Fall 2020

PHYS 480-001: Topics in Applied Physics

Tao Zhou

Physics 480: Topics in Applied Physics

From elementary particles to the cosmos: A survey of current fundamental physics

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

Textbook:

1) *Introduction to Elementary Particles*, 2nd edition, David Griffiths, Wiley-VCH, 2008.
2) *Gravity,* James B. Hartle, Addison-Wesley, 2003

Pre-requisite: Physics 234

Grade Composition:
Class participation and homework: 30%
Project and presentation: 30%
Research papers: 40%

Overview: To quote David Griffiths, "there now exists a coherent and unified theoretical structure in physics that is simply too exciting and important to save for graduate school or to serve up in diluted qualitative form as a subunit of modern physics." Griffiths was referring to the standard model of elementary particles, with quantum field theory as the underlying theory for the extremely small. Yet on the other side, general relativity is an equally powerful and beautiful fundamental theory for the extremely large, including structures ranging from black holes all the way to the entire universe. In this survey course, we will learn the most important experimental facts for elementary particles and the most important observational facts for black holes, gravitational waves, and cosmology. We then will sketch out the basic structures of quantum field theory and general relativity, and see how they account for the vast majorities of these experiments and observations. The covering topics are wide, so we cannot go deeply into the mathematical details of these theories. What I hope we can achieve, other than learning the basic facts about the extremely small and extremely large worlds, is to understand the key physical concepts and ideas behind the two most fundamental theories in physics.

Topics: (preliminary)

Date and Lecture Topic	Text Assignment
Week 1: Historical Introduction to the Elementary Particles	**Chap. 1, Griffiths**
Week 2: Relativistic Kinematics	**Chap. 3, Griffiths**
Week 3: Symmetries	**Chap. 4, Griffiths**
Week 4: Quantum Electrodynamics	**Chap 7, Griffiths**

Week 5: Quantum Chromodynamics	**Chap 8, Griffiths**
Week 6: Weak Interactions	**Chap 9, Griffiths**
Week 7: Gauge Theories	**Chap 10, Griffiths**
Week 8: Gravity as Geometry	**Chap. 6, Hartle**
Week 9: Gravitational Collapse and Black Holes	**Chap 12, Hartle**
Week 10: Gravitational Waves	**Chap 16, Hartle**
Week 11: The Universe Observed	**Chap 17, Hartle**
Week 12: Cosmological Models	**Chap 18, Hartle**
Week 13: The Einstein Equation	**Chap 21, Hartle**
Final Project and Individual Presentation	