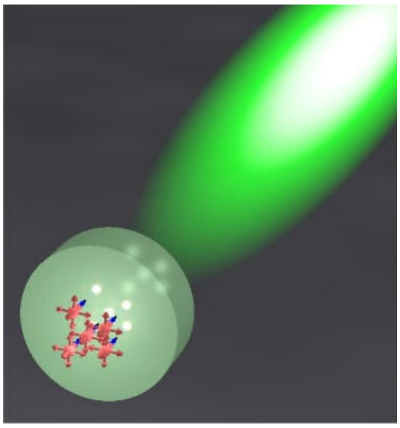
Doktorarbeit

“Controlling light emission by dielectric nanoantennas”



Antennas are all around in our modern wireless society: they are the front-ends in satellites, cell-phones, laptops and other devices establishing communication by sending and receiving electromagnetic waves. While all these devices typically operate at frequencies from 300 GHz to as low as 3 kHz, according to Maxwell’s equations the same principles of directing and receiving electromagnetic waves should work at various scales independently of the wavelength. Thus, one may naturally ask “Can an antenna send a beam of light?” And the answer is that this can indeed be accomplished using nanoscale antennas.

However, nanoantennas have even more to offer than this: They can concentrate light in ultra-small nanoscopic volumes, thereby strongly enhancing its interaction with nanoscale matter. Plus, they can efficiently link these spatially localized near fields with propagating optical fields and, by reciprocity, the other way round. Based on these principles nanoantennas are expected to play an important role in key applications like efficient quantum-light sources, photovoltaics, nonlinear optics, single-molecule detection, and as transmitting and receiving devices for on-chip optical networks. Yet, given the small dimensions of nanoantennas, their precision fabrication still remains a challenge and relies on state-of-the-art nanotechnology.

Even more severely, unlike at radio frequencies metals exhibit strong absorption losses at optical frequencies, intrinsically limiting the nanoantenna performance. A new route to overcome this problem is offered by dielectric nanoantennas, which can have very low losses at optical frequencies. However, low losses are by far not the only motivation to investigate dielectric nanoantennas! Recent theoretical studies show that their strong multipolar Mie-type resonances make them particularly interesting for controlling the emission from new types of nanoscale emitters supporting higher order electromagnetic transitions.

The objective of this doctoral project is the experimental realization of coupled photonic systems consisting of nanoscale emitters and dielectric nanoantennas, and the development of the optical setups for their characterization.

In this doctoral project the following techniques will be applied/developed:

- Photoluminescence spectroscopy and time-resolved photoluminescence
- Back focal plane imaging of emission
- Numerical simulations for dielectric nanoantenna design and optimization
- Nanofabrication and precise positioning of nanoscale light emitters

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The Functional Photonic Nanostructures Junior Research Group will start activities at the Abbe Centre of Photonics and the Institute of Applied Physics, Friedrich Schiller University, Jena, on 01.07.2015. The planned start date for this doctoral project is between July and October 2015. Please also consult our website for upcoming opportunities. Our current focus is on high-index dielectric nanoparticles and on deriving optical functionality from their unique optical properties.