PHYS 7687: SPECIAL TOPICS IN PHYSICS
STRONGLY CORRELATED PHASES OF QUANTUM MATTER

Schedule: MW 8:00 - 9:15 A.M. EST. Online lectures via zoom (Email instructor for link).

Instructor: Debanjan Chowdhury (debanjanchowdhury@cornell.edu)

Prerequisites: Graduate level quantum mechanics and graduate level statistical mechanics. A prior course in solid-state physics is helpful, but not required. Undergraduate students are welcome to register for the course, after discussing with the instructor.

Credits: 3

Course description: This is an advanced graduate level course that will introduce and *demystify* field theory and path-integral based methods for studying quantum many-body systems. We will connect to the latest experimental developments in the field of quantum materials at every stage of the course. The aim of this course is to enable students to develop technical and intuitive skills for solving the many-body problem. The course is meant for condensed matter theorists and experimentalists, as well as students from other fields who want an exposure to the field. A tentative course outline appears below (the list of topics might change based on student feedback and time constraints):

- Interacting fermions
- Boltzmann theory and quasiparticle transport
- Interacting bosons
- Mott insulators and quantum antiferromagnetism
- Quantum spin liquids and emergent gauge theories
- Quantum Hall effect
- Non-Fermi liquids

Course grade: Satisfactory/Unsatisfactory
For a satisfactory grade, the students have to hand in at least 80 % of the assigned homeworks and a final (PRL-style) term paper (can be review or short original calculation; details to be discussed individually with instructor).

Useful books: No single textbook covers all of the topics outlined above. The following books might be useful as a resource. Lecture notes and additional reading material (original papers and review articles) will be provided, wherever necessary.

- S. Girvin and K. Yang, *Modern condensed matter physics*, Cambridge University Press, 2019

- P. Coleman, *Introduction to many-body physics*, Cambridge University Press, 2015
- A. Abrikosov, *Fundamentals of the theory of metals*, Dover, 1988
- P. Nozieres and D. Pines, *The theory of quantum liquids*, Westview Press, 1989
- A. Altland and B. Simons, *Condensed matter field theory*, Cambridge University Press, 2006
- X.G. Wen, *Quantum field theory of many-body systems*, Oxford University Press, 2004
- S. Sachdev, *Quantum phase transitions*, Cambridge University Press, 1999