Building nanoscale orientation sensors

(M.Sc. project)

Main question

What is the information enclosed in the light scattered by a nanoscale particle regarding its orientation?

Description

Nanoscale sensors can provide information about the processes at sub-100-nm scale. Such processes are omnipresent in nano-science and biophysics. Tethered particle moton, for example, uses a nanoscopic reporter attached to a biomolecule of interest in order to monitor the dynamics of the molecule. Interestingly, both translational and rotational dynamics can be monitored in real time by tracking an anisotropic particle such as a gold nanorod. However, understanding the influence of the detection noise is essential for any practical application.

In this project, you will theoretically investigate the information enclosed in polarized images for a sub-wavelength anisotropic particle drowned in a heterogeneous background. Numerical simulations will be developed from an existing code, which associates an elegant electromagnetism formalism based on Green functions with elements from Fisher information theory, which is a robust mathematical way of estimating maximum extractable information in a dataset. In the experimental part of this project, you will use a special dark-field microscope to validate the theoretical predictions.

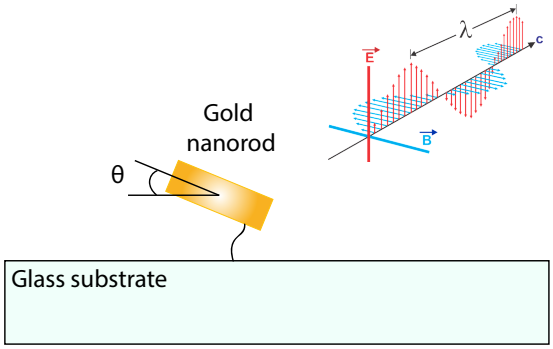

Figure 1: Schematic view of a gold nanorod linked to a glass substrate. The orientation of the nanorod is to be retrieved from the scattered intensity.

Research group

You will join an active Photonics group, which investigates and explores non-conventional methods of imaging in scattering materials by integrating concepts from distinct fields such as space-time wavefront shaping, compressive sensing, adaptive optics and optical metrology.

Requirements

- solid theoretical knowledge in electrodynamics
- motivation to learn elements from information theory
- ability to both work as a team member and to work independently

Contact

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