PHYS-700

Integrated Nonlinear Photonics

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Cursus	Sem.	Type
Photonics		Opt.

Language of teaching	English
Credits	3
Session	
Exam	Oral presentation
Workload	90h
Hours	**56**
Lecture	28
Practical work	28
Number of positions	**99**

Frequency

Every year

Remark

Block course October 16-20, 2023

Summary

This course introduces the principles of nonlinear optics, their use in photonic integrated circuits and the applications of this technology for telecommunication, spectroscopy and metrology.

Content

The objective of the course is to acquaint the students with the principles of nonlinear optics, their use in photonic integrated circuits and the applications of this technology for telecommunication, spectroscopy and metrology. This will be achieved by first introducing some fundamentals of light-matter interaction and the most important nonlinear optical effects. Then an overview of relevant photonic devices will be presented, including lasers, waveguides and photodetectors. It will be discussed how these photonic devices can be considered as building blocks that can be combined into a circuit and which material systems can be used for that, considering both their linear and non-linear optical properties, as well as fabrication requirements.
Emphasis will be put on the required trade-offs and the main differences between material systems. A Python-based simulation software will be used to illustrate the concept of optical mode, and as a design tool to optimize device parameters to obtain efficient nonlinear processes (such as frequency conversion).
Finally, an introduction to the quantum theory of nonlinear photonics and its applications will be given.

After this course the student should be familiar with the main nonlinear optical effects and the main platforms for photonic integration that are available. The student should be able to make a design study, with a qualitative understanding of the required trade-offs and a quantitative knowledge of the typical component and/or circuit operation parameters.

Keywords

photonics, integration, lasers, light-matter interactions, nonlinear optics, waveguides

Learning Prerequisites

Required courses

Electromagnetism, Optics

Learning Outcomes

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

- Explain the physics behind the selected nonlinear optical effects;
- Model a selected device and/or circuit in a design study;
- Explain how a photonic integrated circuit can be made and in which materials;
- Discuss the trade-offs that have to be made when choosing a platform and designing a circuit.

Resources

Moodle Link

- https://go.epfl.ch/PHYS-700