Physics 500 — Quantum Mechanics — Fall 2009
Instructor: Pavel Kovtun
Meeting Wednesdays 9:30 – 12:30, Elliott 161
Office hours: Tuesday 1:30 – 4:30, or send an email

This is a two-semester graduate class on Quantum Mechanics. We'll meet once a week for lectures, in the meantime feel free to stop by my office (Elliott 110) to discuss any physics-related questions. There will be regular homework assignments, and no final exam. Instead of the final exam, every student will give a presentation at the end of each semester. The grade for the class is 70% homeworks, 15% Fall presentation, 15% Spring presentation. Class attendance is optional.

Plan: It is not possible to learn Quantum Mechanics from a short one-year class like this one. Most of what you are going to learn will not come from lectures, but from your own study. Discussions with your colleagues, myself, other faculty members and post-docs should be helpful. This class is not going to be a full comprehensive course on QM. Rather, you should think about it as a collection of topics in QM which are not usually emphasized in undergraduate courses. In this semester we start with discussing various properties of one-dimensional motion, harmonic oscillator, coherent and squeezed states. We then go on to discuss path integrals and semiclassical methods. There will be lectures on perturbation theory, both time-independent and time-dependent, angular momentum, supersymmetry, Aharonov-Bohm effect, magnetic monopoles. Next semester we will discuss (among other things) density operators, quantum statistical mechanics, interaction of atoms with electromagnetic radiation, and scattering theory. Time permitting, we will also discuss non-relativistic quantum field theory.

Prerequisites: I will assume that you have taken an undergraduate Quantum Mechanics class, such as one based on the "Introduction to Quantum Mechanics" by Griffiths. If you have never seen Quantum Mechanics before, you may find the class difficult. We'll be working with differential equations, special functions, contour integration and approximation methods, so it's a good idea to get comfortable with some book on basic mathematical methods used in physics such as Arfken-Weber. Some homework assignments will require the use of a computer algebra program such as `Mathematica` or `Maple` — please familiarize yourself with one of these.

Homework assignments: Feel free to consult any books or research papers to solve the homework problems. It's a good idea to discuss the problems with your colleagues, but the final written solution must be your own. You will pick up your assignments in my office, at which point we will discuss the problems, and you will defend your solutions on the blackboard. Each assignment will have a pick-up date, typically about two weeks from the due date. *Assignments which are not picked up by the pick-up date are recycled and do not contribute to the final grade.* Homework assignments (or parts thereof) submited by email are not accepted. If you write computer code to solve a problem, write a human-readable explanation of what you are doing, and attach a hard copy print-out of the code to your handwritten solutions. References to Wikipedia in your solutions are not accepted.

Final presentations: Student presentations at the end of each semester will cover topics not discussed in the class. Feel free to suggest a subject of your choice – something you have always wanted to learn about, but did not have a chance to. You will need to provide a typed-up writeup (5 to 10 pages) and give a talk, teaching your colleagues the subject that you have studied on your own. The talks are blackboard-only, 1 hour long. These talks will be evaluated based on both the physics content and the quality of the oral presentation.

Books: There is no required textbook for the class. A standard graduate QM textbook is Sakurai's "Modern quantum mechanics". This is a good book, and I recommend you obtain a copy at some point, even though the book (like many other textbooks) is ridiculously expensive. The library has one copy of it on a regular loan, and one copy in the reserve section. Many things discussed in the class will be taken from Sakurai. For a path-integral description of QM, see Feynman+Hibbs "Quantum mechanics and path integrals". For questions related to the interpretation of QM, see J. Bell's book "Speakable and unspeakable in quantum mechanics".