

Expanding super-resolution imaging with optics and computation

Single molecule localization microscopy (SMLM) has matured into one of the most powerful and popular super-resolution imaging methods. In this talk, we'll highlight recent developments of our lab to push the limits of SMLM using optical and computational approaches.

One challenge is to extend SMLM to 3D imaging of entire cells. While many approaches for 3D SMLM have been proposed, accessible and flexible techniques are still in demand. We will present ZOLA-3D a combined optical and computational method that uses PSF engineering to enable versatile 3D super-resolution imaging over up to ~5 μm depth. Software and sample data are freely available from github.com/imodpasteur/ZOLA-3D. We will report on recent and ongoing extensions of ZOLA for dual objective systems, arbitrary PSFs and high density regimes.

A second long-standing challenge is to improve upon the poor acquisition speed and temporal resolution of SMLM. Previous approaches to accelerate SMLM typically trade off spatial resolution. We present ANNA-PALM, a computational technique based on deep learning that can reconstruct high resolution views from strongly under-sampled SMLM data and widefield images, enabling considerable speed-ups without any compromise on spatial resolution. We illustrate ANNA-PALM's robustness and potential for high throughput super-resolution imaging and discuss limitations and perspectives. We will also highlight Imjoy (imjoy.io), a computational platform designed to facilitate the application and retraining of deep learning methods such as ANNA-PALM in the biomedical community.

A third challenge is data sharing. Super-resolution microscopy could greatly benefit from easier access to SMLM data generated by the community, in particular to enrich and retrain machine learning models. We will highlight shareloc.xyz, an online platform dedicated to sharing and reanalyzing SMLM data and illustrate its value for enhanced super-resolution imaging with ANNA-PALM.