Harvard University

Physics 143b: Quantum Mechanics II

Instructor : Subir Sachdev, Lyman 343, sachdev@g.harvard.edu

Fall 2015 Tue-Thu, 10:00-11:30, Jefferson 356

All class materials can be obtained from canvas.harvard.edu/courses/5570

The first class will meet on Thu Sep 3, 2015.

This is the second half of an introductory course on quantum mechanics.

The course will complete the text book by Griffiths, and then move onto advanced topics, depending upon available time.

The first part of the course is ultimately about the "theory of light and matter". We will develop various analytic tools to understand the concept of the 'photon', and describe how electrons emit and absorb electromagnetic radiation. These are clearly phenomena of great physical importance, applying to vision, photosynthesis, solar cells, MRI, cameras, etc.

We will then introduce a fully relativistic version of quantum mechanics in the Dirac equation. This will lead to the introduction of anti-matter, and a deeper understanding of the electron spin.

Finally, in the last part of the course, we will cover the modern subject of quantum information theory. We will describe how quantum entanglement can be used for secure communication, and to perform some computations not possible on a classical computer.

A tentative outline is:

1. Time independent perturbation theory
2. The WKB approximation.
3. Time dependent perturbation theory: two level systems, emission and absorption of radiation.
4. Quantum theory of electromagnetism: the photon
5. Relativistic quantum mechanics: the Dirac equation
6. Scattering theory.
7. Einstein-Podolsky-Rosen "paradox", Bell's Theorem, and introduction to quantum information theory and quantum computing.

Prerequisite: Physics 143a

The text book for the course is

- *Introduction to Quantum Mechanics, second edition*, by David J. Griffiths, QC 174.12.G75 2005

Useful references covering similar material are:

- *Introductory Quantum Mechanics*, third edition, by Richard L. Liboff, QC174.12.L52 1997
- *Quantum mechanics*, by Jean-Louis Basdevant and Jean Dalibard, QC174.2 .B383 2005
- *Quantum mechanics*, by B.H. Bransden and C.J. Joachain, QC174.12 .B74 2000
- *Principles of quantum mechanics*, by Hans C. Ohanian, QC174.12 .O33 1990

For the section on quantum information, useful books are

- *Quantum Processes, Systems, and Information*, by B. Schumacher and M. Westmoreland, Cambridge University Press, QC174.12 .S385 2010
- *Quantum Computer Science*, by N. D. Mermin, Cambridge University Press, QA76.889 .M47 2007

The course will be graded by the homeworks (40%), final (34%) and midterms (26%).
The first midterm will be on Thu Oct 1, 2015.
The second midterm will be on Thu Nov 12, 2015.
The final exam is on Friday Dec 11,2015.