

***In Vivo* Studies with Optical Tweezers**

Lene B. Oddershede

Niels Bohr Institute
University of Copenhagen
Blegdamsvej 17
2100 Copenhagen, Denmark

Using optical tweezers combined with image analysis we investigate motility of single proteins in membranes and of organelles inside living cellular organisms. The talk will begin with an overview of technical improvements performed [1], these improvements being essential for extracting biological information and for 3D optical control of individual silver or gold nanoparticles and quantum dots. The two biological organisms investigated are *E. coli* bacteria and *S. pombe* fission yeast cells, one key issue being that the organisms are kept alive and healthy. To this end, we present viability studies of how the presence of optical tweezers might influence the physiological state of bacteria [2].

By specifically attaching a bead to a single protein, the lambda receptor, which is a porin in the outer membrane of *E. coli* bacteria, we revealed its nanoscale diffusional motion and proposed a model, that allows for extraction of the characteristic physical parameters including the diffusion constant [3]. Protein mobility is crucially dependent on the physiological state of the bacteria, if the organism is alive, the diffusion of the proteins is significantly enhanced in comparison to the diffusion in dead membranes kept at the same temperature. In other words, there is an additional energetical contribution to diffusion other than pure thermal motion.

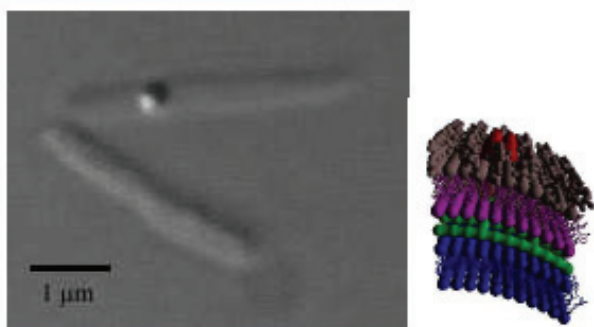


Figure 1: Left: Picture of *E. coli* bacteria with a bead attached to a lambda receptor. Right: Drawing of the bacterial outer membrane with the lambda receptor inserted.



Figure 2: *S. pombe* yeast cells with membrane systems and chromatin inside the nucleus fluorescently marked.

Previously, we investigated diffusion of naturally occurring lipid granules inside a living *S. pombe* yeast cell [4]. At short time scales, from 10^{-4} to 1 sec, the granules typically performed subdiffusive motion, probably because their motion was restricted by polymer networks and membranous structures. At longer times scales, other types of motion related to the biological function of the cell, such as confined motion and super diffusion, also occurred. Using a library of fission yeast with different molecules and cellular structures fluorescently marked, we are presently investigating the diffusional motion of chromatin within the nuclear envelope. For these studies, optical tweezers are a unique tool because they provide quantitative information about the intra cellular environment, information which cannot be obtained by other methods, and the optical damage performed on the system can be minimized such that it is not essential.

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