

PHY 362L: Particle and Nuclear Physics (Fall 2016)

Web pages: <https://utexas.instructure.com/courses/1179703>

Unique Number: 56320

Classroom/Time: RLM 7.104, MWF 1-2 pm

Instructor: Prof. Peter Onyisi (onyisi@physics.utexas.edu).

TA & TA office hours: TBD

Required material:

- Thomson, *Modern Particle Physics* (you **will** need to read this)
- iClicker (either physical or REEF smartphone app)

Recommended texts and other reading:

- Griffiths, *Introduction to Elementary Particles*: technical nitty-gritty from another perspective
- Perkins, *Introduction to High Energy Physics*: the 2nd edition is better than the 3rd
- Riordan, *The Hunting of the Quark*: a history of how the quark model was won
- Cahn & Goldhaber, *The Experimental Foundations of Particle Physics*: key historical experimental papers
- Particle Data Group, [Review of Particle Physics](#): clear review articles on all features of particle physics

Summary and goals: This class will introduce you to the basic concepts of particle physics. We will cover the basic ideas of relativistic quantum mechanics and the interactions of particles, building up to a survey of the Standard Model of particle physics and the open questions in the field. We will discuss the experimental techniques that allow us to extract information about the world of the very small. I hope that by the end of the class you will feel comfortable with the core ideas of how particle physics calculations are done and how we verify those results experimentally. **Prerequisite:** Physics 373.

Office Hours: Wed 2-3 pm, Thu 11 am-12 noon (or by appointment), RLM 10.211

Clicker registration: please register your clicker on Canvas. Go to <http://canvas.utexas.edu>, select this class, choose “i>Clicker” on the left sidebar, then choose “i>clicker Registration.” Enter the clicker ID as described.

Grading: Grades will be based on clicker participation (5%), homework (25%), three midterm exams (15% each), and a final exam (25%). The clicker questions will be scored half for participation and half for accuracy. The plus/minus grading system will be used. The grades will

be curved based on the mean and standard deviation of the class's scores, but in no case will an assigned grade be lower than it would have been uncurved (e.g. a 91 will be at least A-).

This class is challenging and 60% on a test may be a *very good* grade. If you have concerns about your standing, do come and talk to me.

Homework: Homework will be due in class on Fridays; no late homework will be accepted. The lowest two homework scores will be dropped. The homework will be assigned through Canvas (<http://canvas.utexas.edu>); go to the "Assignments" link on the left sidebar.

You are encouraged to work with each other to understand how to solve problems. *However, you will not benefit from the class if, after that, you aren't able to solve them yourself.* All work handed in must be your own.

Exam policies: The only electronic tools allowed in the exams are calculators. You can bring one sheet of paper with notes for the exam. The midterm exams cannot be made up, except for accommodation for disabilities or religious holidays; see the policies below. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

Students with disabilities: Please notify me as quickly as possible if class materials are not accessible. Any student with a documented disability who requires academic accommodations should contact Services for Students with Disabilities (SSD) at 512-471-6259 (voice) or 1-866-329-3986 (video phone), or reference SSD's website for more disability-related information: http://www.utexas.edu/diversity/ddce/ssd/for_cstudents.php. Faculty are not required to provide accommodations without an official accommodation letter from SSD.

Accommodation for religious holidays: By UT Austin policy, you must notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a midterm examination or a homework assignment due date in order to observe a religious holy day, I will give you an opportunity to complete the missed work within a reasonable time after the absence.

Topics

1. Scattering theory, cross sections
2. Relativistic quantum mechanics, Dirac equation
3. Perturbation theory; Feynman diagrams
4. Interaction of particles with matter; particle acceleration & detection apparatus
5. Structure of nucleons; deep inelastic scattering & partons
6. Quark model of hadrons
7. Weak interactions; neutrinos; flavor physics of quarks and leptons
8. Standard Model: electroweak unification & Higgs mechanism
9. Outstanding problems and questions; physics beyond the Standard Model

Tentative Class Schedule

Day	Topic	Note
W 8/24	Intro; quick tour of the particle zoo (1.1)	
F 8/26	Quantum mechanics review (2.1, 2.3.1-2.3.5)	Quiz due, HW1 assigned
M 8/29	Quantum mechanics review (2.3.1-2.3.5)	
W 8/31	Special relativity (2.2)	
F 9/2	Fermi's Golden Rule (2.3.6)	HW1 due, HW2 assigned
M 9/5	No class: Labor Day	
W 9/7	Lorentz-invariant phase space (3.1-3.2)	
F 9/9	Cross sections (3.4-3.5)	HW2 due, HW3 assigned
M 9/12	Klein-Gordon & Dirac equations (4.1-4.3)	
W 9/14	Dirac equation (4.4-4.6)	
F 9/16	Dirac equation (4.7.1-4.7.4, 4.8)	HW3 due, HW4 assigned
M 9/19	First midterm	
W 9/21	Perturbation theory (5.1-5.2)	
F 9/23	Perturbation theory (5.1-5.2)	HW4 due, HW5 assigned
M 9/26	QED (5.3-5.4)	
W 9/28	QED (6.1-6.2)	
F 9/30	QED, Rutherford scattering (6.3-6.4, 7.1-7.2)	HW5 due, HW6 assigned
M 10/3	Form factors, nuclear shape, Rosenbluth formula (7.3-7.5)	
W 10/5	Deep inelastic scattering (8.1-8.2)	
F 10/7	DIS & parton model (8.3-8.4)	HW6 due, HW7 assigned
M 10/10	Parton distribution functions (8.5-8.6)	
W 10/12	Symmetry, isospin (9.1-9.2)	

F 10/14	Quark model (9.3-9.5)	HW7 due, HW8 assigned
M 10/17	Second midterm	
W 10/19	Flavor SU(3) (9.6)	
F 10/21	Passage of particles through matter (1.2)	HW8 due, HW9 assigned
M 10/24	Particle detectors (1.3)	
W 10/26	Accelerators (1.4)	
F 10/28	A few words on QCD & gauge symmetry (10.1)	HW9 due, HW10 assigned
M 10/31	Weak interactions (4.9, 11.1-11.2)	
W 11/2	Weak interactions (11.3-11.5)	
F 11/4	Weak interactions (11.6-11.7, 12.1, 14.2)	HW10 due, HW11 assigned
M 11/7	Neutrino masses & oscillations (13.1-13.3)	
W 11/9	Neutrino masses & oscillations (13.4-13.5)	
F 11/11	Third midterm	HW11 due, HW12 assigned
M 11/14	Neutrino masses & oscillations (13.6-13.9)	
W 11/16	Meson mixing & CPV (14.1-14.3)	
F 11/18	Meson mixing & CPV (14.4)	HW12 due, HW13 assigned
M 11/21	Electroweak unification (15.1, 15.2)	
W 11/23	No class: Thanksgiving break	
F 11/25	No class: Thanksgiving break	HW14 assigned
M 11/28	Electroweak unification (15.3)	HW13 due
W 11/30	The Higgs boson (17)	
F 12/2	Beyond the SM: open questions (18.2)	HW14 due
M 12/5	Review	
Th 12/9	Final, 9 am-noon	