Workshop
"Structured Light and its Applications"
TU Braunschweig, June 12th 2024

Abstracts of the presentations

"Singular modes of light in dynamic random media"

David Bachmann, Mathieu Isoard, Vyacheslav Shatokhin, Giacomo Sorelli, Andreas Buchleitner (Albert-Ludwigs-Universität Freiburg)

We investigate the propagation of structured light through dynamic random media, such as the Earth's atmosphere or underwater turbulence, and refine the methods for accurate numerical simulation or table-top experiments by introducing novel hybrid phase screens. Within this framework, we show that instantaneous spatial singular modes of light offer improved high-fidelity signal transmission compared to standard encoding bases, resulting for Kolmogorov turbulence in a subdiffusive decay of transmitted power in dependence of time.

"Chiral/helical Bessel beams"

Jamal Berakdar (Martin-Luther-Universität Halle-Wittenberg)

I will present some ideas and simulations on how to convert optical spin angular momentum into orbital one via near fields engineering and discuss how in this way chiral/helical fields can be tuned for chirality-selective driving of chiral objects.

"A numerical study of high angular momentum vortex electron beams in crystals"

Christian Bick (PTB)

Electron vortex beams (EVB) have interesting possible applications in electron microscopy, which necessitate a better understanding of the beam behaviour in matter. We present a numerical study of the behaviour of EVB with an angular momentum of $l > 1$ in hafnium dioxide focusing on change of orbital angular momentum and beam shape inside the crystalline matter.

"The Talbot effect for Twisted Light"

Robert Fickler (Tampere University)

Twisted light, i.e. light fields with azimuthal phase gradient, have become a versatile tool to explore fundamental optics effects and explore novel applications in classical and quantum optics. In the talk, I will present our recent studies on utilizing twisted light inside ring-core and step-index multi-mode fibers to observe the fundamental optics effect known as the Talbot effect. The Talbot effect describes the self-imaging phenomenon of periodic waves, which in our case means that the complex interference between multiple different twisted light fields result in a self-imaging in the angular coordinate. We show that this twisted Talbot not only appears in specialized ring-core fibers but also for so-called whispering gallery modes in standard step-index multimode fibers. In addition, we demonstrate that it can be used to implement higher-order beams splitters, which become more compact the higher the splitting ratio. Finally, we link the angular Talbot effect to its Fourier-analog in orbital angular momentum space and describe how combining both can be used to vastly increase the control over structured light fields and it allows the realization of a mode sorting scheme that is theoretically free from cross-talk.

"Scattering of twisted electrons on atoms"

Stephan Fritzsche (Helmholtz Institute Jena and University of Jena)

The electronic structure of atoms and ions often determine details in their interaction with particles and light. This applies especially for the impact of twisted electrons and photons. We here show how this "twist" can be implemented and utilized within JAC, the Jena Atomic Calculator [1].

[1] https://github.com/OpenJAC/JAC.jl

"Twisted light emitted by photonics integrated into an ion trap"

Markus Kromrey (PTB)

Integrated photonics make ion trap setups scalable to large numbers of ions, help to compactify the setup and improve the robustness against vibrations for portable optical clocks and quantum sensors. We are developing ion traps with integrated photonics for quantum metrology. With photonic design structured light can be generated that, combined with improved pointing stability, enables the excitation of forbidden transitions in trapped ions. For the cooling and addressing of Yb^+ ions wavelengths from UV to NIR are required. The light is coupled in from optical fibers, distributed via waveguides, and coupled out through the surface of the chip via gratings. We present our first data on the shape of a structured light beam that is focused on the ion's position. Our aim is to employ the traps in portable optical clocks that can be used for geodetic measurements.

"Interaction of vector light beams with atoms in a time-dependent magnetic fields"

Shreyas Ramakrishna (Helmholtz Institute Jena)

In this talk, I will discuss our recent findings on the interaction of vector light beams with atoms in the presence of time-dependent magnetic fields. The results of this work suggest that we can use this method to determine the strength and frequency of the oscillating magnetic field by looking at the absorption profiles of the vector light beam.

"Propagation of vector beams in magnetized atomic media"

Riaan Philipp Schmidt (PTB) and **Richard Aguiar Maduro** (University of Glasgow)

We investigate experimentally and theoretically the potential application of structured vector light for polarization spectroscopy especially in pump-probe systems. It will be shown that the transmission of the structured vector beam through the atomic sample in the presence of an external magnetic field is very sensitive to the polarization and frequency of the incident radiation. The outcome of our research can open up new opportunities for employing vector light in laser frequency locking schemes.

"Simulating Twisted Light Propagation and Applications using Raman scattering"

Denis Ukolov, Silvia Müllner, and Peter Lemmens (TU Braunschweig)

The simulation of twisted light, or optical vortices, is motivated by the complexities of its theoretical description. This presentation outlines the use of MEEP software to simulate twisted light propagation, addressing the challenges encountered during the process. Several examples of Laguerre-Gaussian beams will be presented to illustrate the method.