

# MATH 609E:201

## TOPICS IN MATHEMATICAL PHYSICS

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### Basic information

- Times and room: Lecture: TTh 11-12:30 in MATH 225
- My office: MATH 228
- Contact me: sbach@math.ubc.ca
- My office hours: by appointment

### About the course

This is a graduate topics course on mathematical aspects of quantum physics. No previous knowledge in quantum mechanics will be required, but some understanding of functional analysis is strongly recommended.

After a brief introduction to the mathematical structure of quantum mechanics, the course will concentrate on quantum lattice systems as examples of interacting many-body matter whose thermodynamic limit can be studied. Although some statistical mechanical questions will be addressed, the course will mostly focus on exotic states at zero temperature such as quantum Hall states or topologically ordered ground states.

The course grade will be made up exclusively of marked homework assignments and possibly a short presentation during the course of the term.

Topics to be covered:

- The general mathematical structure of quantum mechanics
- Quantum spin systems and lattice fermions
- Dynamics and propagation estimates
- The thermodynamic limit
- Adiabatic theorems
- The quantum Hall effect: non-interacting descriptions
- Quantization of conductance with interactions
- Matrix product states and tensor networks

## References

The course will not follow any specific reference. However, the following books are excellent:

Physics textbooks:

- *Quantum Mechanics*, G. Auletta, M. Fortunato & G. Parisi
- *Quantum Mechanics*, A. Messiah
- *Quantum Mechanics, Non-relativistic Theory*, Vol. 3 of *Course of Theoretical Physics*, L.D. Landau & E.M. Lifshitz

Mathematics textbooks:

- *Lectures on the Mathematics of Quantum Mechanics*, G. Dell'Antonio
- *Quantum Mathematical Physics*, W. Thirring
- *Mathematical Concepts of Quantum Mechanics*, S. Gustafson & I.M. Sigal
- *Operator Algebras and Quantum Statistical Mechanics*, O. Bratteli & D.W. Robinson
- *Quantum Spin Systems on Infinite Lattices*, P. Naaijkens