

Optical microscopy simulation with Matlab

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ABSTRACT:

The emerging of optical microscopy in the past decades has led to the development of a series of novel imaging techniques, such as super-resolution microscopy. These techniques are often easy to grasp in principle, widely applied, but difficult to implement one's own idea based on it, as it lacks an easy approach to access the merits of these principles at hands-on level.

This tutorial aims at bridging such gaps. Starting from the point spread function (PSF), I will demonstrate the implement of CCD read-out of a captured digital image, and how it is related with the confocal laser scanning microscopy. With introduction of the optical transfer function (OTF), we can see that the resolution equivalence between a wide-field microscopy and a confocal microscopy, when the pinhole is enlarged.

Next, we discuss the confocal system with a smaller pinhole, and the principle of single molecule localization microscopy (SMLM), which is to find the centroids of each PSFs. We will then move on to the simulation of multiphoton microscopy and stimulated emission depletion microscopy, to see the PSF modulation processes.

Finally, we will study the processes of image scanning microscopy (ISM) and structure illumination microscopy (SIM), which are operated on spatial domain and Fourier domain, respectively.

Requirement: Please bring a laptop with Matlab installed. We will run simulations based on Matlab during the tutorial. Basic knowledge of Matlab is required.