Raman Spectroscopy, Physics 576A Winter 2021
Instructor: Xiaodong Xu

This course will cover Raman spectroscopy application in understanding a wide range of material properties. We will learn the basics of group theory, and how to use group theory to count Raman modes and analyze the Raman optical selection rules based on the symmetry of the system. We will then introduce the application of Raman spectroscopy to understand several material properties, including semiconductors, magnets, superconductors, and charge density waves. Students will have opportunity to form a small group to present the application of Raman in system of their own interest. We will also design and perform a group project, using the equipment in the Xu group: Raman optical study of a 2D materials with application of strain. All students will analyze the data and write a report based on the experimental results.

Group theory + Application to Raman spectroscopy (week 1-4)

- Group theory basics
- Raman selection rules (Raman Active, Infrared Active, …)
- Modes Assignment

Application of Raman (week 5-9, including group presentation)

- Magnetic order
- Superconductivity
- Topological insulator

Group project: (Week 1-7)

- Raman spectroscopy to investigate 2D materials. We focus on CDW superconductor: NbSe2 (Amplitude+ Higgs mode). We will try to investigate the competition of CDW and superconductivity with strain control.

Time line of the project

- week 1-2: develop and test strain setup
- Week 3 –7: Load strain setup and perform Raman spectroscopy
- Week 7-10: Data Analysis and write up the report.

Textbook:

(1) Group Theory and Quantum Mechanics by Michael Tinkham;

(2) Group Theory: Application to the Physics of Condensed Matter by Mildred Dresselhause, Gene Dresselhaus, and Ado Jario.