

## **PHYSICS 432**

### **MODERN PHYSICS LABORATORY (emphasis on Atomic Physics)**

#### **REQUIRED TEXT:**

No text is required for this course. All write-ups for each experiment can be found on the following UW website: <http://courses.washington.edu/phys432>. These write-ups give an overview of the experiments along with a description of experimental procedures. It is important that you read the write-up before coming to the lab to attempt the experiments, some of which are quite complicated. A thorough reviewing of the write-up will help considerably and make your time in the lab more productive as well as more enjoyable.

Additional material related to about 50% of the experiments can be found in individual binders that are located in one of the locked cabinets in B248. You may sign one out for the duration of the experiment that you are doing. You will also find a small number of the texts by Melissinos, "Experiments in Modern Physics," (Academic Press, 1966) and a few helpful manuals by Preston and Dietz, "The Art of Experimental Physics," (J. Wiley and Sons, 1991), which are on reserve in both the Physics Library and Odegard Undergraduate Library.

#### **BASIC REQUIREMENTS:**

1. Buy TWO bound lab notebooks, such as Roaring Springs Paper Products #77227 or #16673 (or equivalent) in the University Book Store. Also, obtain a 3.5" floppy disk (IBM format) for some personal data storage. You may use the same ones that you purchased for Phys. 431 in the Autumn.
2. There will not be any regular experiments available during this shortened first week of classes. However, you must choose up partners (3 persons in a group) before you leave this first week's lab session.
3. Arrange with your partners a time in this first week of classes to do the oscilloscope exercises. The importance of this instrument is second only to the use of a digital multi-meter. You are excused from these exercises only if you have already done them in the previous Autumn Phys. 431 course.
4. Prepare for and complete six experiments from the list that follows. To reserve one of the listed experiments, sign up for it at least a week in advance on the clip board hanging outside the lab door.
5. Record all data in your notebook as you obtain it. Display your data analysis in the notebook as well. For all the labs, include a brief statement of purpose and main conclusions.
6. Turn in notebooks for review and grading by NO LATER than 2-weeks after each experiment has been started. All notebook reports will be graded.
7. Finally, no new experiment can be started in the last regular week of this quarter without the permission of the lab instructor.

#### **EXPERIMENTS:**

You must complete six experiments from the list at the end of this handout and one of them must be the pulsed NMR experiment (unless you completed this experiment last quarter in Phys. 431).

Also, if (and only if) you plan to do experiment #10 (on the hydrogen Lamb shift), you must first do experiment #9 on the "lock- in" which is an integral part of the Lamb shift experiment.

Students working together are encouraged to discuss their analysis and results with each other (and with other students) but must independently generate their own notebook reports.

### **NOTEBOOK:**

You must record your data directly in one of the bound laboratory notebooks.

- a) Include an up-to-date table of contents at the front of each notebook. Write your name on the front cover and number the pages if necessary.
- b) Indicate the experiment, the date, and the names of all lab partners at the beginning of each lab period.
- c) Write a brief statement of purpose for each experiment before coming to the lab.
- d) Write a description of the experimental setup including circuit and/or schematic drawings of setup, etc.
- e) When possible, always make a preliminary analysis of your data before you leave, labeling all graphs and calculations clearly. This way, you will know if you have forgotten to record some important parameter.
- f) ALWAYS have a TA look at and sign your data before leaving the lab. When two or more students are working together, it may be possible for only one to record the data as it becomes available. However, you must either copy the data into your own notebook or get a photocopy in the Physics library which you will staple into your notebook (and have it signed before you leave).

### **DATA ANALYSIS:**

Details of your data analysis must be given in your notebook.

- a) A complete analysis will include calculations and clearly labeled graphs whenever appropriate.
- b) An analysis of the accuracy of your results should be carefully presented in every case as if you did not know what the "accepted" values are. A simple summary of error analysis will be handed out in the first week of classes; please utilize it this quarter, as much as possible.
- c) In general a good analysis of medium quality data counts more than a poor analysis of higher quality data.
- d) When possible, suggest ways in which the experiment could be improved. Your feedback is valuable to us.
- e) Realize that all the above procedures apply to "real" experiments in which the results are not known in advance.

**PHYSICS IS BASED ON EXPERIMENTS!**

### **NOTEBOOK CHECKING:**

- a) For all experiments that you do, a completed report is due a maximum of two weeks after the experimental session in which the experiment is initiated. While

one lab notebook is being graded, use your other notebook. The TAs will make every effort to return notebooks in one week's time.

- b) After you complete each experiment, turn in your notebook with its report (in B248) at the beginning of each week's first official class (either Monday or Tuesday) after the two weekends following the start of the experiment.
- c) The exception to the previous rule is that the last ungraded notebook report must be received by a TA no later than 4:30 p.m. on Friday, March 10, 2006.
- d) Late labs will be reduced by 0.2 grade points per late school day at the TA's discretion.
- e) The teaching assistants will pay particular attention to your data analysis/discussion and will make written comments in your notebook, possibly suggesting further improvements if needed. Improvements may obtain additional credit if pre-arranged or solicited by TA.

#### **GENERAL GRADING:**

- a) Notebook reports will be graded on the 4 point scale. Distinctions in grading on these reports will be limited to: 4.3, 4.0, 3.7, 3.4, 3.1, 2.8, 2.5, etc. minus whatever penalty points you have accrued for being late.
- b) Your final grade will be assigned on the basis of 15% for each of the six notebook reports, and 10% on general lab procedures (subjective judgment) which may include neatness or timeliness based on turning in your notebooks.

#### **THE HIGGS/OSBORN PRIZE:**

The Paul Higgs and Frederick Osborn prize was established as an award to the best and/or most creative student in the senior laboratories. The winner will be chosen in May and all students in Physics 431, 432, and 433 are eligible.

#### **LIST OF AVAILABLE EXPERIMENTS:**

- (1) HYDROGEN-DEUTERIUM MASS DIFFERENCE
- (2) FRANCK-HERTZ
- (3) PULSED NUCLEAR MAGNETIC RESONANCE
- (4) AMMONIUM INVERSION SPECTRUM
- (5) RUBIDIUM OPTICAL PUMPING
- (6) MERCURY ZEEMAN EFFECT
- (7) X-RAY FLUORESCENCE
- (8) HANLE EFFECT
- (9) PHASE SENSITIVE DETECTION (NOISE EXPERIMENT)
- (10) HYDROGEN LAMB SHIFT