PHZ7428

Modern Condensed Matter Physics

Fall 2022

Period 5 (11:45 a.m. - 12:35 p.m.)

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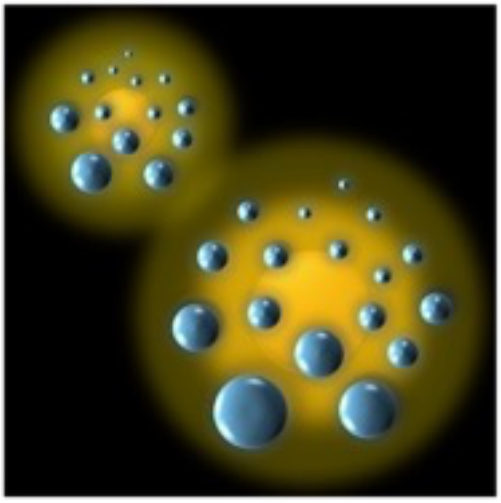
Office hours: Wed & Fri 3:00 p.m.-4:00 p.m. or by appointment

Grader: TBA

All materials for this class will be posted at UF e-learning . Enter with your Gatorlink login and password.



Overview

PHZ7428 aims at two goals. The first one is to expose you to the modern status of Condensed Matter Physics. The second – and the main--one is to teach you basic tools of quantum field theory, as applied to Condensed Matter Physics. This is going to be a very much hands-on course. We will solve a lot of problems in the class, and you will have to solve even more as your homework. The emphasis will be on practical skills in applying theoretical methods rather than on rigorous derivations. Some familiarity with basic notions of Solid State Physics (crystal structure, Bloch theorem, energy bands) is desired but not mandatory. A necessary intro from Solid State will be given as needed. Many problems will not involve the notion of crystal structure.

Some topics to be covered include:

- **Fermi- and non-Fermi liquids**: *Quasi-particles. Collective modes. Breakdown of a Fermi-liquid theory near quantum phase transitions.*
- **Effects of disorder**: *Strong and weak localization. Negative magnetoresistance.. Quantum interaction effects in transport. Kondo effect.*
- **1D and quasi-1D systems**: *Luttinger liquids. Tunneling and transport.*
- **Superconductivity**: *Cooper pairs. Unconventional superconductors*
- **Ferromagnetism and antiferromagnetism.**

Some tools to be covered include

- **Feynman diagrams for condensed matter systems**
- **Kinetic (Boltzmann) equation**
- **Kubo formula**
- **Renormalization group**
- **Bosonization**

Materials

- **Main text:**
- **None**
- **Supplemental texts:**
- A. A. Abrikosov, L. P. Gor'kov, and I. E. Dzyaloshinski, *Methods of Quantum Field Theory in Statistical Physics*, Dover, NY, any edition
- H. Bruus and K. Flensberg, *Many-body Quantum Theory in Condensed Matter Physics: An Introduction (Oxford Graduate Texts)*
- L. D. Landau and E. M. Lifshitz, *Statistical Physics II* (Landau Course of Theoretical Physics, v.9)
- G. D. Mahan, *Many-particle physics*, Plenum, 2nd or 3rd editions

Important dates

No classes:

Mon, Sept 5 (Labor day)

Fri, Oct 7 (UF Homecoming)
Fri ,Nov 11 (Veteran's Day)

Wed, Nov 23-Fri, Nov 26 (Thanksgiving break)

Last day of classes: Wed, Dec 7

Coursework

Bi-weekly homework (100%), due on Mondays by 11:59 p.m. **No exams.**

Units Rule

Every algebraic solution of homework problems must be accompanied by a unit check. Without such a check, no more that 75% of the credit will be given even for an otherwise perfectly correct solution. On the other hand, constructing an answer using dimensional analysis and other general arguments (symmetries, analysis of limiting cases, etc.) may earn you up to 50% of the credit, even if a complete solution is not provided.

University Policies

Students are expected to know and comply with the University's policies regarding academic honesty and use of copyrighted materials. Cheating, plagiarism, or other violations of the Academic Honesty Guidelines will not be tolerated and will be pursued through the University's adjudication procedures.

Students requesting classroom accommodations must first register with the Disabilities Resources Program, located in the Dean of Students Office, P202 Peabody Hall. The Disabilities Resources Program will provide documentation to the student, who must then deliver this documentation to the instructor when requesting accommodations.

Diversity statement

Physics is practiced and advanced by a scientific community of individuals with diverse backgrounds and identities and is open and welcoming to everyone. The instructional team recognizes the value in diversity, equity and inclusion in all aspects of this course. This includes, but is not limited to differences in race, ethnicity, gender identity, gender expression, sexual orientation, age, socioeconomic status, religion and disability. Students may have opportunities to work together in this course. We expect respectful student collaborations such as attentive listening and responding to the contributions of all teammates.

Physics, like all human endeavors, is something that is learned. Our aim is to foster an atmosphere of learning that is based on inclusion, transparency and respect for all participants. We acknowledge the different needs and perspectives we bring to our common learning space and strive to provide everyone with equal access. All students meeting the course prerequisites belong here and are well positioned for success.