PY810: Symmetries and Groups in Physics

Instructor: Thomas Schäfer

Time: Tu/Th 3:00-4:15 (or TBA)

This is a course on Symmetries in Physics aimed at graduate and advanced undergraduate students. Familiarity with quantum mechanics and classical field theory is useful but not absolutely necessary. The aim of the class is to acquaint the student with the uses of symmetry in modern physics. We will focus on the ways in which symmetries manifest themselves in physics. This includes exact global symmetries (such as rotational symmetry or Lorentz invariance), weakly broken global symmetries (such as isospin and flavor in particle physics), spontaneously broken global symmetries and the dynamics of Goldstone modes, and finally spontaneously broken local symmetries and the Higgs mechanism. The class is not intended to be a complete course on the mathematical theory of continuous (Lie) groups. We will provide some of the mathematical background but our main focus is on simple techniques that are useful in constructing group representations and computing matrix elements.

Outline:

1. **Discrete Groups**
2. **Symmetries in Quantum Mechanics**
3. **Lie Algebras: SU(2) and Isospin**
4. **More on Representations: Tensors, Roots and Weights**
5. **SU(3): Color and Flavor**
6. **Spontaneous Symmetry Breaking**
7. **Higgs Mechanism**

Textbook: Lie Algebras in Particle Physics (2nd edition), Howard Georgi