Quantum Theory (PHYS 450): Week 1

Spring 2008 v1.1

Townsend starts his introduction to quantum mechanics with a *two state* system. In this case it is a simple spin-1/2 particle (or a silver atom that acts like one) which is observed to be spin up or spin down - that's it. No positions, no momenta. Just two states, up and down. States are represented by *vectors* in "Dirac bra-ket" notation. This chapter mainly explores this notation and tosses in some intriguing physics such as the Stern-Gerlach experiment and the "Experiment 3".

In seminar I'll explain the format a bit more on then lead off with a discussion of the material. Please read the chapter, work on the problems, and prepare your presentation for Thursday afternoon. Remember to arrive a bit early and to photocopy your problem sets.

Enjoy!

Reading:

Townsend Chapter 1 (have a quick look at the preface, too)

Problems:

Problems are due at the beginning of seminar. Please make a copy of your solutions before you arrive.

- 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9

Notes on text:

- page 2: Be aware! Townsend uses Gaussian units! We'll discuss this more in seminar.
- section 1.3 This is the introduction to Dirac notation. He covers a lot of group in a (logically) informal manner. As a hint when you find you self confused re-express the result in terms of familiar vectors. Note that the changes from the familiar vectors we use in physics are: new notation, a two dimensional vector space, and *complex* vector components. It is enough to be confusing and we'll be spending some time working out (1) what it all is and (2) how to work with it.

Seminar Presentations:

Please stop by or email me if you have any questions on your presentation.

- Seth: (1) Review class structure (2) Present overview of two-state systems, simple spin, and the notation
- Wex: Units and Appendix A: Why? What are they? And how do I get "home" to SI units?
- Dan C.: Derive (1.2) starting from the E&M definition of magnetic moment.
- Ruth: Explain the Stern-Gerlach experiment including classical prediction, apparatus, and results.
- Dan T.: Set up the correspondence between the experimental outcomes and the notation. Explain what is meant by "SG**x**", etc. Explain Experiments 1 and 2.
- Walter: Make a comparison between usual vector notation and Dirac notation. I should be able to quickly find the scalar product, unit vectors, etc. Feel free to use my Dirac notes on the web site and Griffiths' appendix in his QM text. What are some obvious differences between vectors and kets?
- Seth for Mike (who will be interviewing at Med Schools): Summarize Experiment 3, lead us through a discussion of page 11-13.
- Nguyen: Experiment 5! From the results from "Experiment 3" and "Experiment 5" how Townsend obtains

$$|+x\rangle = \frac{1}{\sqrt{2}}|+z\rangle + \frac{1}{\sqrt{2}}|-z\rangle$$

and

$$|+y\rangle = \frac{1}{\sqrt{2}}|+z\rangle + \frac{i}{\sqrt{2}}|-z\rangle$$

In the derivation clearly point out where we can "ignore" the phase and where we cannot.

- Emily: Present your solution to 1.3
- Jordan: Present your solution to 1.7
- Everyone! What does this "quantum mechanics" tell us about one particle? How about one universe?