Marija Drndic

Fall 2006

Physics 411: Quantum Mechanics I

This course is an introduction to the behavior of matter from a microscopic point of view. Schrödinger's Wave Mechanics will be introduced and used to describe the influence of potential fields on the motion of a particle. After exploring Schrödinger's Equation through many useful examples, our focus will shift to Heisenberg's Matrix Mechanics and Dirac's Formalism. Specific topics will include quantum uncertainty, level structure, spin, operators, and symmetry.

Topics to be covered:

1. Pre-history: Einstein's Quanta, de Broglie's Postulate, Bohr's Atom.
2. Particles and Waves: Analogy between Classical Mechanics and Geometrical Optics.
3. Schrödinger's Equation & the Wave-function, _.
4. Born's Interpretation of _: probability density, expectation values, "states" as eigenfunctions, "observable eigenvalues.
5. Particle motion without forces: the free particle, a particle confined to a box, tunneling.
6. Particle motion in a field of force: simple harmonic oscillator (SHO), SHO in an electric field.
7. The evolution of a quantum state in time.
8. Momentum Space vs. Coordinate Space: Fourier Transformations, uncertainty, commutators.
9. Schrödinger's Equation revisited: operator representation of energy conservation.
10. The Hydrogen Atom: 1st encounter.
11. Angular momentum: generators of rotation, Lie Algebras.
12. Spin: Stern-Gerlach Experiment, Pauli's Matrices, SU(2) representation.
13. Hilbert Space: Heisenberg's Matrix Mechanics & Dirac's Formalism, properties of Hermitian matrices.
14. SHO revisited: algebraic solution, raising/lowering operators.
15. Is Quantum Mechanics Complete?: Einstein vs. Bohr, Hidden Variables, Bell's Inequality & Aspect's Measurement.

Prerequisites:

Classical Mechanics, Differential Equations, Linear Algebra.

Course Times:

MWF 11-12 in DRL 3C2. (Office hours: TBA; additional one hour problem solving session/office hours by TA

Main Text:

"Introduction to Quantum Mechanics", by Griffiths. Available at the Penn bookstore.

Supplementary Texts: (*cheap Dover Publishing version available at http://store.doverpublications.com/)

"A Modern Approach to Quantum Mechanics", by Townsend. (commonly used undergraduate text)
"Wave Mechanics", by Pauli.* (terse review of QM by one of its creators).
"The Feynman Lectures on Physics: Vol. III", by Feynman. (a must for any serious student of physics)

Additional Reading:

"Sources of Quantum Mechanics", Edited by van der Waerden.* (collection of early papers)
"The Physical Principles of the Quantum Theory", by Heisenberg.* (thoughts from one of the masters)
"Group Theory and Quantum Mechanics", by Weyl.* (classic text)
"Speakable and Unspeakable in Quantum Mechanics", by Bell. (discussion of the "Foundations of QM")
"Quantum Paradoxes", by Ahranov and Rohrlich. (excellent treatment of the "weirdness" of QM)

Web Resources:

"Eric Weisstein's World of Physics" http://scienceworld.wolfram.com/physics/
"Wolfram MathWorld" http://mathworld.wolfram.com/

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Grader/TA:

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Assignments & Grading:

Homework (40%), In-class mid-term exam (material up to ~ Chapter 2) (20%), Final exam (40%).
No late homeworks accepted. The lowest homework score will be dropped.