

Experimental Superconductivity

July 1 – 14, 2019

Time: 14:00 – 17:40 Tuesdays and Thursdays

Places: Research Labs in SJTU Physics (Details to be announced)

Instructor

Prof. Ying Liu

Office: 705 Building 5, New Sciences Complex

E-mail: yingl@sjtu.edu.cn

Recitation instructor and course supervisor

Dr. Hui Xing

710 Building 5, New Sciences Complex

E-mail: huixing@sjtu.edu.cn

Teaching assistants

Wenjie Liu and Guoxiong Tang

Outline

This 1-credit course deals with the experimental side of the “Basic Aspects of Superconductivity” course at Shanghai Jiao Tong University (SJTU) taken by students from SJTU, Penn State, and University of Illinois Urbana-Champaign (UIUC). Students should participate both classes. The course will provide students with opportunities to perform supervised experimental research on a subject related to superconductivity. An incomplete list of projects is given below. It is intended for physics and physics related majors who have taken general physics and other core physics courses, typically towards the end of their junior year. However, highly qualified students at the end of their sophomore year may also attend, in which case the student should contact Prof. Ying Liu at yingl@sjtu.edu.cn before the student can be allowed to apply to joining the course.

Reference books

1. C. Kittel, Introduction to Solid State Physics, 8th Ed., John Wiley & Sons, Inc., 2005.

Office hours: To be announced

Experiments:

1. Growth and characterization of single crystals of superconducting NbSe₂
2. Preparation and characterization of atomically thin crystals of NbSe₂

Grading

The numerical grade will be determined by the following distribution:

Lab notebook (individual): 40%

Lab report (individual): 60%

Policies

- 1) The project will be done as a group, which includes 1) Experimental/lab work detailed in the lab notebook; 2) 10-page lab report must be in English (Use 12-pt font size).
- 2) Each student will maintain his/her own lab notebook and write his/her own lab report in English even though the experimental data will be shared.
- 3) Assignments must be turned in on time to receive full credits.
- 4) All class activities will take place in SJTU, Minhang Campus.

Instruction for writing lab notebook

It is very important for you to keep good record on your research work. How much notes are needed is judged by a simple criterion: One of your classmates needs to be able to repeat what you have done SOLELY based on your notes.

You need to purchase a good notebook – those with permanent binding and pages numbered. You should be able to purchase one. You're not supposed to tear off any pages. If you make a mistake, or simply don't like what you've written, just cross it out and start over again - Every page of the logbook stays in the book.

More specifically, you need to enter the following information: a) Title of the project, the starting date, your name and your partner's name (and your partner's contact information); b) List of goals; c) List of daily tasks; and d) Other useful information.

Instruction for writing lab report

1. The lab report should include the following sections:
 - Title page. Include the title of the experiment, your name and your lab partners' name, and the date on which the report is turned in.
 - Abstract. Summarize the purpose, method, and the main results of the experiment.
 - Introduction. What? Why? How? A short discussion on the history of the experiment is fine. But it should NOT be the main part of the introduction.
 - Theoretical and other background information.
 - Experimental method(s). A schematic of experimental setup is required.
 - Experimental results. Include raw data in an appropriate form, analysis of the data.
 - Evaluation of experimental uncertainties.
 - Discussion and conclusion. Show main implications of the experimental results.
 - References. Cite the most relevant ones. Elementary things from common textbooks are not necessary to reference. Follow American Physical Society (APS) style when citing a reference.

2. The lab report should be around 5-6 pages, *excluding* illustrating figures and plots of experimental results.
3. Use 12-point fonts and 1.5-line spacing for your reports.
4. Each figure should include a figure caption, placed *below* the figure. If you use tables, each table should have a table caption, placed *above* the table.
5. Writing styles should follow American Physical Society (APS) style handbook, available online at <http://publish.aps.org/STYLE/>
6. The ultimate goal of this exercise is to gain the ability to write research papers.

Error analysis

The experimental error is the deviation of your measurement from the true value of the quantity, a number that can be estimated in a scientific way. It is NOT the same as the difference between your measurement and the accepted value of what you are trying to measure (which, unfortunately, is commonly assumed), even though the accepted value is presumably close to the true value. For the purpose of this course, this distinction means that we usually do NOT obtain the experimental error by simply comparing the result of our measurements with the accepted value.

The error analysis is very important for scientific research as it helps us understand nature of the measurement, and ultimately, how much you can trust your results. To track down all sources of error and come up ways to eliminate them when possible is an intellectually challenging task.

Your final result for quantity X should be written as $(X \pm \delta X)$ followed by the unit of the quantity, where δX is the estimated error of X.

Course Calendar:

Date	Content	Homework/tasks
Weeks 1 (7/1 – 7)	Introduction to the course, lab notebook writing. Organization of groups. Introduction to error analysis, lab report writing, and presentation preparation. Lab work.	- Lab notebook due on Thursday, May 30.
Week 2 (7/8 - 14)	Finish lab report. Classes will not meet	- Lab report and lab notebook due Monday, 7/15/19