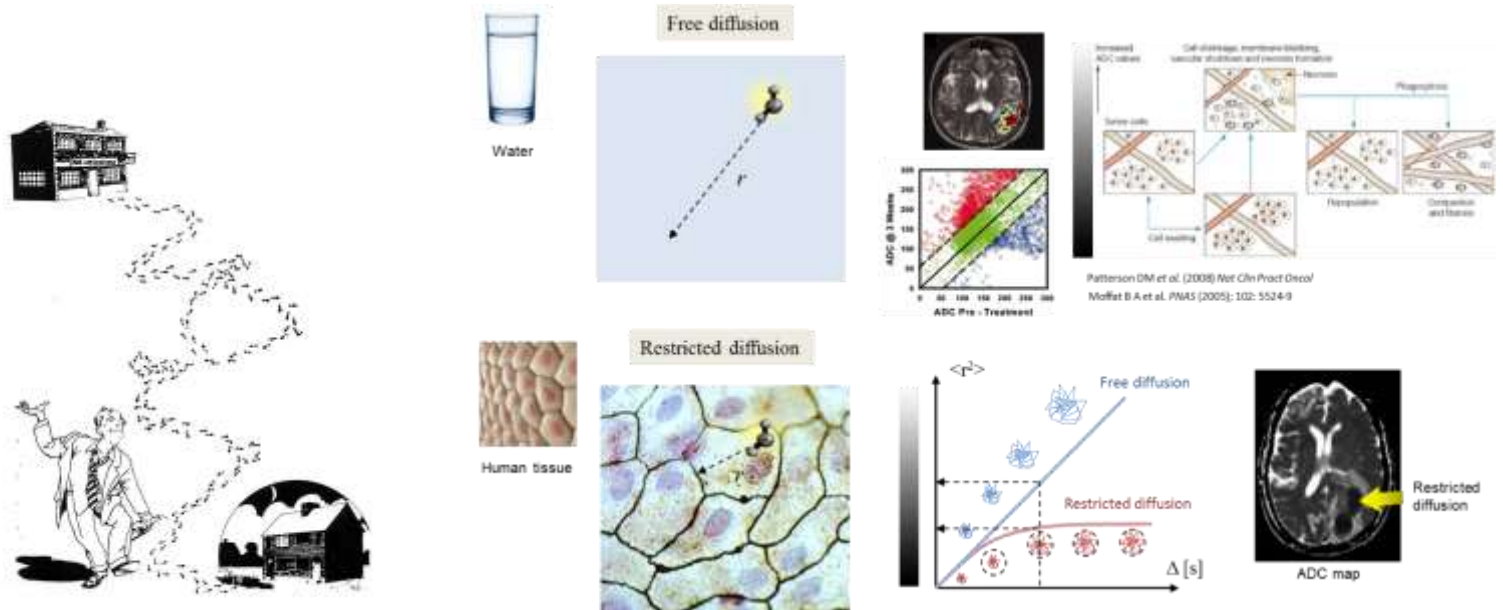


Diffusion

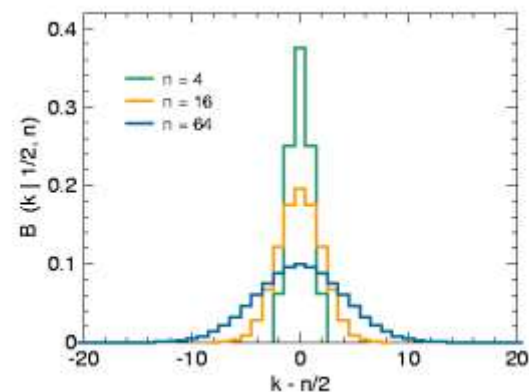
Typical demonstration experiment: Add ink to water and wait (here 30 min)



Random-Walk-Model of Diffusion



Binomial Distribution and Central Limit Theorem



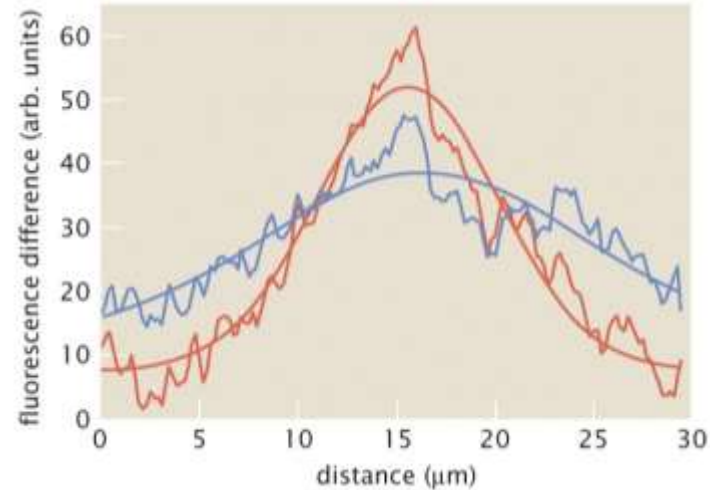
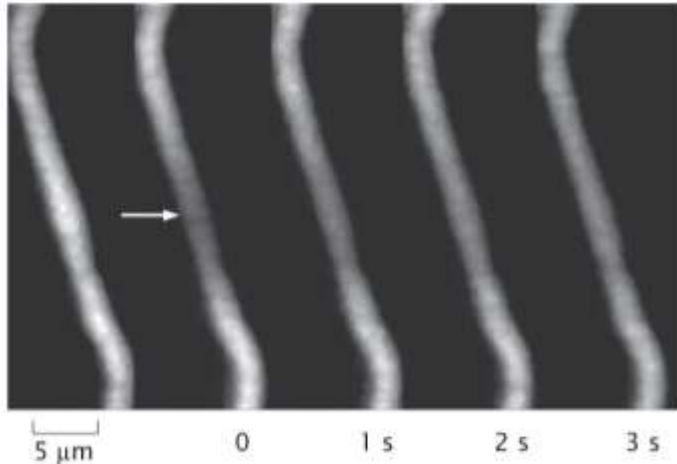
<http://web.science.mq.edu.au/~dyves/masters.html>

<https://upload.wikimedia.org/wikipedia/commons/2/2e/Bindis-sym.png>

http://www.che.hw.ac.uk/teaching/B11MS1/Material/Week%204/lecture_11TheRandomWalk.htm

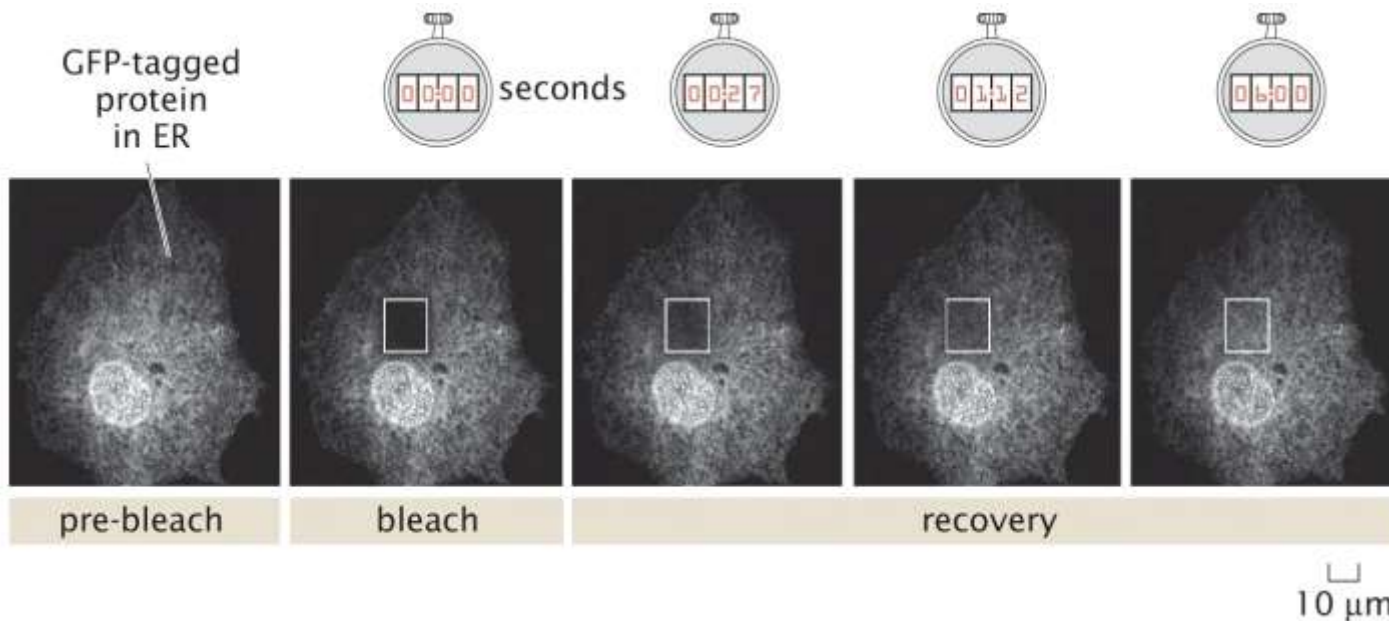
FRAP GFP data recorded in live cells

FRAP = fluorescence recovery after photobleaching



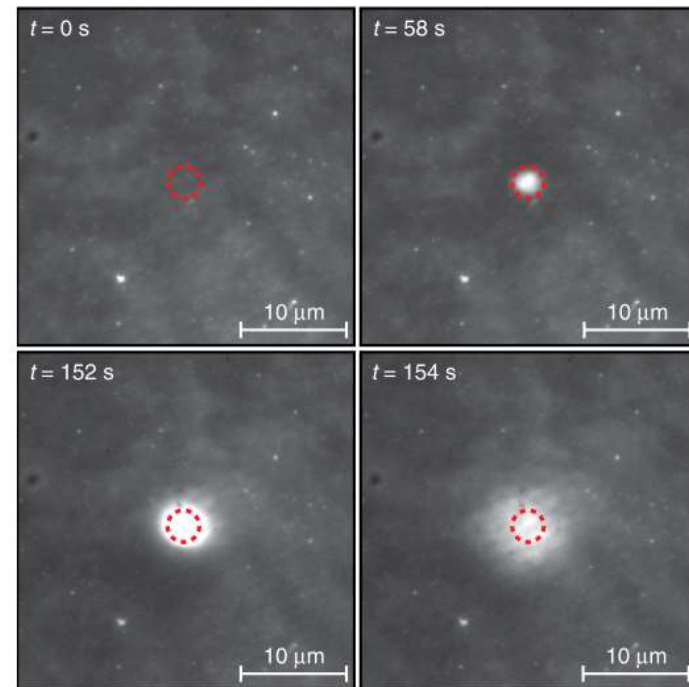
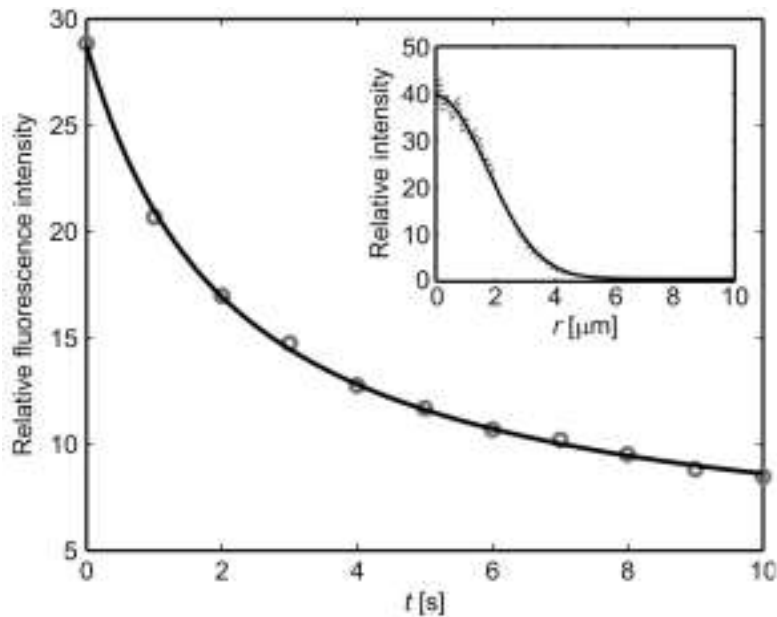
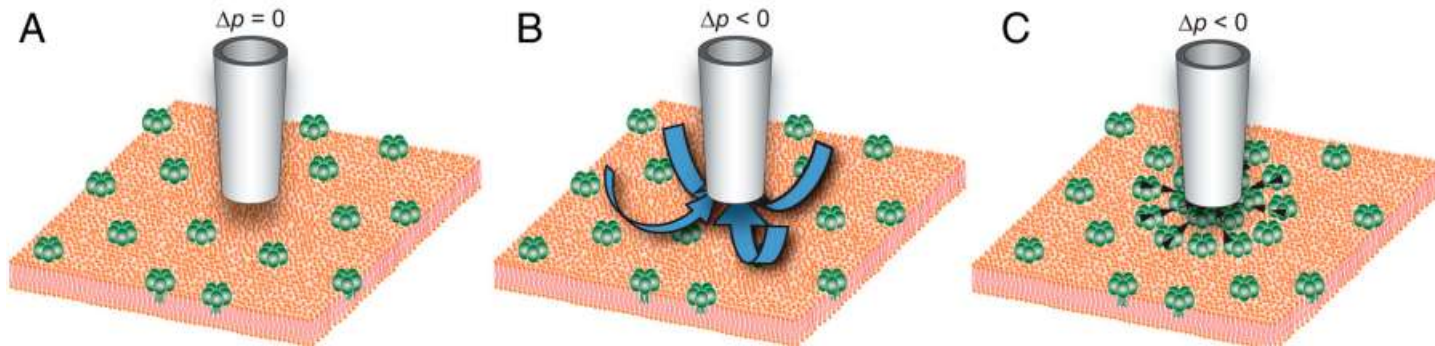
red curve:
right after bleaching
blue curve: after 4s

Mullineaux *et al.*
J. Bacteriol. **188**
(2006)



Ellemberg *et al.*
J. Cell Biol. **138**
(1997)

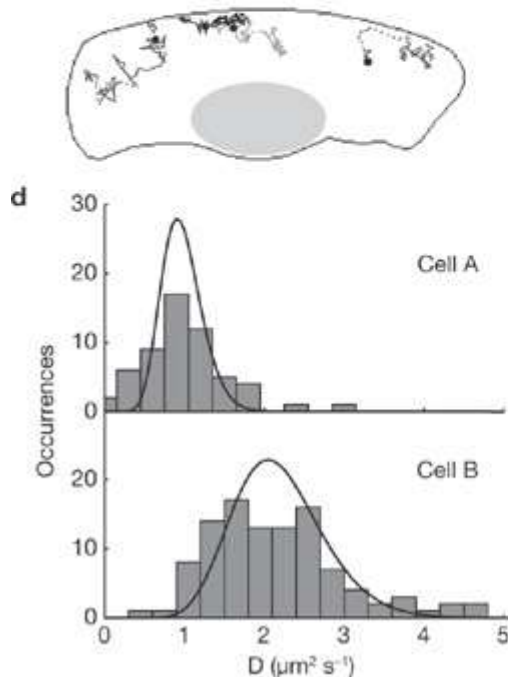
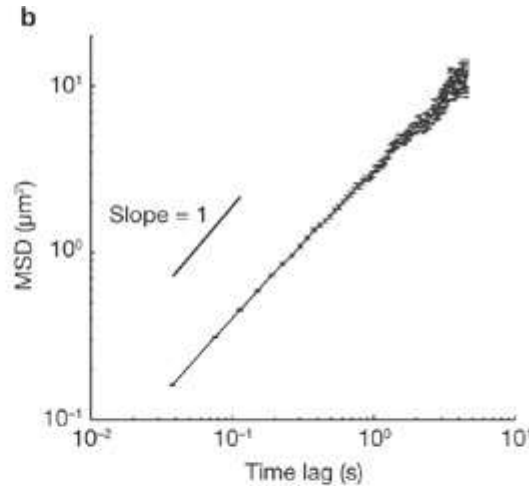
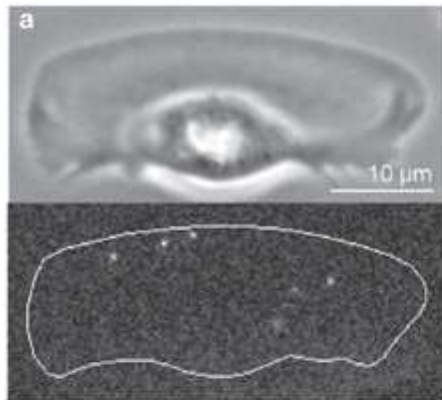
SICM for Hydrodynamic Molecule Trapping



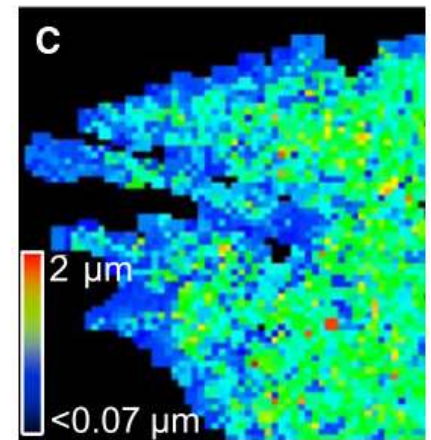
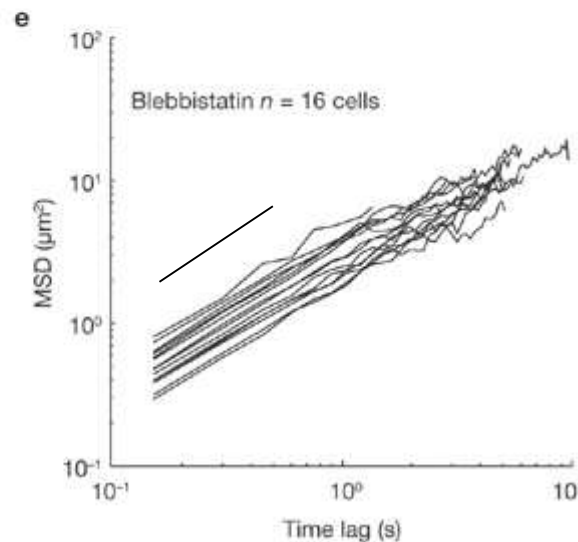
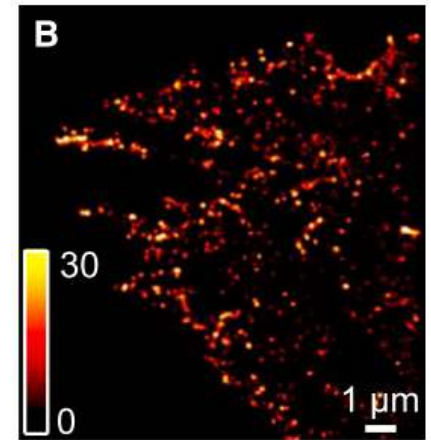
Jönsson *et al.* PNAS **188** (2012)
Johansson *et al.* Chem. Phys. Chem. **15** (2014)

Hindered diffusion in the cytoplasm

Single-particle tracking in live fish keratocyte



Super-resolution single-particle tracking in live fibroblast

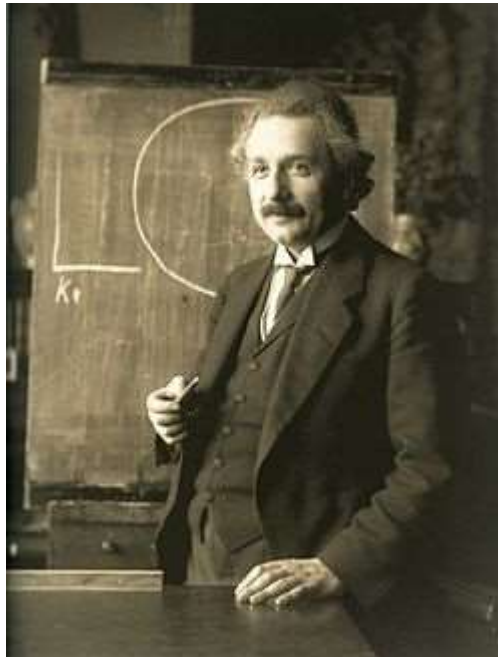
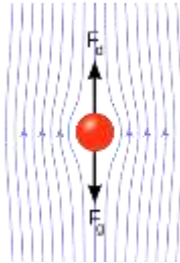


Keren *et al.* Nature Cell Biology **11** (2009)
Giannone *et al.* Biophys. J. **99** (2010)

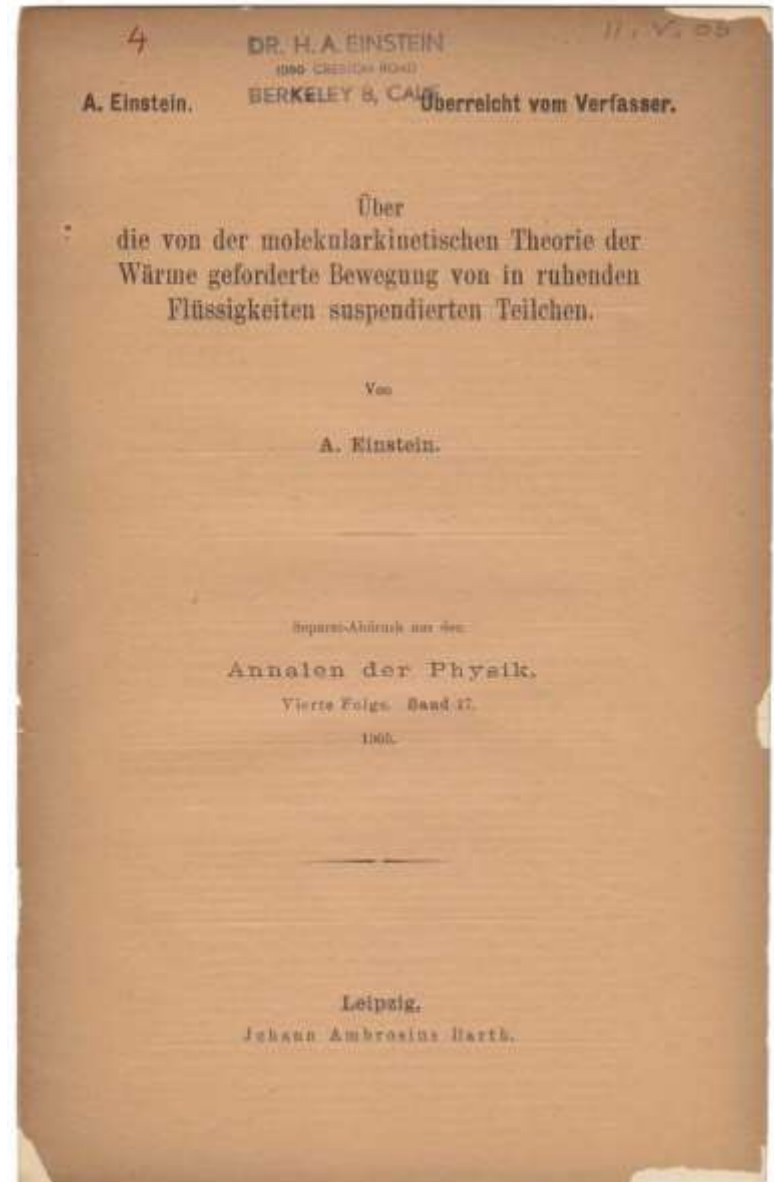
Diffusion

Stokes-Einstein Equation

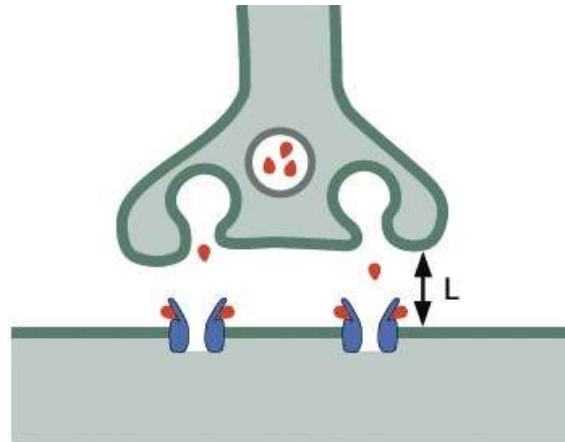
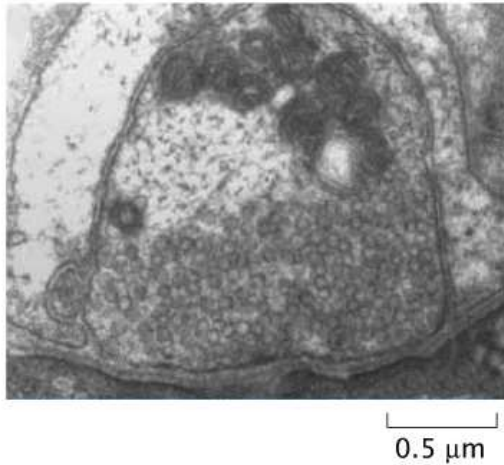
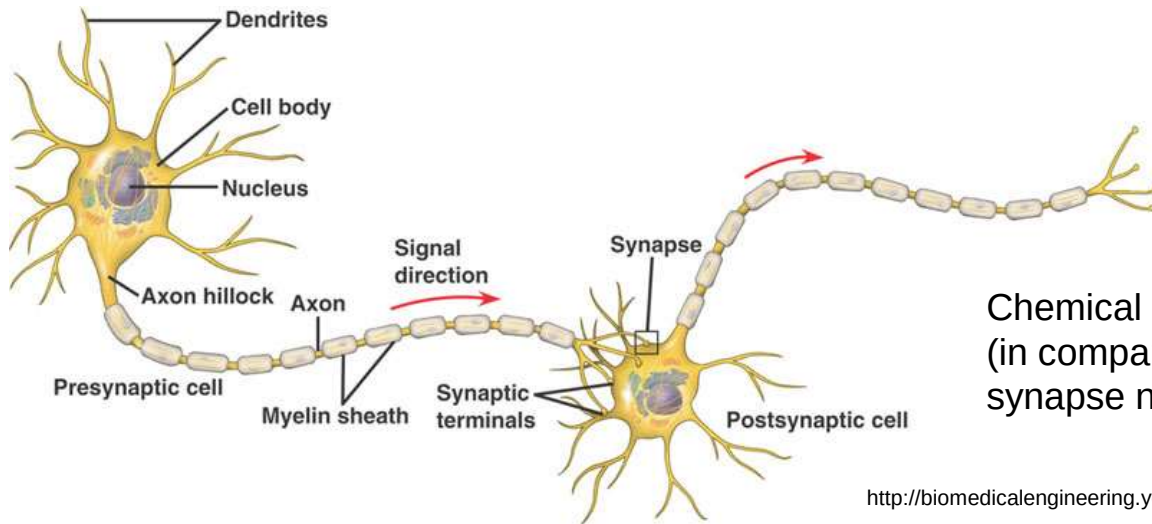
$$D = \frac{k_B T}{6\pi \eta r}$$



http://www.bhm.ch/de/news_04a.cfm?bid=4&jahr=2006

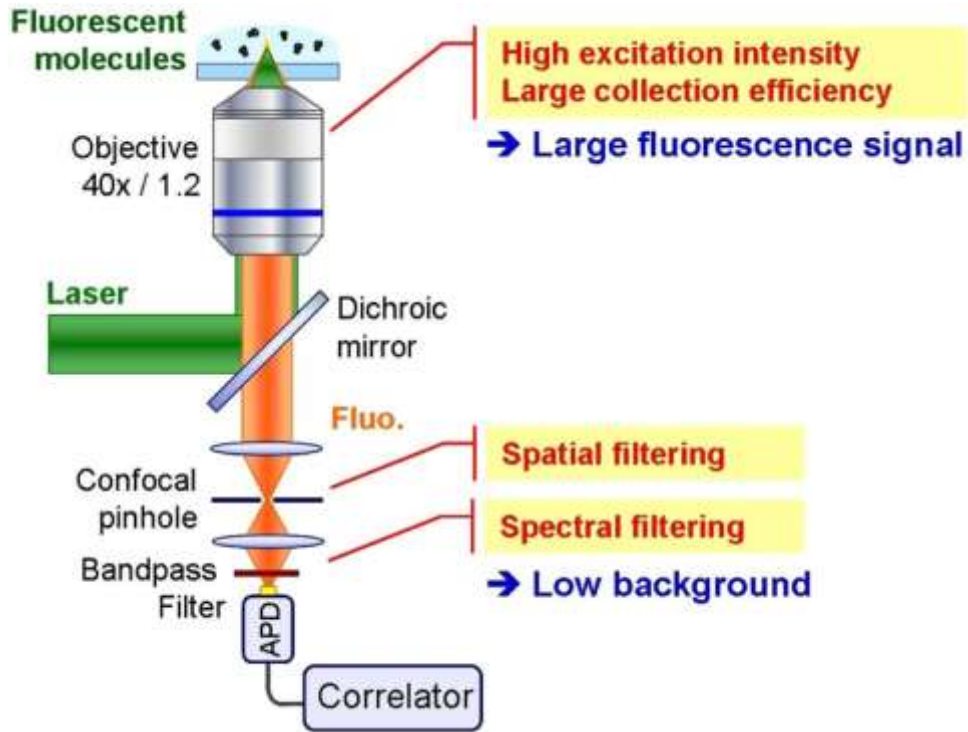


Diffusion in the Synaptic Gap



Time for neurotransmitter
($D \approx 100 \mu\text{m}^2/\text{s}$) to diffuse
 $L \approx 20 \text{ nm}$ is $t_0 \approx 10 \mu\text{s}$!

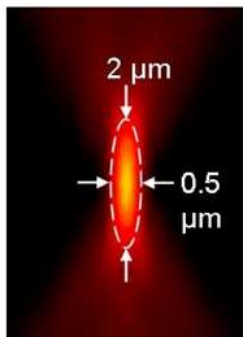
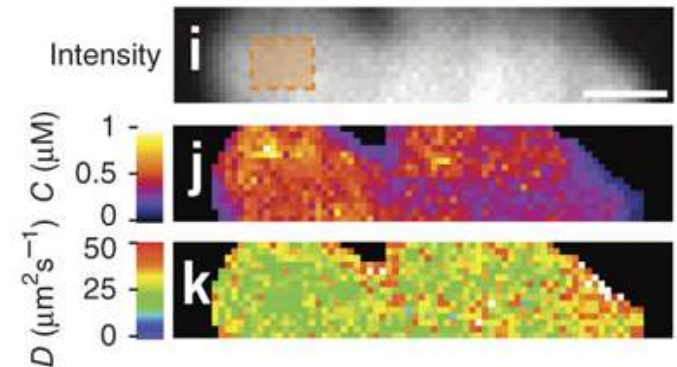
Fluorescence Correlation Spectroscopy (FCS)



Principle / theory

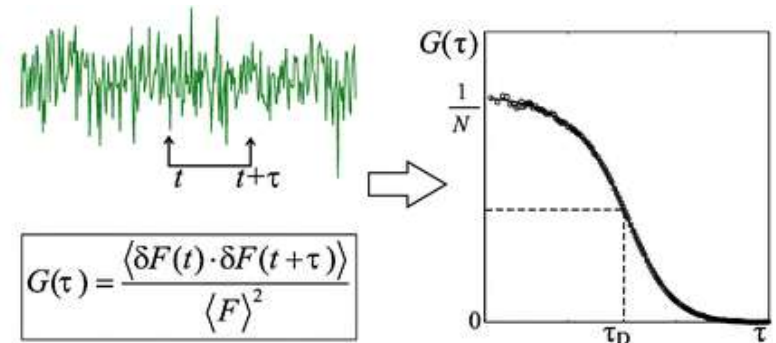
Applications

Further developments



$$V_{\text{eff}} = \pi^{3/2} w_{xy}^2 w_z$$

$$D = w_{xy}^2 / 4\tau_D$$



Diffusion

Typical demonstration experiment: Add ink to water and wait (here 30 min)

