UNIVERSITÄT
HEIDELBERG
ZUKUNFT
SEIT 1386

The Kirchhoff Institute for Physics at the Heidelberg University offers several

Master's or Diploma Theses

in the Group of Applied Optics and Information Processing / Prof. Cremer

Super resolution Microscopy reveals detail of cellular structure *in vivo* beyond the Abbé Criterion. Two new and complementary methods have been developed in our group:

1. Spectral Precision Distance Microscopy. In combination with multispectral labeling techniques, this procedure allows to analyze the topology of bio-molecular machines down to a few nanometers.

2. Spatially Modulated Illumination Microscopy. With this microscope, sizes of fluorescent objects can be determined with high precision. This microscope is used for the biophysical analysis in living cells.

If you are interested to join us, please contact

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to make an appointment for a tour through our lab or if you have any questions on the thesis.

Further information on our research is available at
http://www.kip.uni-heidelberg.de/AG_Cremer

http://www.optics.imb-mainz.de

1. Development of a Procedure to Acquire Patchwork Images in Spectral Precision Determination Microscopy

In our microscopes one single image covers an area of about $(50\ \mu m)^2$. Our biological structures of interest however are in the order of magnitude of about several millimeters. Therefore the development of a patchwork image acquisition procedure is desired. After capturing an image at one location, the sample is moved along a predefined pathway while images are recorded one at a time. Afterwards the data is combined to a big patchwork image. The challenge is to account for inhomogeneities in illumination and the correction of bleaching.

The thesis concentrates on the design of an optimal pathway as well as on the development of the necessary algorithm to stich the acquired data.

We welcome applications of students of physics, bioinformatics, and adjacent fields. Background in programming, especially in Matlab, is advantageous but not mandatory. Furthermore, the candidate should have enthusiasm for science.

2. Optimization of a 3D High Resolution Image Generation Algorithm Based on Micro-Axial-Tomography Data

Due to the nature of most microscopy methods the lateral resolution is higher than along the optical axis. To overcome this, a Micro-Axial-Tomograph was developed in our group. A rotatable micro-fiber is used as the sample holder, so the sample can be rotated while an image stack is being recorded. By that the benefits of the higher lateral resolution of the microscope is exploited yielding highest resolution in all three dimension of space within the sample.

The thesis concentrates on the optimization of an Algorithm that generates a 3D high resolution image using the microscopic data acquired with the Axial-Tomograph. The exact location and orientation of the sample is unknown but should be reconstructible with the image data alone by solving the corresponding minimization problem under variation of the six degrees of freedom.

We welcome applications of students of physics, bioinformatics, and adjacent fields. Background in programming, especially in Matlab, is advantageous but not mandatory. Furthermore, the candidate should have enthusiasm for science.

3. Cell cultivating for Micro-Axial-Tomography -

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Main goal of this work will be finding and improving a way to cultivate cells directly on the micro-fiber.

The cells of interest are RPE (Retinal Pigment Epithelium) cells that play a major role in the human eye. After preparing the samples, the student will validate the results by measuring with one of our microscopes.

For this thesis background in biology and physics or the empathy for learning both is desirable.

We welcome applications of students of Biotechnology, Physics, Biology or adjacent fields. Furthermore, the candidate should have enthusiasm for science and lab work.

4. Empirical Study on the Bleaching of fluorophores

For enhanced and specific contrast in microscopy, fluorescent molecules are used. After these molecules, the fluorophores, are excited by laser light, they emit a photon of longer wavelength. In fluorescence microscopy, such fluorophores are attached to biological target molecules (e.g. specific proteins) inside the cell. Thus, these targeted molecules can be imaged, visualized and further quantified to obtain e.g. information of their distribution in a sample.

However,irradiation with laser light induces also other photo-chemical reactions destroying the fluorophores. This bleaching effect is known for a long time, but so far only little quantitative investigations have been published. Reason for this may be the complexity of the molecule spectra and the many affecting factors, such as wavelength, intensity of laser light, kind of the molecule, kind of the fluorophores, method of labeling, age of sample, neighboring molecules and so on.

Main goal of this work will be an empirical study on bleaching, focused on the effects of laser intensity and age of the sample. Therefore standardized samples will be used. The student will prepare the samples for the measurements before doing the study.

We welcome applications of students of Physics, Biotechnology or adjacent fields. Background in biological or chemical is advantageous but not mandatory. Furthermore, the candidate should have enthusiasm for science and lab work.