

Microscopy

Problem Set 5

June 14, 2019

Please hand in the solutions of this problem set next lecture on June 28 of 2019.

9 3D Imaging

- Illustrate the Ewald sphere indicating its coordinates. Which imaging function does it represent?
- Starting with the previous function, develop a graphic scheme of the shape (or support) of the most important imaging functions for coherent and incoherent imaging.
- How are the 4 functions called and how are they related to each other?

Do not use mixed space (e.g. xy Fourier- and z real space). Consider a 3D stack of independent and uncorrelated emitting planes as a source. Consider a circular pupil. You may fill the following diagram with your answers.

10 Optical transfer functions of a Confocal Fluorescence Microscope

- Build (performing the convolution graphically) and draw the correspondent region of support of the confocal OTF in the $k_x k_z$ -plane. Indicate the regions of higher density and explain the physical meaning of this distribution.

Hint: Remember $\text{PSF}_{\text{total}} = \text{PSF}_{\text{ex}} \cdot \text{PSF}_{\text{det}}$ and hence $\text{OTF}_{\text{total}} = \text{OTF}_{\text{ex}} \otimes \text{OTF}_{\text{det}}$.

- Explain why the OTF_{Det} is considered approximately as OTF_{Em} in the OTF construction of this system.
- From the OTF graph, Calculate $k_{\text{lateral}}^{\text{max}}$ and $k_{\text{axial}}^{\text{max}}$.
- What changes if the pinhole is opened up? Explain and sketch the situation now.

11 4Pi type C Microscopy and SIM

- a) Illustrate a basic scheme of the optical system correspondent to these two techniques.
- b) Using the graphical convolution, build the OTF of 4Pi type C Microscopy.
- c) Explain the Moiré effect and the image formation/reconstruction in SIM.