Quantum Mechanics Series - Orientation

This is intended to be a (roughly) 12-week series introducing some basic concepts in quantum mechanics. The goal is to learn enough to be able to engage in meaningful conversations about things like the various interpretations of quantum theory, and other intesting topics.

By "learn enough" I mean be able to do that math, at least at some level. To be able to work basic textbook problems, for example. In other words, to have some quantitative understanding of the mathematical model before trying to think about its metaphysical implications.

This series takes a linear algebra perspective and was originally targeted at people in the Denver Physics Study Group, who had a basic working knowledge of discrete quantum theory as typically found in the first two or three chapters of a quantum computing or information textbook, or in the "Quantum Study Group Notes" that we used. The idea was to leverage this understanding of the discrete theory (quantum information) as we move into the continuous theory (quantum mechanics). For this reason, the approach is in some ways unorthodox.

Prerequisites

In order to fully benefit from these meetings, you'll need to have:

Knowlege of the basic workings of complex vector spaces. Inner products, outer products, tensor products, change of basis, eigenvalues and eigenvectors, unitary and Hermitian matrices, and so on. The ability to work with all of the above in Dirac notation.

Some knowlege of calculus. You needn't be able to solve difficult integrals "by hand" but you need to have some familiarity with the concepts. Some exposure to differential equations is also desireable. Unless you are able to do the basic undergraduate applied math, you'll need to be able to use various computer tools if you want to work some of the exercises.

The plan in a nutshell

I. The transition from discrete to continuous vector spaces

II. Background and "warm-up" on differntial equations

III. Introduction to the Schrödinger equation

IV. Some elementary quantum systems

V. A first look at philosophical questions in quantum theory

More detailed (tentative) outline

The transition from discrete to continuous

- Transition-Chart.html
- Transition-Doc.pdf
- Functions are vectors
- Integrals are inner products
- Fourier transforms depict a change of basis
- And so on

Warm-up on solving PDEs

- Traditionally taught bullet points
- The linear algebra perspective
- Warm up with the heat equation?

Schrodinger equation introduction

- Pick apart the equation. What do all the symbols mean?
- The quantum state psi (the "wave function")
- Finding solutions

Some elementary examples

- Free Particle
- Infinite Well
- Finite Step
- Linear Potential (constant force, the only one of these that's realistic)
- Harmonic Oscillator?

Philosophical issues / Interpretations

- The textbook heuristic
- The measurement problem
- The locality debate
- The positivist position
- Everett
- de Broglie / Bohm or Pilot Wave
- There are many more, but ...