Directed Methods

PHYS 3110 – Fall 2024

Instructor Info —

Dr. Andreas Papaefstathiou

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Course Overview

The purpose of this Directed Methods course is to introduce the fundamentals of particle physics phenomenology through detailed calculations and simulations. This will be achieved by both theoretical calculations and hands-on experience in Monte Carlo event generators for various particle physics processes in quantum field theory.

Learning Objectives

At the completion of this course, you will be able to

- Understand the fundamental interactions of particles, in the context of the particle physics experiments.
- Understand how Monte Carlo event generators work to perform integrals of cross sections, and generate event samples distributed according to the probabilities of quantum field theory.
- Run, analyze, and interpret the results of complex simulations using established Monte Carlo event generator frameworks, including the creation of properly-formatted data visualizations using scientific graphing software.
- Analyze the pseudo-data generated to obtain an understanding of measurements at particle colliders.

Textbooks

Main Textbooks (You do not need to buy these):
Modern Particle Physics, Mark Thomson.
Concepts of Elementary Particle Physics, Michael. E Peskin.
Elementary Particle Physics: An Intuitive Introduction, Andrew J. Larkoski.
An Introduction To Quantum Field Theory 1st Edition, Michael E. Peskin & Daniel V. Schroeder.
QCD and Collider Physics, R. K. Ellis, W. J. Stirling, B. R. Webber.

Other Material:
How-to: write a parton-level Monte Carlo particle physics event generator, A. Papaefstathiou, https://arxiv.org/abs/1412.4677
Pyresias: A toy parton shower for educational purposes, A. Papaefstathiou, https://github.com/apapaefs/pyresias.

Additional material will become available during the course in the form of notes, articles and suggested textbooks.

D2L

Course information, other material, and announcements will be available on D2L, accessible from https://d2l.kennesaw.edu. To sign on, use your KSU username and password.

Course Requirements and Assignments

For each credit hour of directed methods, 3 hours per week of scientific research are required. This can be literature research, learning particle physics theory, writing computer code, graphing and analyzing simulation output, and/or creating reports, abstracts, or presentations.

Student Responsibilities

The goal of this directed study course is for you to learn physics, as well as some computer programming, as well as develop skills in scientific communication. It will be challenging and fun. Your main responsibility is to read the recommended literature and learn the theory behind the calculations and computer simulations we create, and be able to restate the theory your report. You will keep a notebook in which you will document your research. Maintaining a proper notebook is an important skill for every research scientist. You are expected to meet with me at least one hour per week to discuss your progress. You may also have to take some tutorials on programming in C++ and python.

Scientific research can be very frustrating but is also very rewarding. The skills you learn here go beyond writing computer code and making plots (although that is part of it, of course). You will learn problem solving and data analysis while you reinforce your theoretical physics knowledge.

Evaluation Policies

Regular work and communication is expected during the course, including evaluation of intermediate results and discussion.

You are expected to produce a scientific report in a format akin to a publishable article at the end of the course, in the appropriate scientific language, preferably in the LaTeX format. The report should include an introduction, with background material, a detailed description of the theoretical underpinnings of the research, an analysis and discussion of results, and conclusions with potential suggestions for future directions.

In addition to the scientific report, you are expected to write an essay reflecting on your research experience. I will provide you with the essay prompts later in the semester.

The course is graded S-Satisfactory >70% or U-Unsatisfactory <70%.

Academic Integrity

Every KSU student is responsible for upholding the provisions of the Student Code of Conduct, as published in the Undergraduate and Graduate Catalogs. Section 5c of the Student Code of Conduct addresses the university's policy on academic honesty, including provisions regarding plagiarism and cheating, unauthorized access to university materials, misrepresentation/falsification of university records or academic work, malicious removal, retention, or destruction of library materials, malicious/intentional misuse of computer facilities and/or services, and misuse of student identification cards. Incidents of alleged academic misconduct will be handled through the established procedures of the Department of Student Conduct and Academic Integrity (SCAI), which includes either an "informal" resolution by a faculty member, resulting in a grade adjustment, or a formal hearing procedure, which may subject a student to the Code of Conduct's minimum one semester suspension requirement.

All students are responsible for knowing the information, policies and procedures outlined in the Kennesaw State University Codes of Conduct. The Code is available online at `http://scai.kennesaw.edu/`.

Accommodations for Students with Disabilities

KSU is here to help. Any student with a documented disability or medical condition needing academic accommodation of class-related activities should contact the Office of Studzent Disability Services (`https://sds.kennesaw.edu/`).

Withdrawal Policy

Students are solely responsible for managing their enrollment status in a class.

Non-attendance does not constitute a withdrawal.

The last day to withdraw without academic penalty is Friday, October 25$^{\text{th}}$ 2024, 11:45 p.m..

Additional information on the withdrawal policy can be found at: `http://catalog.kennesaw.edu/content.php?catoid=51&navoid=3701#withdrawalfromclasses`.

The Academic Standing Appeal policy is explained at: `https://appeals.kennesaw.edu/withdrawal_appeal.php`.

Campus Sexual Misconduct Policy

For information about how to report sexual misconduct or how to obtain assistance, please go the following page: `https://scai.kennesaw.edu/procedures/sexual-misconduct.php`.

Other Policies

See the Student Handbook (`http://catalog.kennesaw.edu/`) for other policies and information.

Face Coverings and Illness

If you are feeling ill, please stay home and contact your health professional. In addition, please email your instructor to say you are missing class due to illness.