# QFT III Syllabus

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This course functions as a third semester in the quantum field theory sequence. Topics to be covered include:

- **Effective field theory and the renormalization group.** Review of perturbative renormalization in relativistic QFT. Large log resummation. Renormalizing nonrenormalizable couplings. Mass dependent vs mass independent schemes. Composite operators. Wilsonian vs continuum RG. The decoupling theorem. Universality, flows, and the continuum limit. Top-down EFT using match & run methods. Effective actions. Bottom-up EFT and the CCWZ construction. Chiral perturbation theory. Power counting and naive dimensional analysis. The Standard Model as an EFT. Hierarchy problems.
- **Nonperturbative phenomena.** Monopoles and Dyons. Qualitative aspects of confinement. Calculable confining models. Instanton, strings, and domain walls. Anomaly inflow. Vacuum decay.
- **Supersymmetry.** Constructing supersymmetric models. Superspace. Nonrenormalization theorems. Supersymmetric gauge theories. The minimal supersymmetric extension of the Standard Model.

The course will consist of interactive lectures and approximately 6 homework sets to be assigned ∼biweekly. The grade will be based on homework scores. Lecture notes will be posted on the course website, drawing from the following set of reviews and books, and some of the original literature:

Review Articles:
"Effective Field Theory and the Fermi Surface." J. Polchinski, hep-th/9210046, 1992
"Effective Field Theory." H. Georgi, Ann Rev. Nuc. Part. Sci., 1993
"Effective Field Theories." A. Manohar, arXiv:hep-ph/9606222, 1996
"Five Lectures on Effective Field Theory." D. Kaplan, arXiv:nucl-th/0510023, 2005

Textbooks:
"Effective Field Theories." A. Petrov and A. Blechman, 2016
"Introduction to Effective Field Theory." C. P. Burgess, 2021
"Advanced Topics in Quantum Field Theory." M. Shifman, 2022

"Geometry, Topology and Physics." M. Nakahara, 2003
"Quantum Field Theory and Critical Phenomena." J. Zinn-Justin, 2021
"Dynamics of the Standard Model." J. Donoghue, E. Golowich, B. Holstein, 2014
"Quantum Field Theory." M. Srednicki, 2007
"Modern Quantum Field Theory." T. Banks, 2008
"Supersymmetry and String Theory, Beyond the Standard Model." M. Dine, 2016
"Quantum Field Theory and the Standard Model." M. Schwartz, 2013