

PHYS 382L – Advanced Physics Laboratory (S19)
PHYS 504 – Modern Physics Measurements (S19)

TTh 1:30-4:30, SCL 140 (labs) & SCL 21 (classroom)

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Course Description: An advanced laboratory course focusing on modern experimental methods and concepts in atomic, optical, particle, nuclear, and condensed matter physics. It is intended to prepare students for independent research. This class fulfills SC and WR credit.

Learning Objectives: In this course you will

- learn modern measurement and analysis techniques
- carry out collaborative, open-ended, and independent research
- carry out error analysis and evaluate/assign measurement uncertainties
- learn how to record and maintain data, record observations and progress
- write and revise scientific papers
- give scientific oral presentations

Prerequisites: PHYS 206L or equivalent, maybe taken after or concurrently with PHYS 439 and/or 440, or with permission of an instructor. PHYS 420 is strongly recommended.

Teaching Fellows: Kelly Backes, Nick Frattini, Yunpeng Ji, Grant Schumacher.

Class Size: We welcome all students who have fulfilled the relevant prerequisites. The number of available labs determines the number of students the class can accommodate. Should we have more students interested than the labs can accommodate, priority will be given to Seniors, Juniors, and to those who registered early.

First Class: Tuesday Jan 15, 1:30 PM--meet in SCL 21

You must attend this meeting to take the class. We will introduce the labs and go over safety and logistics. You will select your lab partner and labs for the semester on this day. By 8:30 a.m. on Jan 22, admitted students must accept or decline the seat in the course.

Overview: The goal of this laboratory course is for you to learn modern measurement and analysis techniques. During the semester, you and your lab partner will complete three experiments (Labs). Two experiments are to be chosen from the list included below, and everyone does the Ising Model Lab.

Writing (WR) Credit: This course is designated as a WR course. You will learn how to keep lab books and write scientific papers, and we will go through the submission, review, and rewrite processes, as you would for real scientific paper submission. You will write three (3) lab reports, one of which will be written in a form suitable for submission to a professional peer reviewed

journal. We will use the guidelines from Physical Review Letters. For all three reports, there will be a period of review and resubmission. The review and feedback, and addressing the comments are an important part in the process of writing papers. It is expected that you address all comments made in the review period as you would for papers submitted to journals.

Grading:

Each lab book/report are to be handed in on the due dates indicated below.

The grades will be based on your class participation (50), content of you and your lab partner's lab book for the three labs (50 + 50 + 50 pts), two informal reports (50 + 50), 1 formal report (100), and 1 oral report (100). Here are the details:

Lab books: Lab books will be available for your purchase in the lab for \$5. They should be maintained (with all entries carefully dated) throughout the course. The lab book serves as a record-keeping of your progress and is the basis of your reports. It is meant to help you learn the importance of record-keeping (e.g. for patent purposes) and help in discussions of your progress with the instructors. It should be updated during every lab, and should contain a statement of the general purpose and procedure of the lab, sketch of the apparatus with the parts labeled, a record of the original data, figures used for the analysis including error calculations, calculated values and errors, and results and conclusions including a comparison with accepted values if appropriate (more in a separate handout). Lab books are to be kept in the lab. You may scan or copy pages if you would like to access the information outside of the lab.

- 25 points for maintaining an up to date lab book
- 25 points data analysis and error determination

Informal Report: For two of the labs, you will write an informal report. You are to synthesize what you recorded in the lab books. Your report will be graded as follows:

- 10 points for the draft
- 40 points for the informal report.

Formal Report: For the remaining lab, you will write a formal report. The formal report is to be in Physical Review Letters style. If you decide to turn in an earlier informal report into a formal one, the earlier grade will be replaced assuming the earlier report was turned in on time and had a non-failing grade (above 70). Your report will be graded as follows:

- 10 points for the draft
- 15 points for scientific writing style and following publication guidelines;
- 15 points for abstracts, introduction, description of experimental procedure and apparatus;
- 25 points data analysis and error determination;
- 20 points for the quality of the physics discussion, summary/conclusions given data collected; and
- 15 points for the response to the referee report

The Formal Report will be evaluated in the form of a referee report. Responses to each referee's comment must be submitted separately, along with the reports. The corresponding changes to the manuscript must be detailed in the response.

Submissions that do not include a separate report on how you addressed each and all comments will be rejected and will receive a zero (as would be the case for paper submissions that do not address all reviewer comments).

Oral Presentation: You will give a 20-minute oral presentation on the lab that you write a Formal Report. Your report will be graded as follows:

- 25 points for scientific content in slides
- 25 points for presentation clarity and style
- 25 points for presentation organization
- 25 points for how you handle Q&A

Due Dates: All drafts must be turned in by the end of the lab, at 4:30 PM Eastern on the dates indicated below. All final drafts are due at 11:59 PM on dates indicated below.

Late submission will be accepted until 1 week after the due date, however with a 25% deduction for each late assignment. If something is going wrong with your analysis, please get help early. Sometimes experiments go wrong; let us know early.

Course Schedule:

Week	Tue	Thu	Comments
1	1/15 (Tue)	1/17 (Thu)	1/15: introduction; 1/17: Lab 1 begins
2	1/22	1/24	Lab 1, wk1.5
3	1/29	1/31	Lab 1, wk 2.5
4	2/5	2/7	Lab 1, wk 3.5
5	2/12	2/14	Lab 1, wk 4.5 Feb 12: drafts due; Feb 14: go over draft
6	2/19	2/21	Lab 2, wk1. Feb 21: Lab 1 report due
7	2/26	2/28	Lab 2, wk2
8	3/5	3/7	Lab 2, wk3
Spring break: Mar 8 – 22			
9	3/26	3/28	Lab 2, wk4 Mar 26: drafts due; Mar 28: go over draft
10	4/2	4/4	Lab 3, wk1. Apr 4: Lab 2 report due.
11	4/9	4/11	Lab 3, wk2
12	4/16	4/18	Lab 3, wk3
13	4/23	4/25	Lab 3, wk4 Apr 23: drafts due; Apr 25: go over draft
Oral Presentation: May 1 & 2 (Wed/Thu), May 2: Lab 3 report due			

List of Experiments and their Locations

1. Optical Tweezers*
2. Bell Inequality*
3. Rubidium Spectroscopy*
4. Fusion Nuclear Reaction (SPL Subbasement, Room 3)
5. Compton Scattering
6. Pulsed NMR*
7. Shot and Johnson Noise
8. Superconducting Tunnel Junctions and the Josephson Effect*
9. Quantum Cryptography*
10. Ising Model
11. Laser cooling and trapping of neutral atoms**

(* = challenging, ** = doubly challenging)

Everyone gets to do Experiment 10, Ising Model. You and your lab partner will be assigned two others based on your preferences.

Experiment Selection Sheet-- one sheet per group

Please list your names and three or four experiments that you'd like to do. We will try to schedule each group for at least one of their top two choices. Let us know if there is a special reason you'd like to do a particular lab, e.g., you are interested in biophysics and Optical Tweezers is a tool used in that field. The number of different labs offered will depend on the course attendance and popular demand.

Name_____

Name_____

From the list above, in order of preference:

Choice 1._____

Choice 2._____

Choice 3._____

Choice 4._____

Comments/requests:

We will work out the group Lab schedule on Wed Jan. 16, and send it by email to the class roster. Please report on Thursday, Jan 17 and thereafter (except for announced short lectures) to SCL 140.