

Course Specifications

Valid in the academic year 2024-2025

The Theory of Metals: from Path Integrals to Experiment (C004513)

Course size	(nominal values; actual values may depend on programme)				
Credits 6.0	Study time 180 h				
Course offerings in ac	cademic year 2024-2025				
A (semester 1)	English	Gent			
Lecturers in academic	c year 2024-2025				
Bultinck, Nick			WE05	lecturer-in-charge	
Offered in the follow	ing programmer in 2024-2025			crdtc o	

ffered in the following programmes in 2024-2025	crdts	offering	
Master of Science in Physics and Astronomy	6	А	
Exchange Programme in Physics and Astronomy (Master's Level)	6	А	

Teaching languages

English

Keywords

Quantum mechanics, many-body systems, interacting electrons and bosons

Position of the course

Contents

- 1 **Review of free fermions and bosons:** Second quantization. The free Fermi gas and the Fermi surface. The quantum mechanical description of phonons. Semiclassical equations of motion for electrons. Fermi liquid theory.
- 2 **Coherent states and path integrals:** Derivation of the path integral representation of the partition function for interacting electrons and bosons. Derivation of the Feyman rules for perturbative/diagrammatic studies of interacting electron and boson systems. Application: the Frohlich Hamiltonian and electron-phonon coupling.
- 3 **Linear response theory:** The interaction picture and the definition of linear response coefficients. Connection between linear response theory and different experimental probes of quantum many-body systems. Applications: calculation of the magnetic susceptibility of a metal, calculation of the tunneling density of states, angle-resolved photoemission experiments to 'measure' the Fermi surface.
- 4 **Electron transport theory:** Kubo formula for the electrical conductivity of a many-body system. The role of disorder. Diagrammatic derivation of the Drude conductivity. Electron diffusion.
- 5 Local magnetic moments: The Anderson Hamiltonian and the formation of local magnetic moments. The Schrieffer-Wolff transformation. The Kondo effect.

Initial competences

Quantum mechanics, solid state physics

Final competences

The student can make a connection between the theoretical and quantum mechanical description of interacting electrons and bosons, and experimentally measurable quantities.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Study material

Type: Syllabus

Name: The theory of metals: from path integrals to experiment Indicative price: Free or paid by faculty Optional: no Available on Ufora : Yes Online Available : Yes Available in the Library : No Available through Student Association : No

References

Course content-related study coaching

Assessment moments

end-of-term assessment

Examination methods in case of periodic assessment during the first examination period

Oral assessment, Written assessment open-book

Examination methods in case of periodic assessment during the second examination period

Oral assessment, Written assessment open-book

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

not applicable

Calculation of the examination mark

Oral assessment of the theory (60%), and written open-book assessment of the exercises (40%).