Spring 2018
MW 1:00 – 2:15, 103 Allen Hall
(Proposed recitation time is F 1:00 – 2:15
to be confirmed, location also)

PHYS 3770

Topics in LHC Physics –
A graduate-level special topics seminar

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Office hours: After class or by app't

Overview

We will discuss physics at the LHC by using as a case study the recent discovery and measurements of the **Higgs boson**'s properties. We will work through a number of **seminal papers** to learn aspects of the theory as well as the computing, detectors, and data analysis [1,2,3]. Some **beyond-the-standard-model** ideas will be discussed [4,5,6]. In general, an **experimental viewpoint** like that of Ref. 3 will be taken. The goal of the course is to give graduate students the exposure to LHC research with recent real-life examples.

Some of papers that we will discuss are

[1] P. W. Higgs, Phys. Rev. Lett. 13 (1964) 508 on the spontaneous breaking of electroweak symmetry
[2] ATLAS Collaboration, Phys. Lett. B 716 (2012) 1 on the discovery of the Higgs boson with $\gamma\gamma$, ZZ, WW
[3] ATLAS Collaboration, Phys. Rev. D 92 (2015) 1 on the detailed measurement of Higgs boson decay to WW
[4] T. M. Hong, https://cds.cern.ch/record/2057641 on the relations of rate measurements to Higgs couplings
[5] T. M. Hong, https://arxiv.org/abs/1709.02304 on the searches for dark matter and mediators at the LHC
[6] D. Curtin et al., Phys. Rev. D 90 (2014) 075004 on ideas for non-standard exotic decays of the Higgs

Students will learn

- methods to estimate background contamination in the data sample
- data analysis methods, e.g., machine learning, using ROOT
- Monte Carlo simulations, e.g., MadGraph
- statistical analysis to interpret experimental results
- history of Higgs at the LHC, achievements, and open questions

Homework

Homework will be assigned periodically. Material will be on CourseWeb.

Project

There will be a **fun** final project related to your own research. I will make some suggestions, but you are encouraged to also propose a topic. See dates.

Evaluation

Grade = homework (50%) + final project (50%)
Final project = short write-up + short in-class presentation

Requirements

Basic familiarity of particle physics

Important dates

January 15, 17
No seminar

January 12, 19, 26, … (Fridays)
Make-up seminars & recitations

February 5 (Monday)
Project topic decision

March 5 (Monday)
Project bibliography & review

April 9 (Monday)
Project report due

Week of April 9 and of April 16
Student presentations in class

Week of April 23
Final exam period – no seminars