
- Bisimplicial sets and their realization
- $S_\bullet$ -construction, properties of the  $S_\bullet$ -construction
- Comparison to the  $Q$ -construction

**References** Selections from *The K-book* by C. Weibel, *Algebraic K-Theory* by V. Srinivas, and various research papers by D. Quillen and F. Waldhausen.

## MINOR AREA: SYMPLECTIC GEOMETRY

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### Lagrangian Floer homology

Jonathan Block

I will write a master's thesis and present at the graduate geometry/topology seminar.

#### Symplectic manifolds

- Symplectic vector spaces, linear symplectomorphisms, subspaces of a symplectic vector space, symplectic manifolds and symplectomorphisms
- The cotangent bundle, tautological and canonical forms
- Lagrangian submanifold definition, Lagrangian submanifold from a graph of a symplectomorphism, Lagrangian submanifolds of the cotangent bundle
- Basic theorems (no proofs): Darboux theorem, Moser theorems, Weinstein Lagrangian tubular neighborhood theorem

## Compatible structures

- Almost-complex structures
- Riemannian structures
- Compatible triples

## Hamiltonians

- Hamiltonian vector fields
- Integrable systems
- Hamiltonian and symplectic actions

## Lagrangian Floer homology

- Conley index, Morse homology
- Floer homology chain complex, invariance of Floer homology
- Arnold conjecture (statement and sketch of proof for Lagrangian intersections)

**References** Selections from “Lectures on symplectic geometry” by A.C. da Silva, “Lecture notes on Floer homology” by D. Salamon, and various research papers by A. Floer.