Physics 3101, Fall 2018

Course Title: Collider Physics

Room 419 Allen Hall, MW 9:30−10:45

Prerequisites: Physics 3717 (Particle Physics) and 3765 (QFT), or equivalent.

References:
arXiv:hep-ph/0508097, TASI Lecture notes, Tao Han
V.D. Barger and R.J.N. Phillips: *Collider Physics*, Updated ed.
Review of Particle Physics, Particle Data Group, Chinese Physics C40 (2016)

Course description: The CERN Large Hadron Collider (LHC) is collecting staggering amount of data at the energy frontier. With the outstanding performance of the LHC in searching for fundamental laws of nature, and the planning of its luminosity and energy upgrades, as well as the discussions for future colliders for the next two decades, it is timely to offer such a course for those who have genuine interests in theoretical and experimental high energy physics. The course is open to graduate students in the field of particle physics and cosmology, in either theoretical or experimental research direction.

I intend to present the rather basic knowledge and methodology for collider phenomenology. The theoretical framework is Quantum Field Theory and the Standard Model of particle physics. I would try to present the course in a self-contained manner without relying on too much technicality based on other advanced courses. Given the wide range of topics and the broad spectrum of the registrants, the course is designed to have significant flexibility.

Grade: The grade will be based on:

a. 60% homework performance (bi-weekly)

b. 20% oral presentation (about 20−30 min.) on a topic related to the course materials or your research interests

c. 20% participation of discussions during the lectures and after class

Tips for the course:

I list a few items that hopefully would help the students at any level to optimize their learning in the due course.

- Throughout this semester, any physics topic will be discussed at a *qualitative* level and a *quantitative* level. For a technically poorly prepared student (no Phys 3717 yet), it is of most importance to understand the topics at a qualitative level, namely to learn the basic concepts and the general approaches. It would be viewed as a success if this can even be achieved.

- For a technically well prepared student (with Field Theory Phys 3717, 3718 and particle Physics Phys 3765, 3766), you should go beyond the basic concepts and emphasize collider physics techniques, both analytical and numerical.
- For advanced students who already start research, you may try to make connections between your research, your random thoughts and the course materials.
- The course offers tremendous flexibility and capacity. No one should be discouraged by not learning some topic as well as you wished; and anyone should be encouraged to go as far as you can.
- Group study is strongly encouraged, although you should try out (or struggle) with the homework first on your own.
- Do ask a lot of questions to me, to yourself and to each other.

Hope this course serves well for your future research.

The tentative table of contents follows.

Collider Phenomenology

Basic Knowledge and Techniques

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