PHYS-639

Field Theory in Condensed Matter Physics

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Cursus	Sem.	Type
Physics		Opt.

Language of teaching	English
Credits	4
Session	
Exam	Term paper
Workload	120h
Hours	**56**
Lecture	56
Number of positions	

Frequency

Every 2 years

Remark

Next Time: Fall 2024

Summary

Topics covered: Superfluidity in weakly interacting Bose gas, the random phase approximation to the Coulomb interaction in the Jellium model, superconductivity within the random phase approximation, the renormalization group analysis of non-linear-sigma models, the Kosterlitz-Thouless transition.

Content

In this class I will show, by examples, how field theory can describe some important phenomena in condensed matter physics.
The transition from a discrete to a continuum description is illustrated with the one-dimensional Harmonic chain both in classical and quantum mechanics.
Spontaneous symmetry breaking is introduced with the phenomenon of superfluidity for a weakly interacting Bose gas. This is followed with the study of classical non-linear-sigma models and how to treat then using renormalization-group methods.
The Kosterlitz-Thouless phase transition is also discussed in details.
The concept of screening is introduced through the Jellium model for electrons at the level of the random phase approximation. Superconductivity is described within the mean-field and random-phase approximations.
The Caldeira-Leggett model for dissipation, in the context of a Josephson junction, is used to illustrate the role played by instantons in quantum mechanics.
If time allows it, bosonization will be covered in (1+1) dimensional spacetime.

Learning Prerequisites

Recommended courses

The class will be self-contained and presumes no more than a solid grasp of quantum mechanics, say at the level of the textbook of Gordon Baym.

Resources

Bibliography

Lecture Notes on Field Theory in Condensed Matter Physics,
Christopher Mudry,
World Scientific Publishing Company,
ISBN 978-981-4449-09-0 (Hardcover), 978-981-4449-10-6 (paperback)]

Références suggérées par la bibliothèque

- Lecture Notes on Field Theory in Condensed Matter Physics