Effective Field Theories in Nuclear and Particle Physics
Physics 578B, Winter 2024
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Effective field theory (EFT) concepts and methods permeate all of physics. The basic idea behind effective theories is that dynamics at a given energy (or length scale) does not depend on the details of the dynamics at much higher energy (or much shorter distance). Hence, EFTs provide a systematic approach to exploit the separation of scales in many physical problems, finding applications in diverse fields, such as atomic and condensed matter physics, nuclear physics, particle physics, and cosmology. In this course, students will learn the basic ideas and methods of EFT, with emphasis on applications to nuclear and particle physics.

Prerequisites:. Phys 570 (first quarter of QFT) is required. Phys 571 (second quarter of QFT) is desirable.

Tentative Syllabus

- Examples and basic principles of EFTs
- Review of renormalization and the renormalization group
- The Standard Model as an effective field theory
- EFT approach to Physics beyond the Standard Model
- Low-energy EFT of the SM and applications to weak interactions
- Selected EFTs of Quantum ChromoDynamics (QCD)
  - Heavy Quark EFT
  - Chiral Perturbation Theory for mesons
  - Chiral Perturbation Theory for baryons
- EFTs for nuclear interactions
  - Generalities & nucleon-nucleon scattering at low energy
  - Pion-less EFT
  - Chiral EFT

This is a C/NC class. There will be homework sets and a final project.