PHYS-715

Physical Optics and Advanced Imaging

Guizar Sicairos Manuel, Invited lecturers (see below)

Cursus	Sem.	Type
Photonics		Obl.
Physics		Opt.

Language of teaching	English
Credits	3
Session	
Exam	Oral presentation
Workload	90h
Hours	**49**
Lecture	27
Exercises	8
Project	14
Number of positions	**20**

Frequency

Every year

Remark

Next time: Fall 2024

Summary

This course gives an introduction to principles of Fourier and physical optics, numerical propagation, and sampling. On the second half the course covers topics of advanced imaging, including 3 external lecturers who are experts in application or development of advanced imaging techniques.

Content

The first half of the course will cover Fourier basic principles, wave propagation, and their application and connection to physical optics and to coherent and incoherent imaging techniques. With special emphasis on the relation of Fourier principles with imaging and including optical systems response and detector sampling.

The second half of the course will be devoted to exploring advanced imaging techniques. With particular focus on computed imaging such as holography, coherent diffractive imaging, and tomography, with mathematical depth and emphasis on the inversion strategies.

The course will include a visit to the large-scale facilities of the Paul Scherrer Institute in order to get first hand impression of instrumentation and applications. Additionally for the course we will have 3 invited external lecturers who are experts in application or development of advanced imaging techniques. Confirmed lecturers are Prof. Andreas Schaefer (Sensory Circuits and Neurotechnology Laboratory, The Francis Crick Institute, UK), Dr. Claire Donnelly (Three-dimensional magnetic systems, Max Planck Institute, Germany), and Dr. Ana Diaz (Coherent X-ray Scattering, Paul Scherrer Institute, Switzerland).

As a final project the students will choose one computational imaging topic, related to one scientific publication, which they will explore in depth. They will develop a simple experiment if feasible, or numerical simulation, and attempt to reproduce the main results. Alternatively the student can bring a problem from their research topic. For examination the students will present a written report on their work and give an oral presentation.

Expected student activities:
Participation in class and discussion
Exercises
Bibliographic research

Assessment methods:
Written report and presentation

Keywords

physical optics, numerical propagation, imaging, sampling, applications of advanced imaging, X-ray microscopy, phase retrieval

Learning Prerequisites

Recommended courses

General background in Physics, Optics, and Mathematics at the Master level
Basics of programming with notion of one programming language

Learning Outcomes

By the end of the course, the student must be able to:

- Predict the optical performance of imaging systems based on diffraction theory
- Analyze joint performance of optics with detector electronics
- Perform wave propagation, phase retrieval, and holographic reconstructions
- Detailed knowledge of advanced imaging techniques directly from the researchers shaping their respective fields.
- Critical reading of scientific literature and setting of objectives to replicate partially the results
- Teamwork, team learning
- Communication with professionals of different disciplines
- Identify imaging or processing techniques that may complement their PhD research

Resources

Bibliography

Introduction to Fourier Optics - Joseph W. Goodman

Ressources en bibliothèque

- Introduction to Fourier Optics / Goodman

Moodle Link

- https://go.epfl.ch/PHYS-715