High-speed imaging of rotational diffusion of a gold nanorod on a supported lipid bilayer

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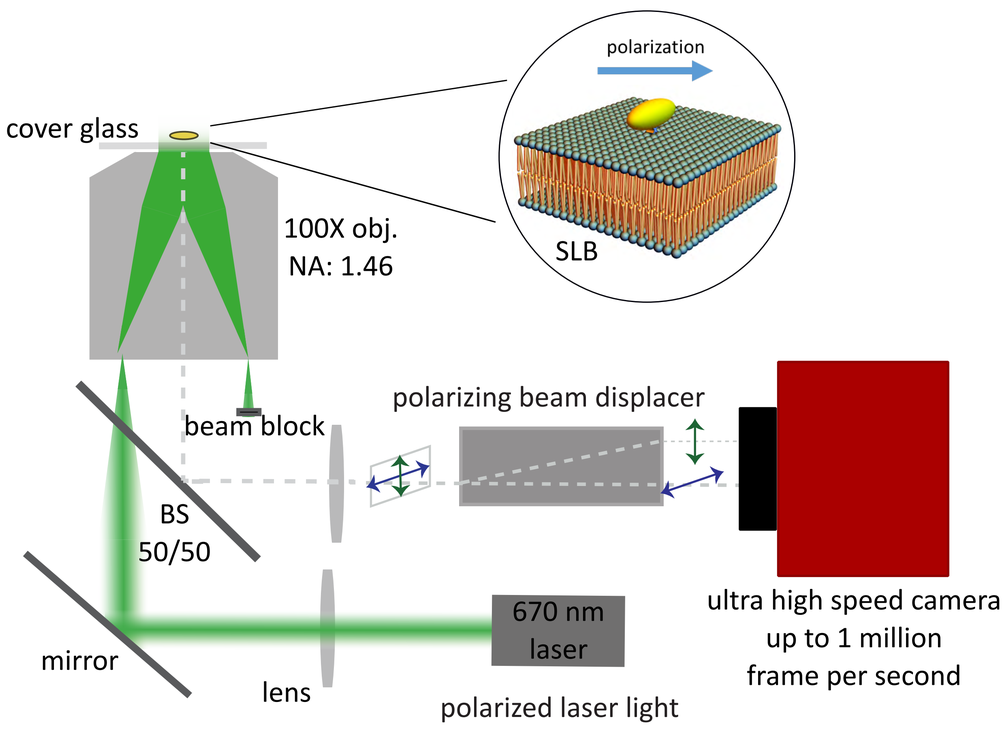
INTRODUCTION

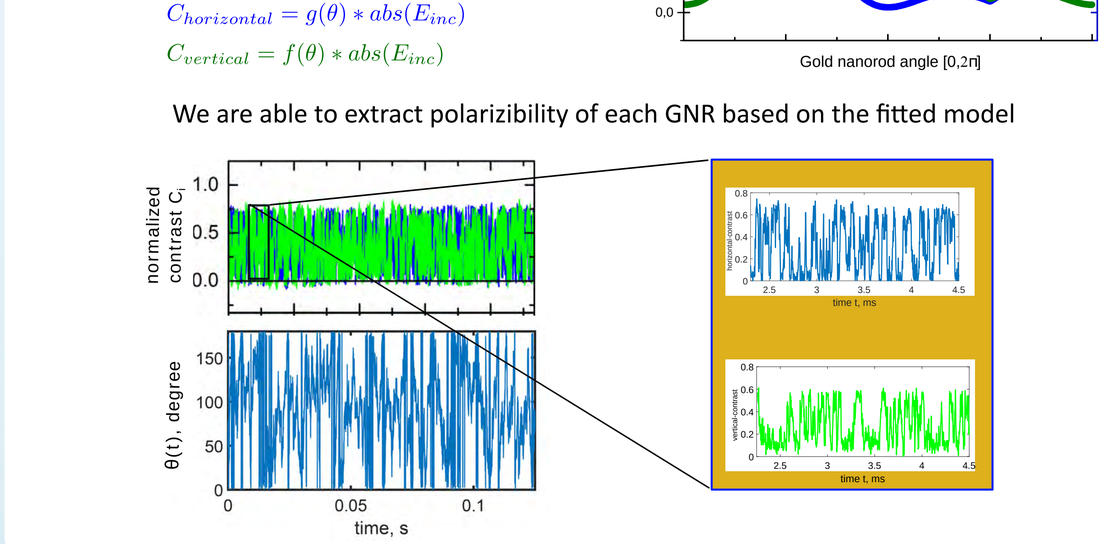
Many of the important functions of biomembranes depend on its fluidity because it determines the translational and rotational motion of lipids and membrane proteins. In this work we use polarization sensitive total internal reflection dark field microscopy (pol_TIRDF Microscopy) to study the lateral and rotational diffusion of gold nanorods (GNRs) linked to an artificial supported bilayer lipid membrane.

Streptavidin-conjugated gold nanorods of length 70 nm and diameter of 25 nm were attached to headgroup-biotinylated DOPE lipids in DOPC supported lipid bilayers. GNRs were illuminated with laser light and their scattered light was detected on a fast camera after separating various polarization components. By monitoring the time-dependent polarization of the detected signal, rotational and lateral diffusion of individual GNRs is imaged. Specifically, we can determine the angular orientation and center of mass position of the rod with microsecond temporal resolution. Using this approach, one can infer information on the physical properties and local dynamic behavior of the membrane such as local viscosity, short-range diffusion, and compositional heterogeneity.

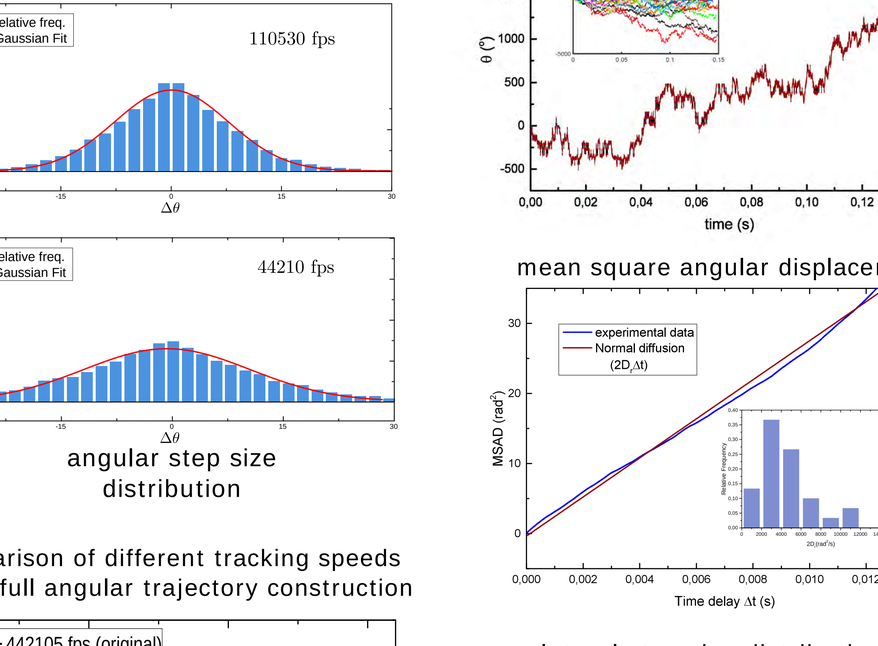
POLARIZATION-SENSITIVE TOTAL INTERNAL REFLECTION DARK-FIELD MICROSCOPY



ILLUMINATING THE SAMPLE WITH LINEARLY POLARIZED LIGHT ALLOWS FOR DETERMINING THE ORIENTATION OF A GOLD NANOROD

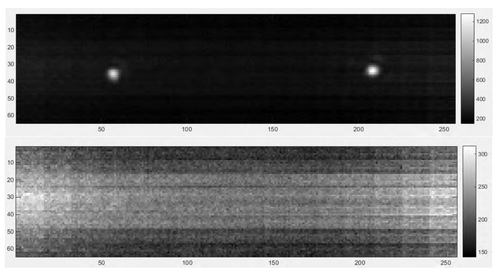


We are able to extract polarizibility of each GNR based on the fitted model

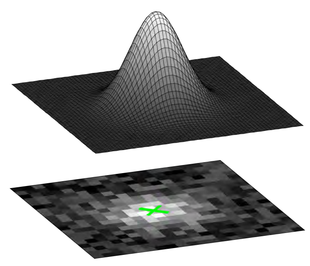


HIGH-SPEED LOCALISATION OF A GNR UP TO 1Mfps

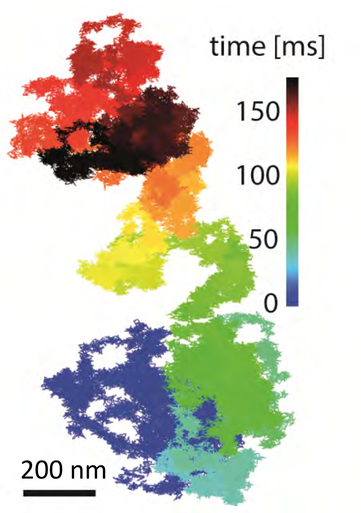
a frame on the camera showing two polarization intensities



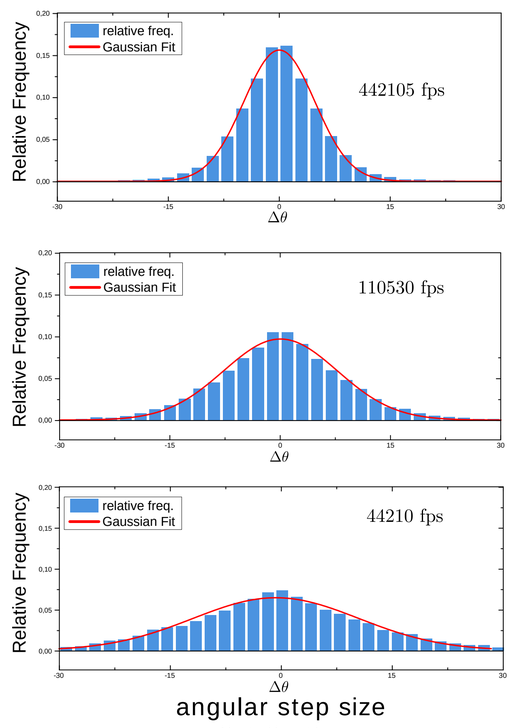
2D Gaussian fit to the PSF



lateral diffusion



ULTRA-FAST OBSERVATION OF THE FULL ANGULAR TRAJECTORY OF A GOLD NANOROD

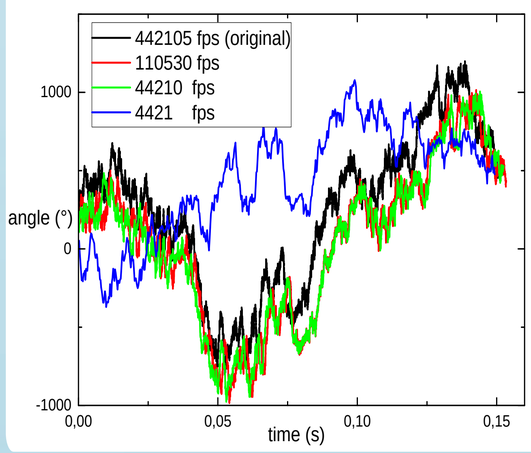


angular step size distribution

only with high speed tracking of a GNR, which results in small angular displacement between consecutive frames, its full angular trajectory can be constructed.

mean square angular displacement

comparison of different tracking speeds on the full angular trajectory construction



lateral step size distribution of a GNR along its long and short axes