Acknowledgement

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xʷməθkʷəy̓əm (Musqueam) people. The land it is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on in their culture, history, and traditions from one generation to the next.

Course Information

Course Title	Course Number	Webpage	Credit Value
Quantum Theory	MATH 512	Through Canvas	3

First day of teaching: Sep 07; Last day of teaching: Dec 07.
University closed: Sep 30, Oct 10 and Nov 11; Midterm break: Nov 09-11.

Lectures are on MWF 11:00am-11:50am in Mathematics 225.

Prerequisites

MATH 320, MATH 321

MATH 420, MATH 421 are recommended but not required

Brief course description

The goal of MATH 512 is to introduce mathematical methods of quantum theory. No prerequisite of quantum physics is required.

The course will cover some aspects of functional analysis, operator theory and the calculus of variations with a short excursion into representation theory. The physical axioms of quantum theory will be introduced and elementary results will be discussed. The question of the stability of matter — why do atoms and molecules exist? — will serve as a guiding principle for most of the course.

We will introduce the Hilbert space formulation of quantum theory, discuss quantum dynamics and its relation to spectral properties of linear operators. Having introduced the two possible types of many-body wave functions — bosons and fermions — we will prove the stability of non-relativistic fermionic matter. We shall conclude the course with symmetries and the particular role played by the rotation group in quantum physics, thereby introducing the intrinsically quantum notion of (half-integral) spin.

Learning Materials

The course material is defined by what is covered in the lectures. Additional reading is welcome and can be found in the following books:

- *Analysis* by E. Lieb & M. Loss
- *The stability of matter in quantum mechanics* by E. Lieb & R. Seiringer
- *Mathematical methods in quantum mechanics, with applications to Schrödinger operators* by G. Teschl
- *Mathematical concepts of quantum mechanics* by S. Gustafson & M. Sigal
- *Methods of modern mathematical physics I & II* by M. Reed & B. Simon
- *Quantum Mechanics* by G. Auletta, M. Fortunato & G. Parisi

Assessments of Learning and Course Grade

There will be

1. Five homework assignments
2. One final exam

The course grade will be given by

$$\max\{0.75G_H + 0.25G_F, 0.5G_H + 0.5G_F\}$$

where G_H is the average grade of the assignments and G_F is the grade of the final exam.

Syllabus Policies

General UBC and Mathematics Department policies can be found here.

Version: August 4, 2022