

# PHY 451: Advanced Laboratory

Department of Physics and Astronomy, College of Natural Science, Michigan State University

## COURSE SYLLABUS

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Instructor:	Dr. Xianglin Ke	Dr. Tyler Cocker	Term:	Spring 2018
Office:	4223 BPS	4252 BPS	Class Days:	Tues. (Sec. 1 Lab), Thurs. (Sec. 2 Lab), Wed. Lecture (all)
Phone:	(517) 884-5658	(517) 884-5682	Class Hours:	9:10-12:00, 6:10-9:00 (Lab) 5:20-6:10 pm (Lecture)
E-Mail:	<a href="mailto:ke@pa.msu.edu">ke@pa.msu.edu</a>	<a href="mailto:cocker@pa.msu.edu">cocker@pa.msu.edu</a>	Class Location:	1245 BPS (Lab) 1308 BPS (Lecture)
Office Hours:	by appointment	by appointment		

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Teaching Assistant: Nicholas Breslin: 4256 BPS, Email: [breslinn@msu.edu](mailto:breslinn@msu.edu)

Course website: [http://www.pa.msu.edu/courses/2018spring/PHY451/desc\\_PHY451.html](http://www.pa.msu.edu/courses/2018spring/PHY451/desc_PHY451.html)

### I. Course Description

As described in the MSU Description of Courses catalog, the focus of PHY 451 is “general research techniques, design of experiments and the analysis of results based on historical experiments in modern physics.” Our approach is to study a small number of experimental systems and techniques in depth, so that you learn how experimental physics is done. As oral conference presentations and written scientific reports are the primary means by which new findings are communicated, students will develop skills in both forms of scientific communication. In the process, this course fulfills the Tier II writing requirement (assuming completion of PHY 431 and PHY 440 as well).

### II. Course Credits: 3 credits

### III. Course Prerequisites

The listed prerequisites are PHY 440 and completion of Tier I writing requirement. However, you should be familiar with electricity and magnetism and quantum mechanics as well.

### IV. Course Objectives

- Learn to design, assemble, and perform experiments.
- Learn how to connect textbook physics to the world of experiment.
- Develop good laboratory record-keeping practices.
- Develop your skills in data analysis.
- Hone your written and spoken presentation skills.
- Learn to prepare a paper in the style of a scientific journal report.

### V. Class Operation and Requirements

Students work in pairs, and perform **three** distinct sets of experiments (4 weeks each) during the course of the semester. The experiments include: 1. diode laser spectroscopy, 2. nuclear magnetic resonance, 3. optical pumping in atomic vapors, 4. nuclear physics (gamma ray spectroscopy and muon lifetime), 5. sonoluminescence, 6. superconductivity and tunneling, and 7. superfluidity in He. You may only do one of experiments 1, 2, and 3 and one of experiments 6 and 7. We encourage you to think about and discuss the experiments with the instructors throughout the course, so that you not only learn basic techniques of experimental physics, but also hone your ability to learn through discussions. Lab handouts and supplementary information for each experiment can be downloaded from the course website.

In accordance with MSU's general regulations, as a three-credit course, PHY 451 requires a *minimum* of 9 hours of work per week. With this in mind, there are three weeks that are set aside at the beginning, middle, and end of semester that are not required lab time but are intended to allow for the time needed to prepare for future experiments and complete high quality oral and written reports.

**Preparation:** As laboratory time is limited, you must read the experimental handouts before class. You will be asked questions by your instructors at the beginning of your laboratory sessions, especially before starting new experiments. These questions will focus on your understanding of what you will measure and how you will perform such measurements before you begin your experiments.

**Class Time and Attendance:** This is a laboratory course with only a limited number of lectures. The class meets one hour each week for lectures or to discuss laboratory problems students are having and their possible solutions. The lectures will cover such topics as cryogenics, optics, nuclear magnetic resonance, data acquisition and measurement methods, noise, scientific presentations, and ethics in research. Attendance at these lectures is mandatory. Attendance of each laboratory session is also mandatory unless you have been excused by your instructor, in which case you will make-up the missed laboratory time during the make-up week following each experiment. Please be on time to class.

**Laboratory Notebooks:** Each student will keep a bound laboratory notebook in which all of your ideas, designs, data analysis, graphs and mistakes will be recorded. (See the handout on lab notebooks for more details.) While you will collaborate in the laboratory, each student will keep his/her own notebook with his/her own analysis. After each experiment is completed, we will grade your lab notebook.

**Written Scientific Report:** By the end of the last week of classes, each student will turn in a term paper on one of her/his experiments. The paper will be presented in the style of a report in a scientific journal such as *Physical Review Letters*. The content of the paper should be based on your work in the lab as reflected in your notebook but with a broader perspective. It should include a literature survey with proper citations, in-depth analysis, and conclusions, in addition to reporting the main techniques and experimental results obtained. The paper should be 3,000 ± 500 words, double spaced, with one-inch margins. A draft of the paper will be prepared by Friday, April 6 and will be reviewed by two classmates and your instructors akin to the refereeing process for papers submitted to scientific journals. The paper will then be rewritten with this feedback in mind.

**In-Class Presentation:** Each group will deliver an in-class PowerPoint presentation on one of your completed experiments. The presentation should be 15-17 minutes including time for questions.

**Quizzes:** There will be one or two in-class quizzes based on the lectures.

## VI. Course Grading

Course Item	Points
Laboratory Performance (independence, quality and quantity of work, experimental skills, preparation, attendance, etc.)	30%
Laboratory Notebook (quality of: (1) the record of your work and (2) your data analysis)	30%
Term Paper	25%
First draft	10%
Referee Report on Classmates' Papers	5%
Final draft	10%
Presentation	10%
Quizzes	5%

Rubrics for grading of the notebooks and quizzes will be posted on the course website.

Reporting of Final Grades:

Michigan State University takes seriously the opinion of students in the evaluation of the effectiveness of instruction, and has implemented the SIRS (Student Instructional Rating System) process to gather student feedback. This course utilizes the “online SIRS” system. You will receive an e-mail sometime during the last two weeks of class asking you to fill out the SIRS online form at your convenience. Please note the final grade for this course will not be accessible on STUINFO for seven days following the University grade submission deadline published by the Office of the Registrar unless the SIRS online form has been filled out. You will have the option in the online SIRS form to decline to participate in the evaluation of the course – we hope, however, that you will be willing to give us your frank and constructive feedback so that we may instruct students even better in the future.

## VII. Course Policies

**Late Assignment Policy:** If an emergency arises and you cannot submit your notebook or paper on or before the scheduled due date, you MUST inform your instructor and obtain approval NO LESS than 24 HOURS BEFORE the scheduled date/time.

**Academic Conduct Policy:** Academic dishonesty in any form will not be tolerated. Academic dishonesty at Michigan State University is defined by the General Student Regulations (<http://splife.studentlife.msu.edu/regulations>) as conduct that violates the fundamental principles of truth and honesty.

If you are uncertain as to what constitutes academic dishonesty, please consult the General Student Regulations for further details. Violations of these rules will result in a record of the infraction being placed in your file and receiving a zero on the work in question AT A MINIMUM. At the instructor’s discretion, you may also receive a failing grade for the course.

## VIII. Course Schedule

All assignments are due at 5:00 PM on the specified dates.

### Experiment 1

Section	Laboratory Dates	Notebooks Due
1	Jan. 16, 23, 30, Feb 6	Feb. 9
2	Jan. 18, 25, Feb 1, 8	Feb. 12

### Experiment 2

Section	Laboratory Dates	Notebooks Due
1	Feb. 13, 20, 27, Mar. 13	March 16
2	Feb. 15, 22, Mar. 1, 15	March 19

### Experiment 3

Section	Laboratory Dates	Notebooks Due
1	Mar. 27, Apr. 3, 10, 17	April 27
2	Mar. 29, Apr. 5, 12, 19	April 27

### Written Reports

Draft	Referee Reports	Final Report
April 6	April 13	April 27

**March 5 – 9: Spring Break**

**March 19 – March 23:** lab open for make ups or to get ahead.

**March 28, April 4, 11, and 18:** student in-class presentations during Wednesday lecture time

**April 22 – 26:** lab open for make ups.