Hilbert Spaces and the Mathematics of Quantum (Information) Theory

Augmester 2022

listed under

MATH 4810/5810, Special Topics in Mathematics

Course Instructor: Dr. Markus Pflaum

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Lecture Hours: MTWThF 9:00 a.m. – 12:00 p.m., August 1 – 18, 2022

Targeted Audience: The course is intended for upper-division undergraduate and graduate students in mathematics, physics, chemistry, computer science or engineering with an interdisciplinary interest.

Basic knowledge of Linear Algebra and Analysis is recommended.

Course Homepage: `http://math.colorado.edu/courses/HilbertSpaces`

Course Contents: The course will provide an introduction to the theory of Hilbert spaces and their application in quantum mechanics. On the mathematical side, the notions of a hermitian inner product, Hilbert space, bounded linear operator, Hilbert basis and Fourier expansion, selfadjointness and the spectrum of a linear operator will be explained. In addition, basic concepts of classical mathematical communication theory à la Shannon will be introduced. These concepts will then be applied to describe the axioms of quantum mechanics, the spectral theorem, von Neumann entropy and fundamentals of quantum information theory.

Course Literature: The course will be based solely on textbooks which are freely available for CU students as eBooks through `http://libraries.colorado.edu` or as online lecture notes under an appropriate open document license.

- Hall, *Quantum Theory for Mathematicians*, Springer Verlag
- Moretti, *Spectral Theory and Quantum Mechanics With an Introduction to the Algebraic Formulation*, Springer Verlag
- Teschl, *Mathematical Methods in Quantum Mechanics With Applications to Schrödinger Operators*, American Mathematical Society
- Wilde, *Quantum Information Theory*, 2nd edition, Cambridge University Press, online version available under `https://arxiv.org/abs/1106.1445`

The following online textbooks can be used to recall the prerequisites from Linear Algebra and Analysis and are available under an open document license.

- Hefferon, *Linear Algebra*
- Trench, *Introduction to Real Analysis*

Credits: The standard number of credit hours for this course is 3.