Phys 480 Quantum Mechanics I

Fall 2011
Time: MWF 10:30-11:20
Place: WAT 114
Instructor: Prof. Klaus Sattler (956-8941), email: sattler@hawaii.edu
Office Hours: W 12:00-1:00 pm
Text: David J. Griffiths, *Introduction to Quantum Mechanics*, 2nd ed. Pearson (2005)
Pre-requisites: Phys 274, Phys 310, Phys, 350, Math 244 or Math 253A and Math 311 (or consent).

Caitilin Sikora, a choreographer and physicist uses the mathematical structure of quantum mechanics in her dance choreography (UC Irvine, Department of Dance, May 2009).

Why Quantum Mechanics?

Quantum mechanics is one of the foundations of modern physics and provides a general scheme for understanding a vast range of physical phenomena. Every physicist needs to be familiar with the main ideas and results of quantum mechanics and a majority use it, in some form, on a daily basis. This course aims to give you a solid understanding of the ground rules of quantum mechanics as well as it applications.

Quantum mechanics is tremendously important in our modern lifestyle; it provides an understanding of the operations of semiconductors, lasers, magnetic resonance and a variety of other technologies that were inconceivable before the development of the subject. It has also profoundly changed our view of the physical world. Nearly 80 years after quantum mechanics was formalized, experts are still able to unearth apparent paradoxes within the theory and dispute their implications.

Course Description: This is the first of a rigorous two semester introduction to Quantum Mechanics. It may be one of the most important courses you take as the subject forms the core of our understanding of the physical world. Thoroughly proven through a wide range of experiments, quantum mechanics has a beautiful logical structure that you will learn and enjoy by using it to solve problems. So while it may be true as Richard Feynman famously claimed that "nobody understands quantum mechanics", you will learn to use it to explore a fascinating realm that classical intuition has not prepared you for.

Max Planck in 1901

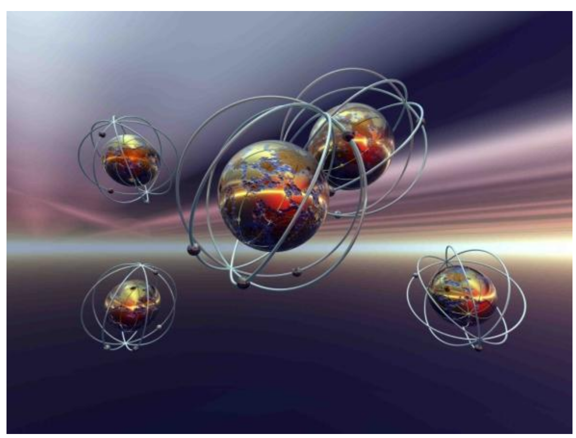
Goals: To obtain a basic understanding of the key concepts of elementary quantum mechanics, especially the use and basic applications of the Schrödinger equation in problems of pedagogical and practical importance, and to prepare students for graduate-level quantum mechanics. The course objectives will be accomplished through lecture and discussion of selected topics in class, and by students working through the assigned parts of text, including all assigned homework problems. Assessment will come from exams and assigned homework.

Topics: Fundamental principles of quantum theory with application to one and three dimensional systems under various potentials; free particle; bound particle; harmonic oscillator, angular momentum, hydrogen atom, two-particle systems, solids, quantum statistical mechanics.

Course Outline:

Chapter 1: THE WAVE FUNCTION
1.1 The Schrödinger Equation
1.2 The Statistical Interpretation
1.3 Probability
1.4 Normalization
1.5 Momentum
1.6 The Uncertainty Principle

Chapter 2: TIME-INDEPENDENT SCHRÖDINGER EQUATION
2.1 Stationary States
2.2 The Infinite Square Well
2.3 The Harmonic Oscillator
2.4 The Free Particle



2.5 The Delta-Function Potential
2.6 The Finite Square Well
Chapter 3: FORMALISM
3.1 Hilbert Space
3.2 Observables
3.3 Eigenfunction of a Hermitian Operator
3.4 Generalized Statistical Interpretation
3.5 The Uncertainty Principle
3.6 Dirac Notation
Chapter 4: QUANTUM MECHANICS IN THREE DIMENTIONS
4.1 Schrödinger Equation in Spherical Coordinates
4.2 The Hydrogen atom
4.3 Angular momentum
4.4 Spin


Erwin Schrödinger

Homework is due once a week on Monday**.** Homework must be turned in at the beginning of class**.** In addition to the main weekly homework sets we will have homework assignments for additional practice.

Exams: We will have two in-class midterm exams and the final examination. In addition we will have weekly quizzes.

Grading
Grade percentages: Homework (25%), Quizzes 15%), Midterm 1 (15%), Midterm 2 (15%), Final exam (30%)
Course grade will be based on a pre-determined absolute scale:
A (85 – 100), B (70 – 85), C (55-70), D (40-55), F(< 40)

Student Learning Outcomes (SLOs):
Students successfully completing this course will
1. demonstrate knowledge of fundamental concepts in quantum mechanics and statistical physics and will be able to apply this knowledge to solve problems in elementary particles, nuclear, atomic and molecular physics, as well as solids.
2. find in quantum mechanics a wholly new and counterintuitive way of thinking about the world.
3. be able to deal with conceptually rich and technically difficult theoretical problems.
4. have learned how to apply concepts of mathematical methods (covered in previous math courses) such as trigonometric functions, hyperbolic functions, differentiation and integration techniques, complex algebra, differential equations, Fourier series, vector spaces, operators and matrices, multivariable calculus, vector calculus, and tensors.

5. be able to read and understand scientific articles in modern physics.
6. know how to use the theory to discuss quantum phenomena quantitatively.
7. have learned the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications.
8. have formed a platform for future studies and professional tasks.
9. have experienced the adept application of physics and mathematics to solve real life problems.
10. have acquired a significant and deep-rooted knowledge in the understanding of the physical phenomena and became inspired by a new philosophy which extends far beyond our common sense thinking.

SYLLABUS: The syllabus describes the intended progression of the course. The syllabus and homework assignments will be revised as needed. Changes to the syllabus and the homework assignments will be announced in class.