Physics of complex phenomena

Semester
Fall

In brief

Course langage: French

Presentation

Prerequisites

Common core courses in statistical physics from Centrale Méditerranée.

Learning objectives

The aim of this course is to acquire the knowledge and skills essential for analyzing complex phenomena in physics and complex systems in the engineering sciences. While emphasizing the general nature of the concepts covered, this course presents a wide range of application areas, with particular attention to the fundamental definitions of randomness, information and complexity. This course provides an introduction to a topical scientific field (Nobel Prize in Physics in 2021, 2022, 2024, Fields Medal in 2022, Abel Prize in 2024), and enables students to question the profound nature of physics while providing operational tools for engineers.

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Description of the programme

Elements of information theory useful for physics and engineering (complexity, entropy and applications).

Complex scalar and vector phenomena and applications to waves and signals.

Quantum physical systems (density matrix, Von Neumann entropy and applications).

Disordered physical systems (random mathematics, frozen disorders, characterization techniques).

Introduction to chaotic phenomena.

Generic central skills and knowledge targeted in the discipline

Know how to define and characterize complexity in physics and engineering sciences,

master elementary techniques for analyzing certain complex systems or phenomena,

Apply fundamental concepts of information theory,

Understand the essential factors involved in the analysis of complex systems,

Acquire critical expertise in the interpretation of physical results.

How knowledge is tested

2 supervised assignments, each contributing 50% of the final grade.

Bibliography

Ph. Réfrégier, « Noise Theory and Application to Physics » - Springer 2003.

T.M. Cover and J.A. Thomas, « Elements of Information Theory» - Wiley 2006.

C. Cohen-Tannoudji, F. Laloë and B. Diu, « Mécanique Quantique T.1 et 2 » - Edp Sciences (2018).

K. H. Fischer andJ. A. Hertz, « Spin Glasses» - Cambridge University Press 1991.

D. L. Stein and C. M. Newman, « Spin Glasses and Complexity» - Princeton University Press 2013.

Teaching team

Julien Fade

Philippe Réfrégier

Sustainable Development Goal

Quality education

Total des heures		**28h**
CM	Master class	16h
TD	Directed work	10h
AA		2h

Useful info

Name responsible for EU

Lead Instructor

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