

Master Physique fondamentale et applications

Photonics for biomedical applications

Informations

Composante : Faculté des Sciences

Responsables

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Langue(s) d'enseignement

Anglais

Contenu

Cell imaging (14h)

Optical contrasts in biological samples: absorption, scattering, fluorescence, molecular vibrational contrasts
The optical Microscope (typical optical system, diffraction and spatial resolution, confocal, TIRF, dark field)
Superresolution techniques: Above the diffraction limit (4pi- microscopy, STED, SIM, PALM, STORM)
Advanced optical microscopy techniques (Fluorescence correlation spectroscopy, fluorescence life time imaging)
Deep tissue Imaging I: clearing, light sheet, non-linear microscopy, adaptive optics, optical wavefront shaping
Deep tissue Imaging II: photoacoustic imaging

Tissue imaging and biomedical applications (10h) :

Introduction to biological tissue optics
Main contrasts: Absorption, fluorescence
Optical scattering, phase function, Rayleigh & Mie scattering
Model of light propagation through biological tissues, Radiative Transfer Equation, Diffusion Equation
Introduction to inverse problems resolution
Instrumentation and imaging/diagnostic setups examples

Compétences à acquérir

The students :

- become aware of the importance of the research community working on optical imaging in biology, and of the most active research activities that are animating the fields of bioimaging and biophotonics
- possess a solid knowledge on all the techniques capable of imaging living matter, from the scale of single cells in culture, to the scale of animals and patients.
- learn/consolidate fundamental knowledge in physics related to main physical contrasts, to light propagation in biological tissues, to molecular fluorescence, Raman spectroscopy.
- know basics in biology, such as in cell biology and fluorescence labelling techniques.
- perform quick calculations of relevant numbers in the lab, and learn how to make reasonable physical assumptions to simplify these calculations

Modalités d'organisation

Type of Examination: written exam

Bibliographie, lectures recommandées

G. Cox, Optical Imaging Techniques in Cell Biology
B. Valeur, Molecular Fluorescence Principles and Applications
M. Born and E. Wolf, Principles of Optics, Cambridge University Press Ed.
Tuan Vo-Dinh, Biomedical Photonics Handbook, CRC Press, 2003
V. Tuchin, Tissue optics, Light scattering methods and instruments for medical diagnosis, SPIE Press, 2000
Miller et al., Deep tissue imaging with multiphoton fluorescence microscopy, Current opinion in biomedical engineering (2017)
Lecoq et al., Wide. fast. deep: recent advances in multiphoton microscopy of in vivo neuronal activity, Journal of Neuroscience (2019)
Ji, Adaptive optical fluorescence microscopy, Nature methods (2017)

<https://aomicroscopy.org/>

Rotter and Gigan, Light fields in complex media: Mesoscopic scattering meets wave control, Reviews of Modern Physics (2017)
Mosk et al., Controlling waves in space and time for imaging and focusing in complex media, Nature photonics (2012)
Wheelock et al., High-density diffuse optical tomography for imaging human brain function, Review of Scientific Instruments (2019)
Vasilis Ntziachristos, Going deeper than microscopy: the optical imaging frontier in biology, Nature Methods (2010)
Paul Beard, "Biomedical photoacoustic imaging" Interface Focus (2011)
Manohar and Razansky, Photoacoustics: a historical review, Advances in Optics and Photonics (2016)

VOLUME HORAIRE

- Volume total: 24 heures
- Cours magistraux: 24 heures

Codes Apogée

- SPFCU47J [ELP]

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