University of Maryland Baltimore County – UMBC
Department of Physics

Phys650 - Special Topics in Experimental Atmospheric Physics (Spring 2009):
(future PHYS 427/627: *Atmospheric Physics Measurements: Instrumentation and Techniques*)
http://userpages.umbc.edu/~martins/PHYS650/

Instructors:

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Overview:

This course covers the design, simulation, and execution of experiments in atmospheric physics and earth sciences using teaching and research instrumentation. The students will be exposed to the processes of development, construction, calibration, and application of instrumentation for the measurement of relevant parameters of the atmosphere. Students will also use state of the art instrumentation from the atmospheric research laboratories connected to the department.

Main Objectives:

- Bottom up development of experimental techniques starting from basic physical concepts through the development of a dedicated apparatus, its calibration, measurement, data analysis and interpretation;

- Provide training in advanced laboratory techniques on current research instrumentation for atmospheric physics;

- Introduction to the development, design, and execution of Ground Based, Aircraft, and Satellite Missions.

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Schedule and Course Structure:

- **Location:** Physics 213 or other scheduled location for specific experiments.
- **Regular Classes:** Wednesday 9:00 – 11:30AM
    - 9:00-10:00 Discussion of previous experiment and student reports (PDF file sent by students the day before), theory and discussion of next activities
    - 10:00-11:30 Hands on activities
- **Open Lab:** Wednesday 11:30-15:00 the lab will be open for students to work on their projects or on their weekly experiments. This is equivalent to homework and library work in theoretical classes. Additional laboratory time can be scheduled if needed.

Instrumentation Project: Each student is supposed to design, build, calibrate, and use instrumentation to measure optical properties of the atmosphere. A term paper and an oral presentation of the project will be required at the end of the course.

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Course Grading:

- Class participation and short weekly reports (typically 3-5 pages including figures and tables) of relevant results and analysis should be sent to the instructors in a PDF file the day before class until noon. These results will be discussed during class (50%).
- Project execution (25%).
- Oral presentation of the project in the last class (10%).
- Term paper describing the project and main results in a format similar to a Journal publication (15%).

Hint: Start early and keep up with the Course Project! The project is a great tool for learning and to expose you to new challenges. Work as much as you can with the course instructors in order to develop, design, and execute your project.

Laboratory notebooks:

You are required to obtain and use a standard laboratory notebook for this course. The best ones typically have a brown hard-paper cover, and roughly 100 sheets of ~ 9 1/4 X 11 3/4 inch graph paper. *The UMBC bookstore sells laboratory notebooks for $16*; they can also be obtained at many office supply stores.

You should make every effort to record and describe everything you are doing (a good model is to assume you will return to your notebook after 10 years, and then eventually be willing to reproduce, or understand your results!). Write down anything and everything that seems important, including some stuff that doesn't seem so important (personal notes, opinions, ideas, etc.).

Draw or take pictures of everything! Any printed output, like digital pictures, graphs and tables should be printed and taped in. Notice that lab-notebooks have numbered pages. This eases cross referencing and avoids ripping pages out. And a last advice: don't erase any notes out. Just cross them out. They may be useful sometime.

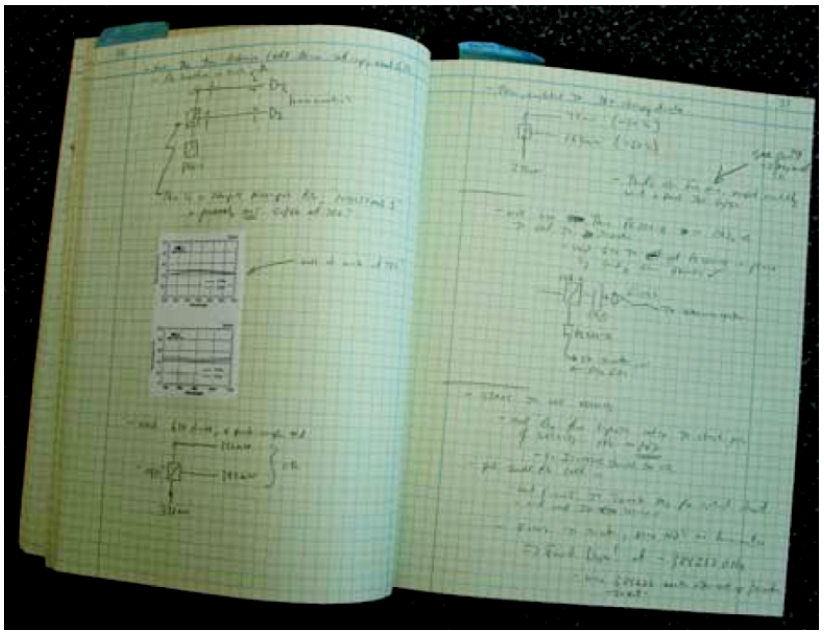

Figure 1 - Example of a good laboratory notebook. Notice that from time to time we may want to signoff on your lab notebook.

Reports

Short weekly pdf reports: You have to write short weekly lab reports (with relevant pictures, data and data analysis) for each experiment. A pdf file of these short reports should be sent by e-mail to the instructors until noon, the day before class. Highlights of all pdf reports will be discussed in class. While it is not always necessary to get a "right answer" to receive a high grade, poorly written reports will ensure a poor grade.

Project term paper: You have to submit a term paper, and prepare an oral presentation about your project. *The term paper will be due one week after the oral presentation*. The grading will be based on the quality of the experimental work, the technical writing and your oral presentation. Though the project and the oral presentation will be developed in group, the term paper is individual and should reflect your own writing style and comprehension. The paper is to be written for an audience of the area that is assumed to have some scientific background, but do not know your particular experiment or ideas. There are many resources on the net on how to write a report or a term paper. We strongly recommend you to search for them.

Safety

Our primary goal is to ensure our safety in the lab. Some of the equipment relies on high voltages and current and proper precautions must be taken at all times. If you are unsure about the operation of *any equipment or tools*, please ask the instructor or support staff for help. The basic rule is to be over-careful.

No matter how "weak" the source seems to be it can always cause serious damage to the human eye. Never look directly into a laser beam, no matter how many times it has been reflected or how small a laser system is (even a laser pointer). Always wear laser goggles when they are needed. Do not take shortcuts with laser safety.

For some of our calibrations and experiments we may also use other light sources like integrating spheres, special lamps, fiber illuminators, etc. Never underestimate the potential for eye damage of any light source. Many of these sources are important source of UV radiation and must be properly handled. **Always wear safety goggles as instructed.**

1. Turn on the "Laser In Use" sign that hangs outside the lab when the laser is in use.
2. Familiarize yourself with the location and contents of the first aid kit. It is mounted on a wall in the Foyer area of Rooms 213 & 214, and contains bandages, cleansers, etc.
3. The labs are equipped with a master "kill switch'". In the event of an emergency, please use the "kill switch'" if appropriate.
4. Practice multi-user laboratory work needs some kind of "*good neighborhood code*".

Preliminary Class Schedule:

- 1. PM10 and PM2.5 Local Aerosol Characterization:
- 2. Project: Construction of atmospheric radiometers-I:
- 3. PM10 and PM2.5 Local Aerosol Characterization:
- 4. Project: Construction of atmospheric radiometers-II:
- 5. Scanning Electron Microscopy-I:
- 6. Scanning Electron Microscopy-II:
- 7. Radiometric Calibration of Optical Instruments:
- 8. Light Scattering - Laboratory and Remote Sensing:
- 9. Integrated Scattering and Phase Function of aerosols and Clouds:
- 10. Use and analysis of IR spectrometric data:
- 11. BRDF and Spectral Reflectances:
- 12. Physical parameters of the Atmosphere:
- 13. Radiometry from Space: Mission Design and Requirements
- 14. Invited Lecture: Backstage of a Space Mission
- 15. Project presentation and discussion:

Experiment 1:

1. PM10 and PM2.5 Local Aerosol Characterization:

1.1 Objectives

- Design and execute a 60 day Aerosol Sampling Campaign at UMBC
- Get a general description of the local aerosol

1.2 Activities and Discussions

- Introduction on Atmospheric Aerosols, Samplers and Measuring Devices
- Assemble samplers and sampling station, calibration of components, data sheets
- Organize sample station maintenance, filter change, blank policy, etc.
- Filter weighting and storage

1.3 Sources and complimentary information

- Revision of Error and Data Analysis. Expectations
- Revision of Aerosol Fundamentals.
- Aerosol filters and aerosol measurement devices.

Experiment 2:

1. Project: Construction of atmospheric radiometers-I:

1.1 Objectives

- Construction of an optical instrument for the measurement of solar radiances using photodiodes and portable spectrometers;
- Measurement of atmospheric properties using sun photometry.

1.2 Activities

- Conceptual Design and utilization of a sunphotometer
- Simulation of the solar signal arriving at the surface
- Sensitivity issues, Signal to noise limitations and possible solutions;
- Characterization of the instrument components, sensors, and electronics

1.3 Sources and complimentary information

- Basic Principles on Instrument Design
- Optics (FOV, lenses, etc.)
- Optoelectronic components
- Radiometric analysis and signal to noise ratio (SNR) simulations