

Target group: PhD students and postdocs in mathematics & mathematical physics

Course Title: Advanced topics in geometry and topology

Extend: 3 hours per week / 15 weeks / 5 ECTS

Aims The aim of this course is introducing students some advanced topics in differential geometry, algebraic geometry and algebraic topology so that student know and master advanced knowledge and the cutting edge progress in various aspects of geometry and topology. Specific topics, which fits into thesis topics of PhD students and is useful for all PhD students, will be determined commonly by instructor and students together at the beginning of semester (text will be given upon topics are decided). Another aim is for students to practice giving a math lecture. Students will learn how to manage time constraints during a talk and also how to field questions from the audience.

Synopsis Possible topics includes mirror symmetry, Fukaya category, microlocal sheaf theory, geometry representation theory, geometric Langlands program, quantum invariants of knots, topology of 4-folds, stable homotopy theory and so on. In the beginning of one semester, we will decide a commonly interested topics. Specific content will be determined afterwards by instructor based on thesis topics of students.

Every week, one student gives a two-hour presentation. After the presentation, we will continuous a one-hour discussion. Students will discuss the topics under supervision of the instructor.

Evaluation method:

The evaluation will be based on the two-hour presentation by each student in class (using the hours allocated for the course) on one of the topics covered in the course. The lecturer and an internal censor will be present during the talk to evaluate the presentation and ask the student questions. The evaluation will be pass/fail.

Teaching method: In person lectures

Responsible lecture(s) Bingyu Zhang

Literature -Mirror symmetry:

D. A. Cox, S. Katz, Mirror symmetry and algebraic geometry. 1999.

Kentaro Hori, Mirror symmetry. 2003.

Paul S. Aspinwall, et al., Dirichlet branes and mirror symmetry. 2009.

Anton Kapustin, Dmitri Orlov, Lectures on Mirror Symmetry, Derived Categories, and D-branes. 2003.

Paul Seidel, Homological mirror symmetry for the quartic surface. 2006.

Denis Auroux, Ludmil Katzarkov and Dmitri Orlov, Mirror symmetry for weighted projective planes and their noncommutative deformations. 2008.

Nick Sheridan, Homological mirror symmetry for Calabi–Yau hypersurfaces in projective space. 2015.

Benjamin Gammage, Vivek Shende, Mirror symmetry for very affine hypersurfaces. 2017.

Vivek Shende, Toric mirror symmetry revisited. 2021.

-Algebraic geometry:

R. P. Thomas, Derived categories for the working mathematician. 2001.

Alexei Bondal, Dmitri Orlov, Derived categories of coherent sheaves. [math.AG/0206295](#).

Dmitri Orlov, Derived categories of coherent sheaves and motives. [math.AG/0512620](#).

-Fukaya categories:

Paul Seidel, Fukaya Categories and Picard–Lefschetz Theory. 2008.

Denis Auroux, A beginner’s introduction to Fukaya categories. [math.SG/1301.7056](#).

-Algebraic topology

J. P. May, A Concise Course in Algebraic Topology. 1999

J. P. May, A Concise Course in Algebraic Topology. 2012

Michael Hopkins, Spectra and stable homotopy theory. 2012

Urs Schreiber, Introduction to Stable homotopy theory. 2016

-Microlocal sheaf theory

Jun Zhang. Quantitative Tamarkin Category. 2018

Claude Viterbo. An Introduction to Symplectic Topology through Sheaf theory. 2016.

Pierre Schapira. A short review on microlocal sheaf theory. 2016.

Masaki Kashiwara and Pierre Schapira. Sheaves on Manifolds. 1994.