Fall 2018

PHYS 731-001: Quantum Mechanics II

Tao Zhou

Physics 731 Course Outline

Instructor: Prof. Tao Zhou, taozhou@njit.edu, Tel: 973-642-4931, Room: T478

Textbook: *Quantum Mechanics with basic field theory*, B.R. Desai, Cambridge University Press, 2010.

Pre-requisite: Physics 631, Quantum Mechanics I.

Grade Decomposition

Class participation and quiz 30%
Home work: 30%
Final term project: 40%

Learning Objective: Students are expected to learn the particle version of relativistic quantum mechanics, have a detailed understanding of Klein-Gordon equation, Dirac equation, their consequences and shortcomings. Students are then expected to get familiar with the second quantization method, its application on quantizing different Fermion and Boson fields, and the general notion of quantum electrodynamics (QED). Finally students are expected to have some basic knowledge of spontaneous symmetry breaking and the standard model.

Learning Outcome Evaluation Metrics: Through in-class quiz and discussion, instructor can evaluate students' understanding of basic physical concepts. Through homework, instructor can evaluate students' problem solving capability. The final project will test students' capability of literature search and basic research skill.

At the end of the semester, students are expected to be able to:

- Solve the Dirac equation for free electron.
- Solve the Dirac equation for electron under a central force, i.e. the single particle relativistic hydrogen atomic model.
- Solve the Dirac equation for electrons under external electromagnetic field.
- Understand second quantization and the canonical quantization methods.
- Understand the classical Lagrangian expression of fields
- Using the Green's function method to solve scattering processes.
- Understanding the equivalence between Green's function method and Feynman diagram method.
- Extend these methods to solve relativistic scattering processes, including the radiative correction, electron self energy, anomalous magnetic moment, and Lamb's shift.

Topics:

Date and Lecture Topic	Text Assignment
Week 1: Special Relativity and quantum mechanics : An Introduction	Chap. 31
Week 2: Klein-Gordon Equation	Chap. 32
Week 3: The Dirac Equation I	Chap. 33
Week 4: The Dirac equation II	Chap 34 -36
Week 5: Lagrangian formulation of classical fields	Chap 41
Week 6: Scattering, S-matrix and Green's function	Chap 20, 23
Week 7: Multi-particle systems and second quantization Continue	Chap 37
Week 8: Basic QED and Feynman diagrams	Chap 43
Week 9: Radiative corrections	Chap 44
Week 10: Anomalous magnetic moment and Lamb Shift	Chap 45
Week 11: Superconductivity	Chap 39
Week 12: Spontaneous symmetry breaking	Chap 42
Week 13: Basics of Standard model	
Final Project	