

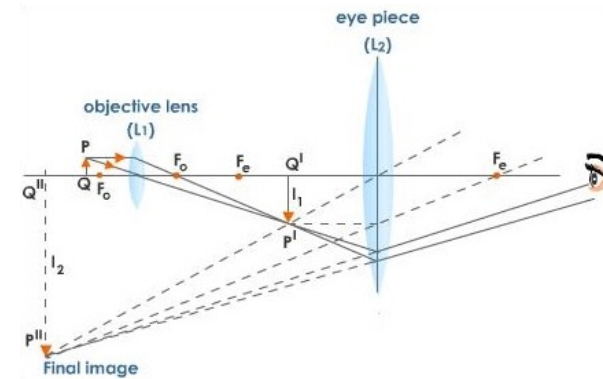
Super-Resolution Microscopy Techniques

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Diagram of the Compound Microscope



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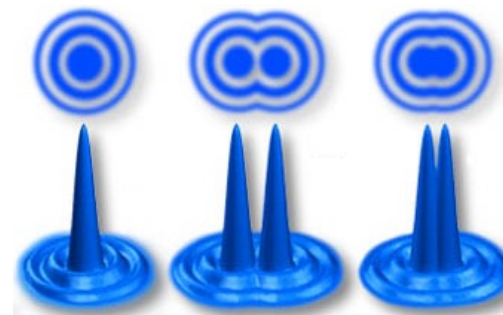
Point Spread Function (PSF)

The PSF is the transfer function (impulse response) of the microscope.

As a consequence of the wave character of light, the image of a point of the object is not a point, but an extended blob.

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The Effect of the Wave Character of Light on the Image



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Abbe's Principle

The smaller the detailed structure of the object, the wider the angle of diffraction.

Each spatial frequency component in the object produces diffraction at a specific angle dependent upon the wavelength of light.

Two points can be resolved in the microscope if and only if at least the first order diffracted beams are combined in the image.

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Abbe's Formula

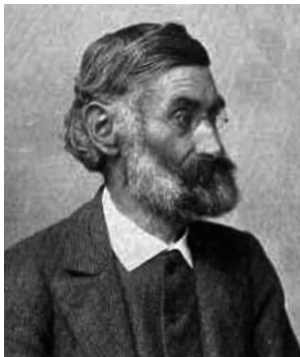
$$\delta = 0,61 \cdot \lambda / (n \cdot \sin\omega)$$

Tacit assumptions:

- different parts of the object are imaged simultaneously
- details of the object are distinguished by the fact that the light coming from them give distinctive image patches.

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Ernst Karl Abbe (1840-1905)



Physicist and social reformer

He placed the production of optical devices on a scientific basis.

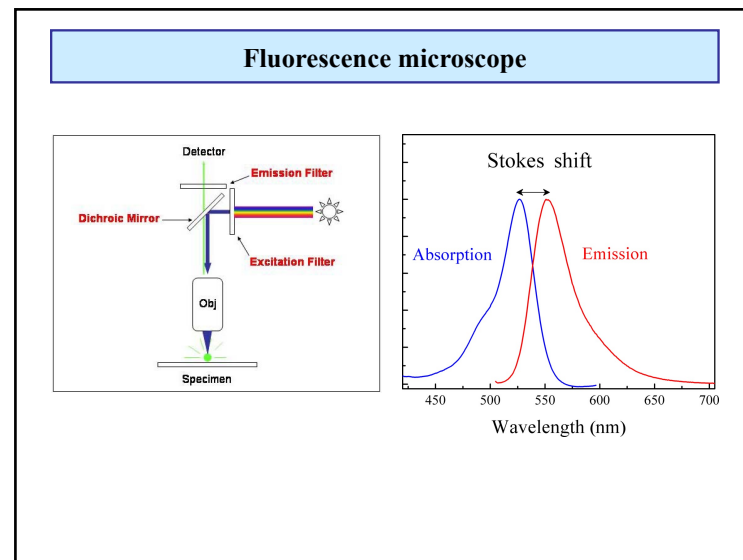
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Super-Resolution Microscopy

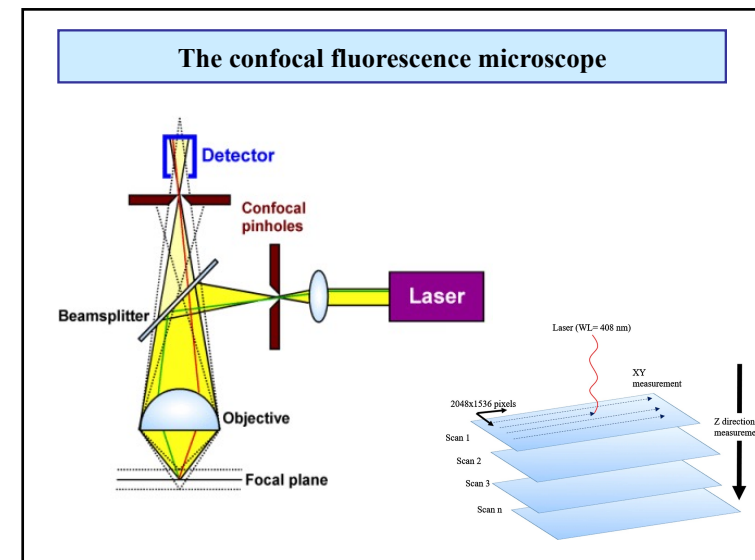
2014 Nobel prize in chemistry:

- Eric Betzig
- Stefan W. Hell
- William E. Moerner

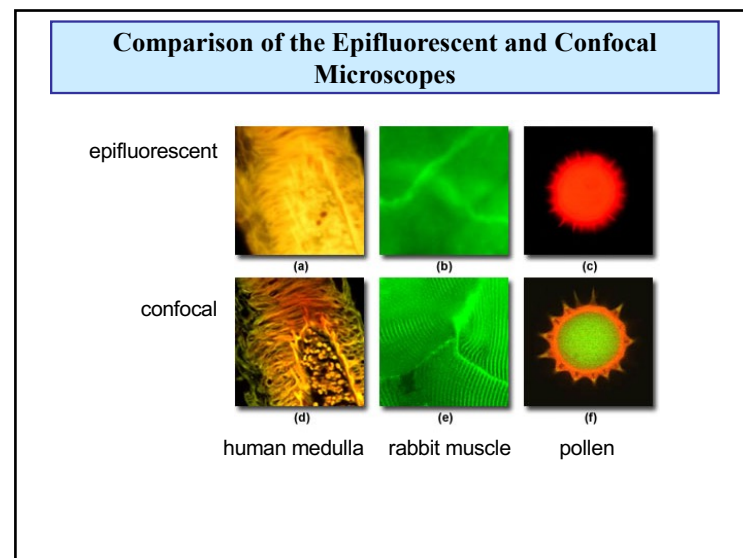
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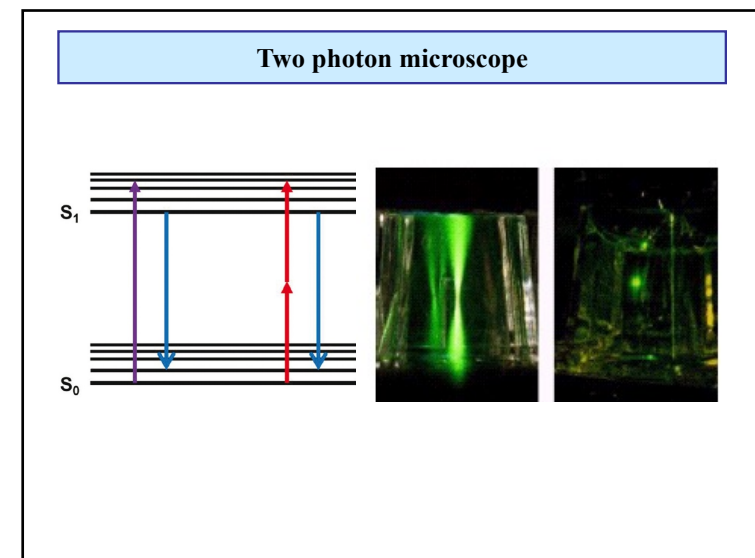
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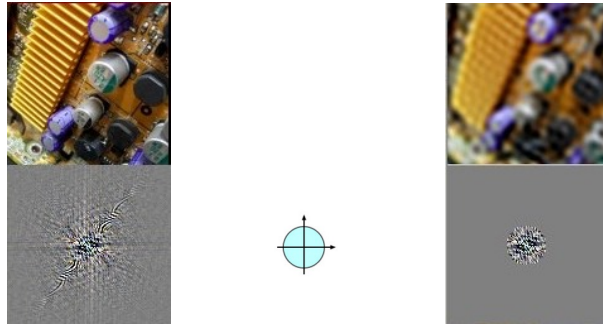


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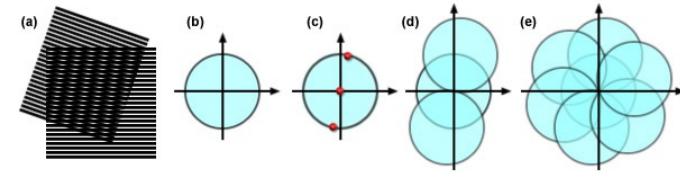
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Abbe's Principle in the Wavenumber Representation



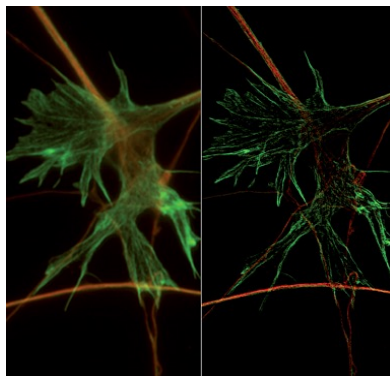
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Structured illumination microscope



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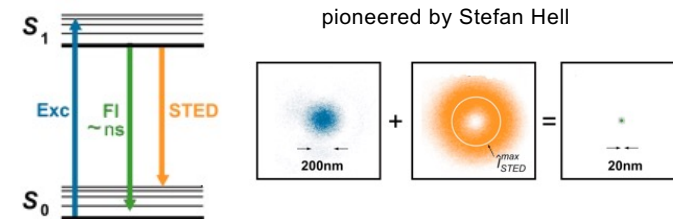
Structured Illumination Microscope



Traditional (left) and structured illumination microscope image (right) of neural cells.

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STimulated Emission Depletion (STED) Microscope



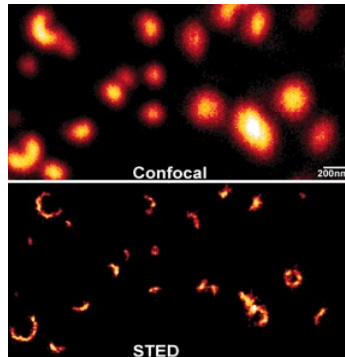
pioneered by Stefan Hell

$$\Delta r \approx \frac{\Delta}{\sqrt{1 + I_{\max}/I_s}}$$

I_{\max} the maximal used STED intensity
 I_s the STED saturating intensity

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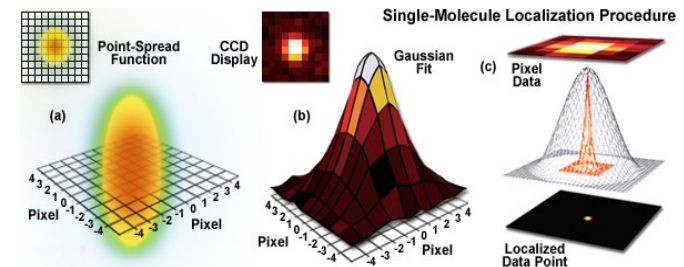
STimulated Emission Depletion (STED) Microscope



Organization of synaptophysin in reused synaptic vesicles.

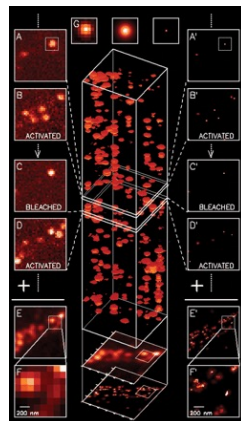
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Localization



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Photo-Activated Localization Microscopy (PALM)

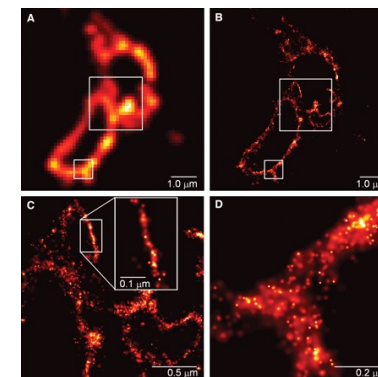


Invented by Eric Betzig and Harald Hess

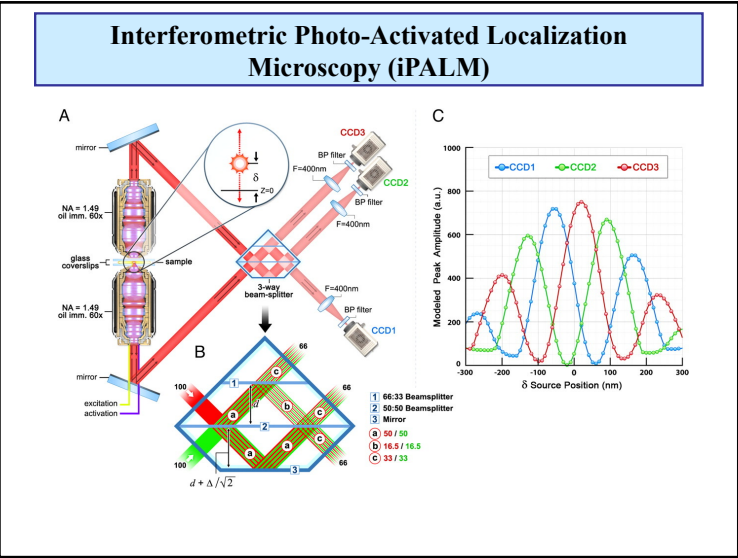
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Photo-Activated Localization Microscopy (PALM)

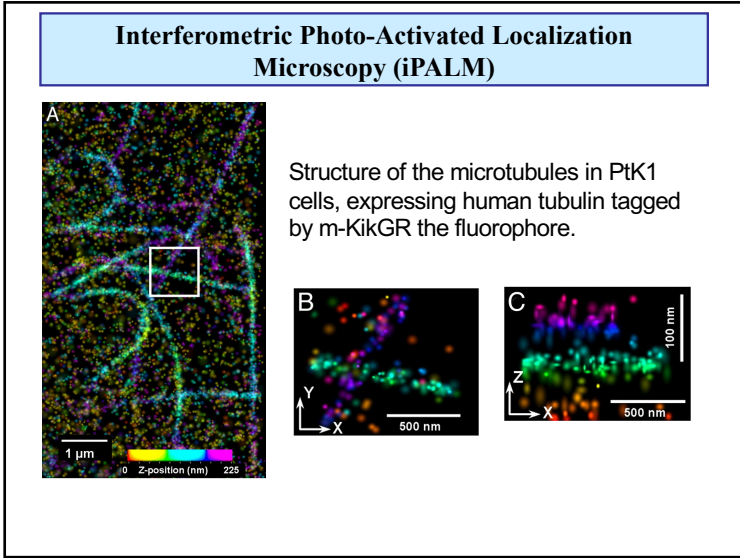
CD63, lysosome transmembrane protein



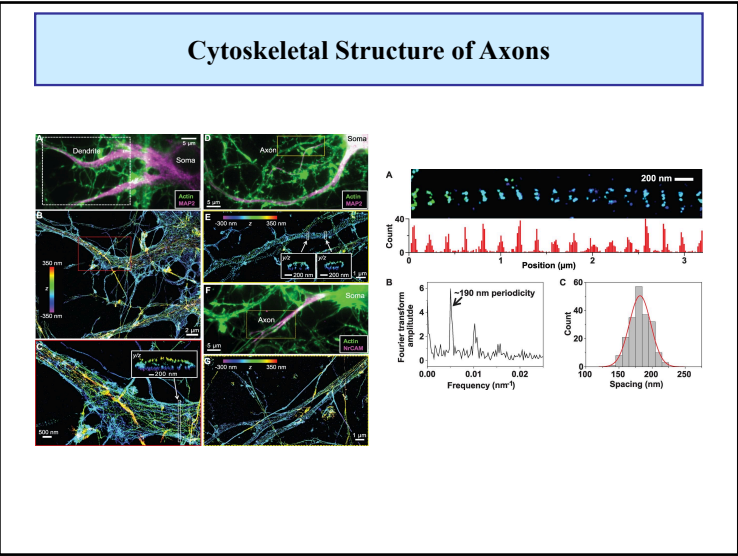
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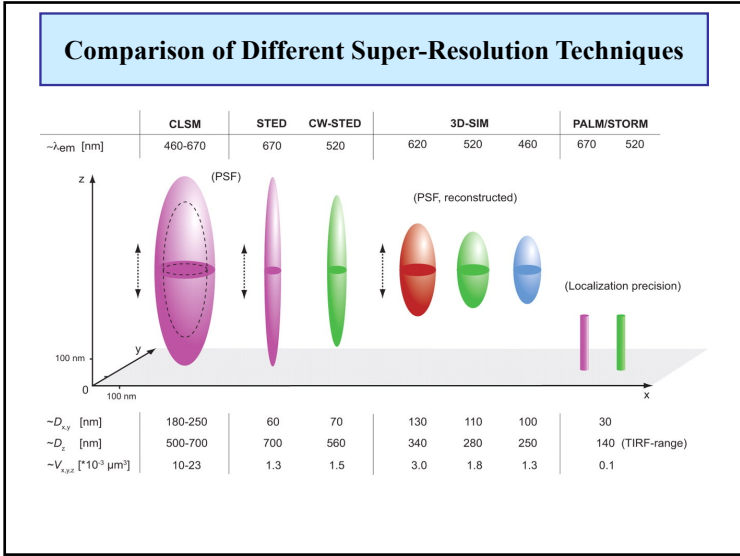
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