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Optics beyond the Abbe Limit:

“Molecular Constellations“

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For more information see www.imb-mainz.de
Above: Viruses; Below: 2 Protein types within a human cell nucleus. The crosses/circles denote positions of single molecules (exciting wavelength 488 nm)

Conventional Resolution

Localization Microscopy

From: C. Cremer et al., Biotechnology J. 6 (2011)

From: Y. Markaki et al., CSH Symposia 75 (2011)

3 point-like objects in x,y plane with next neighbour distances 50 nm

a) Labelling with same spectral signature

b) Labeling with different unique spectral signatures B,G,R

Computation (scalar Theory):

NA = 1.4, $\lambda_{\text{exc}} = 488$ nm

Optical Isolation by the “Supernova“ Mode: Induction of stochastically distributed short flashes of light emission by individual molecules

Present State of Superresolution Far Field Light Microscopy realized @ C. Cremer Lab (December 2011)

- **Optical Resolution** OR (resolvable distance):
  
  OR ~ 5 nm (~ 1/100 \( \lambda_{exc} \), from localization precision)

- **Structural Resolution** (imaging capability):

  - Mean (2D) distance between individual molecules actually detected: ~ 6 nm (~ 1/80 \( \lambda_{exc} \))
  
  - Density of individually detected Molecules: ~ 2,8 \( \cdot 10^4/\mu m^2 \)

- **Multicolor- Localization Microscopy**:

  - 2 – 3 different molecules types
  
  - 3D single Molecule Resolution inside cells (best values): 3D Observation Volume about \( 1*10^4 \) times smaller (i.e. 3D resolution \( 10^4 \) times better) than in conventional Light Microscopy (“Abbe-limit”)
Some recent references (CremerLab):


