PHYSICS 268r Spring 2004

PHYSICS OF STRONGLY CORRELATED ELECTRON SYSTEMS

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Teaching Fellow	Ryan Barnett
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Course Meetings:	MW, 1:00 - 2:30 in Jefferson 256
Homework:	One every 2-3 weeks; 1/2 of grade
Final Presentations:	1/2 of grade

Course Outline

1. Electron-electron interaction. Random phase approximation.
2. Electron-phonon interaction. Phonon contribution to the electronic self-energy. Migdal's theorem.
3. Kohn anomalies in metals. Instabilities of electron-phonon systems.
4. Superconductors with strong electron-phonon coupling. Eliashberg equations. McMillan's formulae.
5. First principle calculations of Tc. Superconductivity in MgB2.
6. Phonon mechanism for superconductivity in the high Tc cuprates.
7. Antiferromagnetic fluctuations and d-wave superconductivity in the cuprates.
8. Classical phase fluctuations in superconductors. The "Uemura plot".
9. Quantum phase fluctuations in superconductors. Boson Hubbard model. Superconductor to insulator transition in thin films and wires.
10. Superfluid to insulator transition of ultracold atoms in optical lattices.
11. Competing phases in strongly correlated electron systems. Spin and charge density wave phases. Stripe phases in the cuprates.
12. Higher symmetries in condensed matter systems. SO(5) theory of antiferromagnetism and superconductivity.
13. Electron fractionalization in one dimensional systems. Solitons in polyacetylene.
14. Electron fractionalization in higher dimensions. Topological order.

Primary references

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

2. A. Abrikosov, L. Gorkov, and I. Dzyaloshinski. *Methods of quantum field theory in statistical physics.*

3. S. Doniach and E. Sondheimer, *Green's functions for solid state physicists.*

4. A. Fetter and J.D. Walecka, *Quantum theory of many-particle systems*

5. G. Mahan. *Many-Particle Physics.*

6. Landau and Lifshitz course on theoretical physics. *Statistical physics*, part 2.

7. J. Schrieffer, *Theory of Superconductivity.*

8. M. Tinkham, *Introduction to Superconductivity.*