



Dottorato di Ricerca in Fisica

Title:	<i>Ultrafast Laser Physics</i>
Lecturers:	Prof. Giulia Fulvia Mancini
Duration:	20 - 26 hours of frontal lectures
CFU:	4
Period:	Spring Semester on even years, every other year (2024, 2026, ...)
Content:	Learning pre-requisites: A basic (M.Sc.) knowledge of Photonics and Diffraction are recommended Learning Objectives: The course will cover fundamental concepts and recent developments in the field of ultrafast laser physics, and it will introduce the basic theory to understand ultrafast (10^{-15}-10^{-9}s) phenomena in chemistry, biology and condensed matter physics. It has the goal to give also to the non-expert an efficient starting position to enter the field of ultrafast laser physics providing all the detailed derivations. The course will cover fundamental technological and theoretical aspects of: (i) Linear pulse propagation and dispersion compensation, (ii) Nonlinear pulse propagation and nonlinear optics with ultrashort pulses, (iii) Pulse generation, pulse duration measurements Program and contents: <u>Principles of femtosecond laser systems</u> • Overview of laser oscillators and pulse amplification • Pulse measurement/characterization <u>Time-resolved methods</u> • Transient absorption (pump-probe) spectroscopy • Time-resolved core-level spectroscopies (X-ray absorption, emission, RIXS) using synchrotron and XFEL radiation • Time-resolved Coherent Diffractive Imaging methods with XFEL and table-top High Harmonic Generation (HHG) sources & Fundamentals of Fourier Optics • Electron-based methods (scattering, crystallography, microscopy, spectroscopy) <u>Theory</u> • Linear & Non-linear optics Expected results: The student shall be capable of formulating original questions upon reading an article in ultrafast science Teaching Methods: • Interactive lectures • Group activities in the classroom • Homework Reference textbooks: • U. Keller, Ultrafast Lasers - A Comprehensive Introduction to Fundamental Principles with Practical Applications, Springer International Publishing, eBook ISBN 978-3-030-82532-4, 2021 • O. Svelto, Principles of Lasers, Springer, New York, ISBN 978-1-4419-1301-2 Learning verification methods: Oral presentation on a selected topic & discussion on the overall program
Notes	This course may be of interest to PhD students in the Schools of Engineering and Physical Chemistry