

Physics 490 – Modern Physics – Syllabus¹

Spring 2026, University of Hawaii at Manoa

Class: TR, 13:30-14:45, in WAT 113

Instructor: Prof. Sven E. Vahsen

Phone: (808) 956 2985

Office: Watanabe Hall 227A

E-mail: sevahsen@hawaii.edu

Office Hours: Usually Tuesdays 3:00-4:00 pm

Lecture Format and Rules

- Lectures in-person. Attendance required.
- No cell phone use or texting in class.
- Please interrupt me **any time** to ask relevant questions. I strongly encourage it.

Course materials

News and materials (such as homework assignments) will be distributed via Google Classroom.

Homework should be turned in on paper at the beginning of the class the day it is due.

There is no need to turn in anything via google classroom.

- **Join google classroom at:**

<https://classroom.google.com/c/NzkzMzAzMTM3MjEw?cjc=ilmhgezt>

You may need the class code, which is: ilmhgezt

Description in Course Catalog

Introduction to nuclear and elementary-particle physics.

Course Description

This class introduces modern elementary particle physics, also known as high energy physics. We will briefly review the status of the field, open questions, and experimental methods. Our main goal will be to understand the Standard Model (SM) of Particle Physics and how it is used to make theoretical prediction. Because the SM describes the interactions of the fundamental constituents of matter via relativistic quantum fields, we must use and extend what we have learned in previous classes on special relativity and quantum mechanics. The course will necessarily be mathematical, but I will attempt to

¹ Version: 1/20/2024.

explain everything from the ground up as much as possible.

Particle physics is my own field of research, and I am very excited about teaching this class. Please note that our textbook contains at least one year's worth of material and is in my opinion excellent both for advanced undergraduates and graduate students. In the future I hope to extend this into a yearlong course that will cover the whole book. For the current one-semester course I will have to cover only selected topics from the book, and the exact final list of topics will involve some improvisation depending on how I feel we do as a class in the first weeks.

The textbook by Thomson emphasizes clarity of presentation and theoretical understanding. Thomson purposely avoids the historical approach of many other books. I agree that Thomson's choice is best for optimizing clarity and pedagogy. That said, it means the book lacks a bit of the excitement associated with the many discoveries in the field. We will therefore supplement the book with student presentations. Each student will give a 30-minute presentation on a fundamental experimental discovery in particle physics.

Prerequisites

Formal Prerequisites: Physics 480; or consent. Co-requisite: Physics 480. In practice, you need to be comfortable with quantum mechanics (and hence linear algebra, complex numbers, differential equations, and probability density functions) and special relativity.

Required Materials

Textbook: *Modern Particle Physics*, by Mark Thomson

Homework

Please keep reading the book, following my suggestions in class. There will be weekly sets of written problems, typically due one week after assignment at the beginning of class. Honest collaboration is encouraged, but the **material handed in must be your own work**. Late homework will be accepted only one lecture after it is due, and the score will be reduced by 50%.

Learning Goals

- You should understand and will be tested on *topics and material presented in class and/or covered in homeworks*.
- You should be able to independently solve problems of the same difficulty level as the homework.

Evaluation (may be revised – preliminary plan)

Homework	20%
Tests (there may be up to four)	60%
In-class Presentation	20%

Although the homework only counts 20%, that is where most of the learning happens, and the effort you put into your homework will determine most of your grade. My past statistical analysis has shown that homework effort can predict tests scores. Therefore, it is in your interest to take your time and to puzzle out how to solve the homework problems. This will then help you on the tests. Similarly, if you were to take any shortcuts on the homework, it is likely to reflect in our test scores.