Physics 253b: Quantum Field Theory II

Harvard University, Spring 2023

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Course Description: Analytic properties of the S-matrix and constraints from unitarity. Bound states and resonances. Infrared divergence. The 1PI effective action. Improved perturbation theory via Gell-Mann-Low equation. The Wilsonian renormalization group. RG fixed points and the epsilon expansion. Non-Abelian gauge theory and its quantization. Operator product expansion and deep inelastic scattering. $1/N$ expansion and the color flux string. Spontaneous symmetry breaking. Effective field theory of pions. Anomalies and instantons.

Prerequisites: Physics 253a or equivalent (familiarity with the path integral, perturbative computation of Green functions and S-matrix elements, quantization of fermion fields and abelian gauge fields.)

Slack Workspace: harvardqftspring2023.slack.com

All written communication in this course will be conducted through the slack workspace (contact Xi Yin for invitation.)

Lectures: Wednesdays and Fridays 1:30-2:45pm at Jefferson 256

The lectures will be live streamed over Zoom at the link

https://harvard.zoom.us/j/93664510985?pwd=NW1La1RYcGI2VmpaTW9CQ3pxZmdCQT09

The recording will be posted after each lecture.

Sections: time and location TBA

Course Requirements and Grading:

Homework: There will be (roughly) biweekly problem sets. You are encouraged to discuss the problem sets but you should write your solutions individually. The problem sets will account for 70% of the grade.

Final Project: You will choose one problem from a list, write up your own solution as a term paper, and give a 30 minute presentation on it. Both understanding the problem and solving it will likely involve reading beyond the lecture material. You may also find the answer in the literature, but your solution should be self-contained. The list of possible problems and references will be handed out during the second half of the semester. The presentations will be held in the reading period, and the term paper is due by the end of the exam period. The term paper and presentation will account for 30% of the grade.

There will be no final exam.

Textbooks: We will adopt the conventions used in Weinberg's *The Quantum Theory of Fields* volume 1 and 2. Hand written lecture notes will be posted as the course proceeds.