

PHYS-619

Many-Body Approaches to Quantum Fluids

Invited lecturers (see below)

Cursus	Sem.	Type
Physics		Opt.

Language of teaching	English
Credits	1
Session	
Exam	Oral presentation
Workload	30h
Hours	18
Lecture	14
Practical work	4
Number of positions	20

Frequency

Only this year

Remark

Next time: Fall 2023

Summary

Starting from a microscopic description, the course introduces to the physics of quantum fluids focusing on basic concepts like Bose-Einstein condensation, superfluidity, and Fermi liquid theory.

Content

concentrating on quantum fluids as basic examples of quantum many body systems in condensed matter physics, I will give an introduction to the physics and phenomena arising due to the interplay of interaction and quantum statistics. I will focus on the understanding from the microscopic point of view, based on various theoretical tools from mean-field theory over diagrammatic methods to variational and quantum Monte Carlo calculations.

Outline:

- Basics of statistical physics and quantum mechanics (some reminder)
- Dilute Bose gases: Mean-field treatments and beyond
- Macroscopic quantum effects: Bose-Einstein condensation and superfluidity
- Quasi-two-dimensional Bosons: Kosterlitz Thouless transition
- Normal Fermi liquids
- many-body wave functions

Computational methods and algorithms will be part of the practical work (TP).

Note

Host: G. Carleo

Keywords

Bose-Einstein condensation, superfluidity, Kosterlitz-Thouless transition, Fermi liquid theory, electron gas, quantum Monte Carlo methods, diagrammatic expansions

Learning Prerequisites**Required courses**

Statistical physics
Quantum mechanics
basic scientific programming

Resources

Bibliography

Quantum Liquids by A.J. Leggett

Methods of Quantum Field Theory in Statistical Physics by A.A. Abrikosov, L.P. Gorkov, and I.E. Dzyaloshinski

Theory of Interacting Fermi Systems by P. Nozières

Interacting Electrons by R.M. Martin, L. Reining, and D.M. Ceperly

Ressources en bibliothèque

- [Quantum Liquids / Leggett](#)
- [Methods of Quantum Field Theory in Statistical Physics / Abrikosov](#)
- [Theory of Interacting Fermi Systems / Nozières](#)
- [Interacting Electrons / Martin](#)

Moodle Link

- <https://go.epfl.ch/PHYS-619>