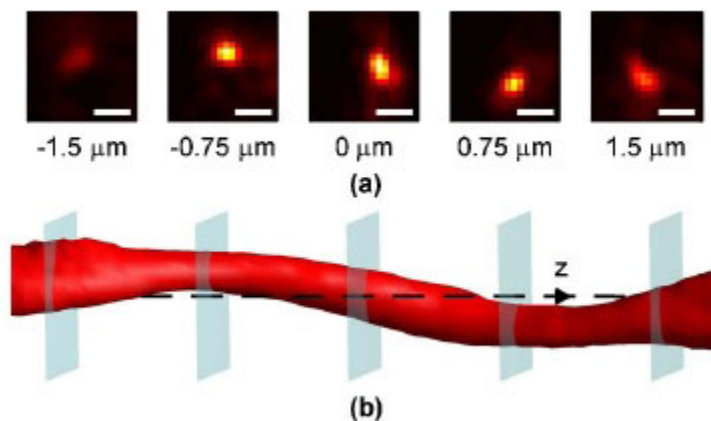


Docket #: S10-162

3D Super-Resolution Microscopy with Corkscrew Point Spread Function

Researchers in Prof. W.E. Moerner's laboratory have developed a compact point spread function (PSF) that enables optical imaging in three dimensions with nanoscale precision using a limited number of photons. Conventional imaging systems are designed to compose two-dimensional (2D) images from three-dimensional (3D) scenes; once the image has been taken, it is difficult to extract 3D information from these 2D images. With this novel, corkscrew-shaped PSF, a conventional microscope can be simply modified to enable 3D information to be captured in 2D images with precision unmatched by existing localization methods. This PSF has applications in biological or materials imaging with either widefield or confocal illumination and with either scattering or fluorescent point objects.



Images from a fluorescent bead (a) and 3D isosurface rendering (b) of the corkscrew PSF. The scale bars in (a) are 1 μm and the blue planes in (b) correspond to the cross sections in (a).

Stage of Development

The inventors used the corkscrew PSF to localize objects with nanoscale precision in three dimensions through a 3.2 nanometer depth of field. They are also planning to use the corkscrew PSF for single molecule imaging in a biological cell.

Applications

- **Super resolution microscopy** with
 - widefield illumination to localize multiple objects simultaneously in three dimensions
 - confocal illumination and detection to localize objects in 3D in small volumes at fast frame rates
 - both scattering and fluorescent point objects
- **End user applications** for imaging:
 - living cells
 - material structures

Advantages

- **Precise** - localizes objects in **three dimensions** with nanoscale precision (2.7 nm in x, 2.1 nm in y, and 5.7 nm in z)
- **Compatible:**
 - implemented with a simple modification to a conventional microscope using a 4f imaging system
 - easy to use in both widefield and confocal imaging modes
- **Compact** - the corkscrew PSF takes up less x-y transverse space on the camera than the double helix PSF, enabling faster image acquisition for single-molecule super-resolution microscopy
- **Large depth of field** - corkscrew PSF can determine the 3D position of an emitter throughout a 3.2 μm depth of field
- **Efficient** - limited number of photons required to localize objects

Publications

- Matthew D. Lew, Steven F. Lee, Majid Badieirostami, W.E. Moerner, [Corkscrew point spread function for far-field three-dimensional nanoscale localization of pointlike objects](#), *Optics Letters*, Vol. 36, No. 2, January 15, 2011.

Patents

- Published Application: [20130147925](#)
- Issued: [9,693,034 \(USA\)](#)

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