PHYS-761

Attosecond radiation sources

Carbone Fabrizio, Invited professor(s) , Puppin Michele

Cursus	Sem.	Type
Ing.-phys	MA1, MA3	Opt.
Physicien	MA1, MA3	Opt.
Physics		Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	

Frequency

Every year

Summary

This course introduces the basic principles of lasers to then focus on the latest developments in ultrafast radiation sources, including X-ray and gamma-ray sources, attosecond pulses generation, free electron lasers, ultrashort electron pulses and atomic lasers.

Content

1.Basic principles of lasers L1-L2
Population inversion, light amplification, Cavity and feedback. Some laser types: Solid state laser (YAG), Semiconductor lasers, Gas-lasers, Excimers lasers, Vibronic lasers (Ti:Saph), Glass lasers, Rotonic lasers (CO2), Fiber lasers (principles, the nonlinear Schrodinger equation and the propagation of solitons)
2. Optical properties of coherent light sources L3-L4
Coherence (transverse and longitudinal) (broadely defined for all particles, photons, electrons, neutrons, protons)

Radiation/matter interaction L5
Nonlinear optics (Pockels effect, Second harmonc generation, third harmonic generation, four wave mixing, optical parametric amplification, Raman and Brillouin effect)

Pulsed laser operation L6-L7
Q-switching and mode-Locking, Laser amplification: Regenerative and non regenerative amplification of fs pulses

High-energy laser sources L8-L9
Radiation generation mechanisms, fundamental principles, Compton effect, Smith-Purcell effect, Cerenkov effect, Bremstralung, beam accelerators for radiation generation, ultrashort electron pulses (femtosecond and attosecond), Synchrotron radiation

High-harmonics generation L10-L11
principles and methods of HHG in gases and solids

X-ray lasers (principles) L12-L13
Free electron laser (principles, SASE vs seeded operation)

Exotic lasers L14
Microwave lasers (MASER), Phononic laser, Atomic lasers, Gamma-ray laser (wishes and ideas)

During the excercise sessions a 50-50 distribution of theoretical excercises and laboratory activities will be planned. The goal will be to understand how to model and predict the basic characteristics of a radiation source (theory) and how to operate the most common femtosecond lasers and electron sources (experimental activity at the LACUS facilities).

Note

Invited lecturer: Prof. Steven Johnson, ETHZ johnson@phys.ethz.ch

Keywords

ultrafast, ultrashort, laser, radiation, femtosecond, attosecond, coherence

Learning Prerequisites

Required courses

Basic knowledge of electromagnetism and quantum mechanics are necessary for this course

Learning Outcomes

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

- Operate Simple pulsed laser sources
- Describe the newest radiation sources
- Describe the majority of currently available sources
- Design Simple ultrafast laser sources
- Describe high-energy radiation sources
- Operate Simple pulsed electron sources

Assessment methods

Oral

Resources

Bibliography

Some of the material can be found on classic books such as "Principles of lasers" by Orazio Svelto. Other material will be distributed in class.

Ressources en bibliothèque

- Principles of lasers / Svelto

Moodle Link

- https://go.epfl.ch/PHYS-761