Modern Physics Laboratory (Phys 321)

Instructor: Dr. Zhigang Chen
Office: Thornton Hall 526 (Office hours: M 3-4pm)

Meeting Time and Place: LEC T1235- 1:25 TH 231; (Dr. Z. Chen)
LAB T1:35 - 4:20 TH 231 (Dr. Z Chen)
LAB F1:10-3:55 TH 231 (Dr. A. **Bezryadina)**

Learning Objectives:

Enhance classroom learning of modern physics by performing some milestone physics experiments, and learn basic skill and technique in data acquisition and analysis, as well as in writing lab reports.

Course Description:

PHYS 321 is a laboratory course focusing on important experiments in modern physics. The term "modern physics" is outdated. There is really nothing "modern" about the experiments you will perform since many of them were originally completed some 100 years ago. The lab course is really a sequence of experiments designed to study the properties of electrons, photons, atoms and their interactions. It is the hope that these experiments will enhance your classroom learning about modern physics and quantum mechanics.

During this course, you will have the opportunity to

1. repeat some very important experiments and gain experience with a variety of experimental techniques,
2. analyze and synthesize non-trivial experimental data, and
3. gain experience in writing a lab report on the experimental work you performed.

Note:

Lab reports (lab notebooks) need to be completed and turned in by the end of each lab. If you cannot complete in lab, you need to turn in no later than 5 pm on Friday each week.

There is no make-up of lab, and lab attendance is considered towards the total credit.
Please refer to more detailed course information and grading policy in following pages.

We may not have exclusive use of room Th231, so that setups may be taken down between labs.

All lab notebooks and final reports (on Millikan) are due by December 14 for final grading.

Students with disabilities who need reasonable accommodations are encouraged to contact the instructor. The Disability Programs and Resource Center (DPRC) is available to facilitate the reasonable accommodations process. The DPRC is located in the Student Service Building and can be reached by telephone (voice/TTY 415-338-2472) or by email (dprc@sfsu.edu)

Physics 321 Lab Schedule – Fall 2014

Tuesday's Lab Group

Week	Lab#	Experiment
Aug 26	Lab 0	Registration
Sep 2	Lab 1	Data Analysis
Sep 9 & Sep 16	Lab 3	Spectral Lines, Balmer Series
Sep 23	Lab 2	Radioactive Decay, Counting Statistics
Sep 30 & Oct 7	Lab 4	Michelson-Morley
Oct 14	Lab 5	e/m of electron
Oct 21 & Oct 28	Lab 6	Photoelectric effect, Planck's Constant
Nov 4	Lab 7	Frank-Hertz
Nov 11 Nov 14 (optional)	No Lab Lab 7	Veterans Day Frank-Hertz
Nov 18	Lab 8	Charge of electron (Millikan)
Nov 25	No Lab	Thanksgiving
Dec 2 & Dec 9	Lab 8	Charge of electron (Millikan)

Pre-requisites:

This laboratory accompanies Modern Physics lecture. Physics 320 is the (pre- or) co-requisite for this course.

Required Materials

You must always have this lab manual and your laboratory notebook with you in laboratory.

Grading:

Grades will be based upon 1) attendance, 2) your lab book, 3) quiz grades 4) the thoughtfulness, initiative, and quality of your performance in the laboratory itself. If you attend all the labs, take the quizzes, and turn in a notebook recording your participation, data, and results, you may get C or better. Grades of B and above will depend primarily on the quality of your laboratory book, your quiz grades, final lab report, and secondarily for your performance as a thoughtful experimentalist in the laboratory.

The points one looks for in the laboratory book are 1) clarity, 2) *thoughtful* estimation and treatment of errors, 3) record of observations (and not only of data). The emphasis is on a presentation that shows care and thoughtfulness, not upon getting done (or a lot of volume particularly prepared outside of lab). Lab books should be mostly completed within laboratory. Thoughtful comments are best made during lab. You may insert materials you prepare outside of laboratory (e.g., spreadsheets), though.

Synopsis

The objective of the lab is to advance your education regarding the approach and techniques of the physics laboratory as well as to complement your introduction to the concepts of modern physics as represented by the experiments in quantum physics you will perform here. (Note, however, that it is increasingly questionable as to whether the physics discovered some 100 years ago should be given the title of *modern physics.* In no way does this diminish the importance of these experiments to your own development.) A major part of that goal is to develop your *observational* and experimental skills as a physicist. Paramount to that goal is the development of good laboratory notebook skills including the careful and complete recording of observations and the treatment of experimental data and uncertainty. This cannot be over-emphasized! Always keep in mind that the purpose of any lab book is to record your activities and conclusions in order to enable you to reconstruct what you did (and how) at some time after the actual performance.

The basis for this laboratory will be two introductory labs plus six classic experiments which were basic to the paradigm change that led directly from the classical world to world of physics as we know it today: (1) the Spectrometer and the Balmer spectrum of hydrogen, (2) the Michelson interferometer and ether drift, (3) the Measurement of e/m, (4) the Measurement of h/e, (5) the Frank-Hertz experiment (quantized energy levels), and (6) the Millikan oil drop experiment (the measurement of the charge on an electron). Some experiments may be more difficult than others, and results sometimes are at considerable variance (that is, may have a discrepancy outside experimental error) from accepted results, either due to errors in calculation or observation, or due to factors associated with the equipment. However, the experience of the better student is usually that careful data analysis will lead to quite satisfying results while initially the results may have appeared hopeless.

Read the manual and be prepared before you get to laboratory! Do calculations as you go, and think and write as you go. You should be spending a good fraction of your time in laboratory just writing in the

notebook rather than just finishing up measurement with only notes taken. Try to finish the lab book and return everything to its place at end of laboratory before you leave.

The Lab Book:

The laboratory notebook is one of the most important aspects of this course.

1. Use a standard lab book such as National 43-591 – do not use the spiral bound; number the pages (either consecutively, or by date); use black or blue ink only. If you need a second book, please join the two together to make one super-notebook.
2. Be sure you have in mind how you are going to organize your notebook, and that you have prepared the notebook to some extent in advance of the lab.
3. Log into your notebook (date and time) at beginning of lab session, log out at end. Note your laboratory partner's name, or if none, say so.

Organization:

Keep in mind that you need to make a useable record of what you have done. You basically want to record what you hope to do, what you observed (data, sources of error, etc.) and what you were able to establish (that is, what conclusions *your* data justifies).

A quick way of checking as to whether your book is adequate is to look at the book as if you were an outside observer, attempting to understand exactly what you did. If that outside observer can't determine what you did and how, and how much s/he can trust your work, you haven't put down the right things in your lab book.

A typical characterization is the 3-D approach: Description, Data, and Discussion. The following is a suggestion how you should organize your lab book:

1. Lab number /title, date, partners if any
2. A brief paragraph about objective or purpose of the lab
3. List of apparatus with a drawing of your experimental setup
4. **Description:** Includes a brief description of the experiment (introduction to background, theory behind if any, and procedure).
5. **Data:** Before you begin to record your data, state in words *what* you are doing. You should normally plan to record data in a data table, and include your estimate of uncertainty for each part or column of numbers. You should note how you arrived at each uncertainty. When writing up, be sure to include your graphical plot of results.
6. **Discussion:** State clearly what you have observed or established, and discuss your uncertainty in the final answer as well as your discrepancy from accepted results. State any questions or thoughts you have about the experiment
7. Summary and conclusion