Physics 3790: Particle Astrophysics

Spring 2025

- Textbook: D. Perkins: "Particle Astrophysics," 2nd edition
- Further reading: E. Kolb and M. Turner: "The Early Universe"
- Prerequisites: Graduate-level E&M, QM and TSM (see below for more details)
- Lectures: TH 9:30-10:45am (103 Allen Hall)

Course description

This class is tailored to a wide audience of graduate students as a detailed survey of the interplay between astrophysics, particle and nuclear physics and cosmology. A familiarity with quantum mechanics (in particular perturbation theory and addition of angular momentum), special relativity and statistical mechanics (such as Bose-Einstein and Fermi-Dirac distributions) is assumed.

Topics covered: A short introduction of the Standard Model of particle physics and its symmetries, early universe cosmology and its thermal history, Big Bang Nucleosynthesis, baryogenesis. Dark matter, its interpretation, and methods for its detection. Aspects of structure formation, and cosmic ray physics.

The recommended textbook by Perkins will be adequate for most of the class content, but additional material will be presented in the lecture for some chapters. Thus class attendance is very important. Since this is an advanced graduate course, students are also expected to consult additional resources besides the standard textbook.

Homework

Homework is an essential part of learning the material of this course. Homework will be assigned each week on Tuesday and collected next week on Tuesday. You are encouraged to discuss the homework problems with each other after you have tried them to the best of your ability, but you cannot copy the solutions from each other. The homework assignments and solutions will be available for download on [Canvas](#).

Some of the homework problems will be discussed in class (after they have been graded and returned). For this purpose I will occiasionally pick one student at random to present her/his solution on the board. In this way, you can learn from each other's solutions, and also practice your presentation skills.

Exams and grading

There will be one mid-term exam and a final exam. They will be essay-style take-home exams. The dates and detailed modalities for the exams will be announced several weeks in advance.

The final grade will be determined by the homework submissions (40%), and mid-term (25%) and final exam (35%).

Academic policies

Academic integrity

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

Disability resources

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services, 140 William Pitt Union, (412) 648-7890 as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Copyright and recording

Course materials provided by the instructor through CourseWeb or some other means may be protected by copyright. United States copyright law, 17 USC section 101, et seq., in addition to University policy and procedures, prohibit unauthorized duplication or retransmission of course materials.

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.