PHYSICS 295 A Fall 2018

INTRODUCTION TO QUANTUM THEORY OF SOLIDS

Instructor Eugene Demler

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Office hours: Wed 3:00 - 4:00 pm

Teaching Fellow

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Course Meetings: Mon Wed 10:30 - 11:45 in Jefferson 356

Homework: Weekly or biweekly problem sets

Midterm: October 10

Final Take-Home exam (24-hour): starting on Dec 10 at 11am

Grading: Homework 25%, Midterm 25%, Final Exam 40%, Class participation 10%

Tentative Course Outline

1. Crystal structure of solids: Bravais lattices and primitive vectors. Lattices with bases. The reciprocal lattice. Xray and neuron scattering experiments.

2. Free electrons in a periodic potential: Bloch theorem and band structure. Electrons in a weak periodic potential. The tight-binding approximation. Topological aspects of band structures.

3. Electron-electron interactions: Hartree and Hartree-Fock approximations. Density functional theorem. Thomas-Fermi theory. Kohn-Sham equations. Landau Fermi liquid theory.

4. Phonons: Lattice vibrations. The force constant model. Vibrations of a quantum mechanical lattice.

5. Electron transport: dynamics of Bloch electrons. Boltzmann equation.

6. Semiconductors and their applications.

7. Collective phenomena in electron systems: Magnetism. Superconductivity.

Primary references

1. A. Abrikosov. *Fundamentals of the theory of metals.*

2. **N. Ashcroft and N. Mermin. Solid State Physics**.

3. E. Kaxiras. *Atomic and electronic structure of solids.*

4. C. Kittel. *Introduction to Solid State Physics.*

5. C. Kittel. *Quantum theory of solids.*

6. G. Mahan. *Condensed Matter in a nutshell.*

7. M. Marder. *Condensed matter physics.*

8. P. Nozieres and D. Pines *The theory of quantum liquids.*

9. J. Ziman, *Theory of solids.*