Modulbezeichnung:	Seminar: Modern Optics - Advanced Microscopy & Biophotonics (PS-MO-Micro) (Seminar: Modern Optics - Advanced Microscopy & Biophotonics)	5 ECTS
Modulverantwortliche/r:	Kanwarpal Singh, Jona Kayser	
Lehrende:	Jona Kayser, Kanwarpal Singh	

Startsemester: WS 2020/2021	Dauer: 1 Semester	Turnus: unregelmäßig
Präsenzzeit: 30 Std.	Eigenstudium: 120 Std.	Sprache: Englisch

Lehrveranstaltungen:

Physics Seminar: Modern Optics - Advanced Microscopy & Biophotonics (WS 2020/2021, Hauptseminar, 2 SWS, Kanwarpal Singh et al.)

Inhalt:

In this seminar we will cover the following topics:

- 1. Optical coherence tomography imaging (OCT): OCT is an imaging technique which can provide axial resolution better than 1 micron using broadband low coherence light source. This has allowed to perform optical biopsies for several biological samples in vivo.
- 2. Confocal microscopy: Confocal microscopy is an imaging technique which provides improved resolution and contrast compared to full field imaging by using a pin hole which helps reducing the out of focus light. Confocal microscopes are backbone for most of biological labs and are used frequently to study cellular mechanics.
- 3. Raman microscopy: Raman microscopy is a technique within vibrational spectroscopy, which is based on the inelastic scattering of light. It provides information on the chemical composition of the sample based on its vibrational spectra. Since the development of the first commercial Raman spectrometer in 1953, advances in lasers and detectors and the discovery of new phenomena have expanded the use of this technique in several research fields.
- 4. Stochastic optical reconstruction microscopy (STORM): STORM is one of the most ubiquitously employed super-resolution imaging techniques. It utilizes sequential activation and time-resolved localization of photoswitchable fluorophores to create high resolution images. During imaging, only an optically resolvable subset of fluorophores is activated to a fluorescent state at any given moment, such that the position of each individual fluorophore can be determined with high precision.
- 5. Structured illumination microscopy (SIM): Structured illumination microscopy (SIM) enhances spatial resolution by collecting information from frequency space outside the observable region. This process is done in Fourier space. The reverse Fourier transform then returns the reconstructed image to a super-resolution image.
- 6. Stimulated emission depletion (STED): STED creates super-resolution images by the selective deactivation of fluorophores, minimising the area of illumination at the focal point, and thus enhancing the achievable resolution for a given system.
- 7. Multi-photon excitation (MPE): MPE microscopy is an imaging technique which operates in non linear regime that combines point scanning methods with multiphoton fluorescence to create high-resolution, three-dimensional images of biological samples. Several forms of MPE such as 2 photon, 3 photon microscopy etc, are available. MPE is particularly useful in biology because it can be used to probe delicate living cells and tissues without damaging the sample.
- 8. Optical coherence elastography (OCE): Biomechanical properties play important role in biological samples at tissue, cellular and sub-cellular level. OCE in combination of OCT and a mechanical transducer can measure the mechanical properties of the tissue in three dimensions. OCE has been sucessfuly used to determine cancer tissue margins during surgery based on the mechanical properties.
- 9. Digital holographic microscopy (DHM): Several cells offer very low contrast when visualized with standard microscope. DHM provides improved contrast and is a label-free imaging technique allowing visualization of transparent cells. The quantitative DHM phase contrast image provides information about the optical path length change introduced by the sample because of its refractive index and thickness.

- 10. Polarization sensitive optical coherence tomography (ps-OCT): ps-OCT is gaining attention because of its ability to diagnose certain pathological conditions at an early stage. Several pathological conditions such as cancer can be detected at an early stage by measuring birefringent properties of the tissue. ps-OCT uses low coherence polarized light to probe the birerefregence of the tissue.
- 11. Brillouin Microscopy: Brillouin microscopy is an emerging optical technique that enables non-contact measurement of viscoelastic properties of a material with diffraction-limited resolution in 3D. It exploits Brillouin scattering, the interaction between light and acoustic waves intrinsically present in any material due to thermal vibration.
- 12. Optogenetics: Optogenetics is a method that uses a combination of techniques from optics and genetics to control the activities of individual cells, especially neurons, in living tissue - even within freely-moving animals. It is based on photosensitive proteins that have been genetically integrated into the cells of interest.

Lernziele und Kompetenzen:

Students

- comprehend an interesting physical topic in a short time frame
- identify and interpret the appropriate literature
- select and organize the relevant information for the presentation
- compose a presentation on the topic at the appropriate level for the audience
- use the appropriate presentation techniques and tools
- criticize and defend the topic in a scientific discussion

Literatur:

Will be provided individually for each talk.

Studien-/Prüfungsleistungen:

Modern Optics - Advanced microscopy and biophotonics (Prüfungsnummer: 71931)
Prüfungsleistung, mündliche Prüfung, Dauer (in Minuten): 45
Anteil an der Berechnung der Modulnote: 100% Prüfungssprache: Englisch

Erstablegung: WS 2020/2021, 1. Wdh.: WS 2020/2021 (nur für Wiederholer)
1. Prüfer: Kanwarpal Singh

Organisatorisches:

www: https://www.studon.fau.de/crs3252544_join.html Für diese Lehrveranstaltung ist eine Anmeldung erforderlich. Die Anmeldung erfolgt über: StudOn