UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Biophotonics

2021-1-F1701Q125

Aims

Knowledge of the main spectroscopic techniques for the characterization of biosystems.

Ability to design experiments based on these techniques for the study of biological systems.

Knowledge of advanced diagnostic methods for biosciences and medicine.

Contents

- UV-Visible radiation interaction with biomolecules at the fundamental state: absorption spectroscopy.
- Fluorescence spectroscopy, spontaneous emission coefficient, Stickler-Berg expression, Stokes shift, fluorescence lifetime, quantum yield. Methods for time resolved fluorescence detection.
- Concepts of optical microscopy, imaging, resolution limit and Point Spread Function of a microscope.
- FRET (fluorescence resonant energy transfer) between two fluorophores (Forster theory) with application to microscopy.
- Fluorescence Polarization anisotropy (steady state and time-resolved), molecular form factors.
- Fluorescence fluctuations correlation techniques: FCS in solution (diffusive motions, binding kinetics, photodynamics). Temporal image correlation (TICS), space and space-temporal correlation for cellular motions detection. Flow measurements by correlation techniques.
- Super-resolution microscopy techniques:STED, STORM and PALM.
- Analysis of stochastic processes in biophysics.

Detailed program

- Introduction to absorption spectroscopy UV-VIS: semiclassical model, derivation of the transition dipole strength. Protein and nucleic acid absorption, Solvent effects. Interaction among the chromophores: excitonic effect (examples) ipocromism (examples)
- Fluorescence spectroscopy: semiclassical model for the light0matter interaction: spontaneous emission coefficient, quantum yield, fluorescence lifetime. Jablonski diagrams, Stickler-Berg rule. Intrinsic fluorophores in biomolecules and tissues, probes.
- Time resolved fluorescence, methods and instrumentation.
- Notes on fluorescence microscopy, spatial resolution of an optical microscope,
- FRET, Forster theory, derivation and application in fluorescence microscopy
- Fluorescence anisotropi, strada state and time -resolved. Shape effect of biomolecules.
- Fluorescence correlation spectroscopy: principles and applications. Derivation of the expression for brownian diffusion, drift motion, chemical reaction and photodymanics.
- Image correlation: temporal correlation (TICS) and spatio-tenporal correlation(STICS): derivation an applications.
- Super-resolution techniques: STED, PALM, STORM
- Optical microscopy, an introduction
- stochastic equations for Biophysics.

Prerequisites

Knowledge of the basic concepts of quantum mechanics atomic physics achieved during the bachelor degree.

Teaching form

In non-emergency time: Lectures and exercises to be done by teh students.

during covid19 times the lectures will be partially in streaming (then recorded and uploaded on the elearning site) and video-recorded. Some homeworks will be suggested.

Textbook and teaching resource

Lakowicz “Principles o Fluorescence Spectroscopy”

Parson “ Modern Optical Spectroscopy"

Doi&Edwards, Polymer Dynamics,

web site for java simulations: https://phet.colorado.edu/

Scientific papers selected by the teacher

Teacher's notes

Semester

I semester

Assessment method

Oral exam. The candidate can prepare a topic at her/his choice. Other questions on fundamental topics of the course will follow. The exam will typically require 30-45 min.

The requirements to be met in order to successfully pass the exam will be clearly defined during the lessons at the beginning and end of each macro-topic.

During the course you will be asked to carry out 4 problems to be delivered during the course or before the exam. These will be based on classroom problems during the course.

During the Covid-19 emergency time the exams will be organized in videocalls through the Webex platfomr and scheduled on the elearning page of the course.

Office hours

always, on request.