PHYS-631

Fundamentals of superresolution optical microscopy and Scanning Probe Microscopy

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Cursus	Sem.	Type
Computational and Quantitative Biology		Opt.
Photonics		Opt.
Physics		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Multiple
Workload	60h
Hours	**32**
Lecture	14
Exercises	10
Practical work	8
Number of positions	**20**

Frequency

Every year

Remark

Next time: Spring

Summary

The course starts from general discussion of the microscopy spatial resolution problem and different proposals to beat classical criteria in the field. Afterwards, modern scanning probe microscopy methods are discussed.

Content

1. Spatial resolution of optical far-field microscopy. Light diffraction and Abbe criterion. Attempts to beat Abbe criterion in the frame of far-field optics: engineering of a pupil function, immersion microscopy, 4pi-microscopy, confocal microscopy and their limitations.

2. Ultramicroscopy: how to distinguish blue from red (not to mix this problem with the real optical resolution problem!). Its relation with Abbe criterion and modern implementation: Photoactivated Localization Microscopy (PALM), Stochastic Optical Reconstruction Microscopy (STORM).

Stimulation Emission Depletion (STED). Two-photon microscopy and SIM (structured-illumination microscopy).

3. Near-field optical microscopy and its modifications (aperture and apertureless approaches). General concept of Scanning Probe Microscopy, piezoelectric scanners. Peculiarities of scanning for SNOM (connection between fiber probe and tuning fork, shear force).

4. Scanning Tunneling Microscopy. Tunneling phenomenon, tunneling in 1D and 2D/3D cases. Field Electron/Ion Emission Microscopy.

5-6. Atomic Force microscopy and its modifications. AFM cantilevers, angular detection methods and their sensitivity. Contact and non-contact imaging modes. How to pass from 3D dithered beam to simple 1D oscillator when discussing AFM results.

7. Single molecule force spectroscopy. Bell-Evans model of the bond breaking under the action of a force. Parallel bonds and bonds in series.

Keywords

far field and near-field microscopy, scanning probe microscopy, superresolution, force spectroscopy

Learning Prerequisites

Important concepts to start the course

The course is of an introductory character (actually almost each topic here deserves its own course) so no special knowledge are presupposed from students, just a course of general physics at the level of Physics Department.

Resources

Websites

- http://will be prepared on Moodle