PHYS625-0101: Non-relativistic Quantum Mechanics-Spring 2022 jaydsau

An introduction to field theory in condensed matter physics:

Phys 625 introduces field theory techniques for the understanding of many-body condensed matter systems focusing mostly on the many-electron system. While quantum field theory originated in high-energy physics, it also provides the framework to understand many-body quantum systems specifically response as well as perturbation theory. A key complication is that Lorentz invariance typically doesn't apply to condensed matter systems, but simplification is the presence of a natural regularization scale. Familiarity with graduate level quantum mechanics, statistical mechanics and E&M will be assumed.

Dr. Jay D. Sau

jaydsau@umd.edu
(mailto:jaydsau@umd.edu

Class Meets

Mondays & Wednesdays

12:30 pm – 1:45 pm

Phy1219

Office Hours

PSC 3143 by appointme

Grader

TBD

TBD

Suggested Prerequisite

Phys 604, 606. 622, 623

Graduate E&M, quantum
math-methods

Some of the topics covered are (suggestions welcome):

- Phonons as an intro to quantum fields
- Field theory for fermions
- Jordan-Wigner/Hubbard models etc
- Green functions, Wick's theorem etc
- Linked cluster theorem, RPA etc
- Fermi surface and Fermi liquids - zero sound
- Imaginary time Green functions
- Linear response, Kubo formula etc
- Diagrams for electron diffusion versus localization
- Landau theory of phase transitions
- Goldstone theorem
- Anderson-Higgs mechanism

- Path integral for Bosons/Fermions
- Coherent state path integral for magnets
- Hubbard stratonovich transformation
- Nambu-Gorkov Green function approach to superconductivity
- Local moments and the Kondo effect

Required Resources

Course website: **elms.umd.edu**

Text book: Introduction to Many-body physics, Piers Coleman, 1st edition, Cambridge University Press 2015.

Course Communicatio

All updates and informati regarding the course will made using the announc on ELMS – please make your ELMS settings do n delay announcements. I may not repeat in class.

Please send any questio notifications of absences you need to inform me preferably by email (see

Campus Policies

It is our shared responsibility to know and abide by the University of Maryland's policies that relate to all courses, which include topics like:

- Academic integrity
- Student and instructor conduct
- Accessibility and accommodations
- Attendance and excused absences
- Grades and appeals
- Copyright and intellectual property

Please visit **www.ugst.umd.edu/courserelatedpolicies.html (http://www.ugst.umd.edu/courserelatedpolicies.html)** for the Office of Undergraduate Studies' full list of campus-wide policies and follow up with me if you have questions.

Activities, Learning Assessments, & Expectations for Students

Lectures: Class time will be occupied by lectures that follow a set of notes that closely follow sections in