“Tailoring the optical response from photonic nanostructures”

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Abstract:

Photonic nanostructures are small objects that strongly interact with an external electromagnetic field. They give rise to a notable scattering response in a narrow spectral region, they enhance the amplitude of light in their close vicinity, and they modify the local density of electromagnetic states; hence changing the optical environment as perceived by quantum emitters.

Generally, a multipole expansion is a suitable tool to discuss the optical response from photonic nanostructures. There, either the scattered field or the current distributions induced by an external field are expanded in a suitable base that can be discussed on physical grounds. For long time, scatterers characterized by only electric and magnetic dipole moments where considered and the corresponding scatterers were rather simple. However, modern nanofabrication technology provides nanostructure with an unprecedented complexity that unlocks many degrees of freedom in tailoring and designing the multipolar response. Here, we survey the field and summary our latest contributions. In particular, we will discuss scatterers that are dominated in their response by electric dipole and electric quadrupole moments. The carefully balance of their amplitudes and the resulting interference enables highly directive optical nanoantennas. Having additionally

nanoantennas available that lack mirror symmetry enables directional dependent effects. We also shed light on the nature of toroidal multipole moments. This is a recently re-explored class of multipole moments thought to be not considered in an ordinary multipole expansion that only studies electric and magnetic multipole moments. Eventually, we also analyse dual scatterers that possess a drastically different response to light with different helicity. This paves the way for various applications in the interaction of light with chiral matter.

Biography:

Carsten Rockstuhl received the Ph.D. (Dr. rer. nat.) degree from the University of Neuchâtel, Neuchâtel, Switzerland, in 2004. His work there focused on the investigation of light fields around micro- and nano-optical structures.

After a PostDoc period at AIST in Tsukuba, Japan, he has been since 2005 with the Friedrich Schiller University of Jena, Jena, Germany first as a research assistant and later as a Junior Professor. In 2013 he was appointed full professor at the Karlsruhe Institute of Technology, Karlsruhe, Germany. There, he is heading groups at the Institute of Theoretical Solid State Physics and the Institute of Nanotechnology. His research interests cover many aspects in the context of theoretical and computational nanooptics. Among others, he works on metamaterials, photonic crystals, near-field optics, plasmonics, and quantum optics at the nanoscale. Dr. Rockstuhl is a member of the Optical Society of America and the German Physical Society. He serves the community as an editor with multiple journals, is currently the coordinate of the EUPROMETA, a doctoral school on Metamaterials, and is the organizer or co-organizer of various conferences.