PHY781: High Energy Physics

(Advanced Quantum Field Theory)

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Prerequisites: PHY681 (Quantum Field Theory)

Summary: This is a second course on Quantum Field Theory (QFT) following PHY681. QFT is one of the fundamental tools of modern physics with broad ranging applications in all of theoretical physics including condensed matter physics, particle physics, and other areas of high energy physics.
This second course is primarily divided into two parts. The first part introduces the path integral formulation and reconsiders the quantization of scalar, fermionic and electromagnetic theories in this formulation. We will then consider more general Yang-Mills theories and look at path integral quantization here. The second part of the course deals with renormalization. Answers to various processes in quantum field theory often turn out to be infinite. The process of regularization and renormalization is used to extract physical answers out of these infinites. This course will lay out these formal procedures and show how to renormalize various quantum field theories. Time permitting, we will also cover some extra topics mentioned below.

Topics to be covered:

1. Introduction
2. Functional methods
    a. Path integrals for quantum mechanics
    b. Path integral quantization of scalar fields, fermions and electrodynamics
3. Yang Mills theories: Classical aspects and Quantization
4. Renormalization
    a. Systematics of renormalization
    b. Renormalization group
5. Additional topics (time permitting)
    a. Spontaneous symmetry breaking and Higgs mechanism
    b. Critical Exponents and Scalar field theory
    c. Anomalies

Evaluation*:
*   Assignments/Take home examinations: 50%
*   Project: 50% (Report: 10%, End term presentation: 40%).

 *To be finalized after assessing number of students in class.

References:
The course would be constructed out of several books and notes and will evolve depending on the students in the class. Below is a list of books that would be useful.

*   M. Peskin and D. Schroeder: *An Introduction to Quantum Field Theory*
*   S. Weinberg: *The Quantum Theory of Fields: Vol 1 and 2.*
*   M. Scredniki: *Quantum Field Theory*
*   L. Ryder: *Quantum Field Theory*
*   A. Zee: *Quantum Field Theory in a Nutshell.*