PHYS 339
Advanced Quantum Mechanics and Particle Physics
Spring 2007

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Office Hours: Tue & Thu 10:30–12:00 and Fri 3:00–4:30

Course Web Page: `http://www.eg.bucknell.edu/~bvollmay/Teaching/phys339`

Text

- Introduction to Quantum Mechanics, 2nd Ed., David Griffiths
- Introduction to Elementary Particles, David Griffiths

Additional Reading

- A Modern Approach to Quantum Mechanics, John Townsend.

  There are roughly two types of quantum mechanics texts: those which begin with wave mechanics and those which begin with the state representation. Griffiths is a good example of the former and Townsend a good example of the latter.

- Particle Physics Booklet.

  This is a handy reference for our current knowledge of particle physics. It is updated annually and you can (should) request a free copy at `http://pdg.lbl.gov/cgi-bin/pdgmail/edit.pl`.

Course Description

This is two courses rolled into one, as the title suggests. While it would be easy to spend a semester on topics in advanced quantum mechanics, we will instead focus on some of the more essential topics and techniques. First, we will review the three-dimensional Schrödinger equation and the hydrogen atom. Then we will study time-independent perturbation theory, time-dependent perturbation theory, and scattering. These all play a central role in our understanding of fundamental particle physics.

However, quantum mechanics as you've learned it, and as we'll have covered it to this point, is strictly non-relativistic. The 20th century saw two revolutions in fundamental physics — relativity and quantum mechanics — and they were born incompatible. Early on Dirac recognized this as an important conflict and set out to reconcile the two. He made heroic strides forward, but the full resolution required quantum field theory, which took many more people and a few more decades to sort out.

In our study of particle physics, then, we will begin with some essential features of special relativity. Then we can address the fundamental issues in *fully relativistic quantum mechanics*, such as the CPT theorem and symmetries, Feynman diagrams, the Dirac equation, and calculating cross-sections and decay rates for fundamental processes.

Course Structure

The course material is drawn from the texts and the lectures. Assigned reading will be given on the board for the coming lecture, and should be done before the next lecture. Class time will be used to expand on the reading and to work through examples.

A homework set will be assigned each class period and will be due at the beginning of the following class. You are encouraged to work together on the homework sets, though you must write up the problems yourself. I will randomly decide (based on a tossed die!) whether to collect the homework (1/3 of the time) or have you self-grade it (2/3 of the time). I will provide guidelines for the self-grading, and solution sets for each homework set.

There will be three midterm exams.

Grading

- Weekly problem sets: 20%
- 3 Midterm exams: 50% combined
- Final Exam: 30%