Physics 736

Experimental Methods in Nuclear-, Particle-, and Astrophysics

Course Introduction

Karsten Heeger
heeger@wisc.edu
Course Organization

**Instructor**
Prof. Karsten Heeger  
Email: heeger@wisc.edu  
Office: Chamberlin Hall, room 4287

**Lectures & Office Hours**
- **Lectures:** Mon, Wed, 2.30-3.45pm, room 2223  
  course will meet twice a week  
- **Office Hours:** after the lectures, or email me to fix a time

**Course Webpages**
- Course info, schedule, homework, lectures, etc  
  [http://neutrino.physics.wisc.edu/teaching/PHYS736](http://neutrino.physics.wisc.edu/teaching/PHYS736)

  Library Course Reserve Page with protected information

**Grader**
Walter Pettus  
Email: pettus@wisc.edu
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this is the one-stop, must-visit info page for the course
Course Website

- All materials will be posted on course website, except for handwritten lecture notes.
Course Goals

• My course goals:

  – provide overview of experimental techniques used in nuclear, particle, and astrophysics
  – develop understanding of detectors and experimental techniques
  – provide the tools and basic to start research: hardware, statistics, analysis etc
  – convey basic statistical techniques and error analysis
  – make you appreciate what goes into a detector design
  – prepare you for research...
  – you will learn as much as you put into this course!
Reading

• Reading will be assigned in preparation for lectures and to provide more details and depth than I can cover.

• It is a chance for you to “explore” a topic.

• We will discuss reading material in class.

• I may ask someone to summarize a paper or topic that was assigned for reading, or lead a discussion. It will be a discussion.
Homework, Projects, Exams

- Homework and course reading will be assigned on a roughly biweekly basis

- No final exam, but final project

- You will get time to work on final project.

- We will get together as a course for a couple of afternoons during last week of semester to hear presentations.
Computational Tools

• Some homework problems and the final project may require some computational work.

• Tools I can recommend and am familiar with
  – ROOT
  – Mathematica
  – C/C++

• You can choose the tool you want or that is used in your research area of interest (Python, etc...)
Grades

• We need to give grades but you shouldn’t worry about them. They should not be a major concern at this point. This is graduate school and you are getting ready for research.

• Grades will be based on:
  – participation in class (~30%)
  – homework (~30%)
  – final project (~40%)

• Attendance and participation is required. Please email me if you will need to miss class.
Course Goals & Feedback

• I welcome feedback and suggestions often and early.
  – Don’t wait until the end of the semester. This would be a waste of everyone’s time.
  – Your input will help shape this class.
  – I welcome suggestions on topics you are interested in, would like to see covered. Things that work/don’t work in class

• Leaving feedback
  – For undergraduate classes I usually have an anonymous comment box in classroom. Hope this is not necessary.
  – I prefer if you come and see me, or email me with feedback.
Textbooks

• There is no one, single good textbook for this course. We will use chapters from a variety of books.

• As a researcher I recommend you own at least one experimental methods and one statistics book. The books I recommend are:
  – Leo “Techniques for Nuclear and Particle Physics Experiments”
  – Bevington, “Data Reduction and Error Analysis for the Physical Sciences”, or

• Scanned PDFs of chapters will be available to registered course participants on library reserve page.
  – https://

• Supplemental course material will also be posted on course website.
  – http://neutrino.physics.wisc.edu/teaching/PHYS736/

• All textbooks are available in the library.
Textbooks - Some Comments

• **Detectors:**
  – **Knoll:** good reference book for experimentalist, a good coverage of most topics, not quite in enough depth, focus on hardware and measurements
  – **Leo:** similar to Knoll, shorter, not quite the same coverage, not quite as advanced
  – **Green:** theory, hardware, and design of particle physics detectors, relatively recent, published in 2000
  – **Longair:** high energy astrophysics, theory and detectors
  – **Pobell, Enss:** Low temperature detectors and physics

• **Statistics/Error Analysis**
  – **Bevington:** the standard in error analysis
  – **Barlow:** good intro into statistics
  – **James:** more on statistical techniques

• **Reference**
  – **Particle Data Group:** good review articles, concise and dense
Course Schedule

- See [http://neutrino.physics.wisc.edu/teaching/PHYS736](http://neutrino.physics.wisc.edu/teaching/PHYS736)
- The first 2 weeks

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| 1     | 1   | Wed Jan 23, 2013 | **Course Introduction**  
- organization, syllabus, textbooks  
**Radiation and Matter:**  
- nuclear processes, radiation sources and radioactivity |  |  |  |
| 2     | 2   | Mon Jan 28, 2013 | **Examples of Particle Detectors**  
(Prof. Maruyama):  
- CUORE, DM-Ice, and IceCube (detectors in the cold) | PDG, detectors for non-accelerator physics  |  | lect2 |
| 2     | 3   | Wed Jan 30, 2013 | **Radiation and Matter:**  
- nuclear processes, radiation sources and radioactivity  
**Interaction of Radiation with Matter:**  
- neutrons  
- photons | PDG, interaction with matter  
PDG, common radioactive sources  
PDG, radioactivity | HW#1 due Feb 6  | lect3 |
| 3     | 4   | Mon Feb 4, 2013 | **Interaction of Radiation with Matter:**  
- neutrons  
- photons | Longair, chapter 4  
Longair, chapter 2  
PDG, interaction with matter |  | lect4 |
| 3     | 5   | Wed Feb 6, 2013 | **Interaction of Radiation with Matter:**  
- photons  
- charged particles | Longair, chapter 2  
Longair, chapter 5  
PDG, interaction with matter | HW#2 due Feb 13  | lect5 |
## Course Schedule

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| 2     | 3   | Wed Jan 30, 2013 | **Radiation and Matter:**
- nuclear processes, radiation sources and radioactivity

**Interaction of Radiation with Matter:**
- neutrons
- photons | **Leo, chapter 1&2**
**PDG, interaction with matter**
**PDG, common radioactive sources**
**PDG, radioactivity** | | |
| 3     | 4   | Mon Feb 4, 2013 | **Interaction of Radiation with Matter:**
- neutrons
- photons | **Longair, chapter 4**
**Leo, chapter 2**
**PDG, interaction with matter** | HW#2 due Feb 13 | lect5 |
| 3     | 5   | Wed Feb 6, 2013 | **Interaction of Radiation with Matter:**
- photons
- charged particles | **Longair, chapter 2**
**Longair, chapter 3**
**Longair, chapter 4**
**Leo, chapter 2**
**PDG, interaction with matter** | | |

introductions to different experimental techniques
Any Questions & Concerns?

• Email me (Karsten Heeger) with any questions or concerns: heeger@wisc.edu
Now, two class exercises ...
• Please write down your name and email, and if you are taking this course for credit vs audit.

• I will use this to establish a class email list. Email will be an important form of communication outside class time.
Course Goals

• What are your fields of interest?
  – (Please make a poll.)

  • high-energy?
  • astro/cosmology?
  • neutrino?
  • other?

  • experiment?
  • theory?
Course Goals

• What do you hope to get out of the course? What are your expectations for Phys 736?
Course Goals

- What do you hope to get out of the course?
- What are your expectations for Phys 736?
  - take 2 min to write down some personal goals on piece of paper
  - what would you like to learn?
  - can be general or specific