Institute of Applied Physics
Friedrich-Schiller-Universität Jena

Structured light for material processing

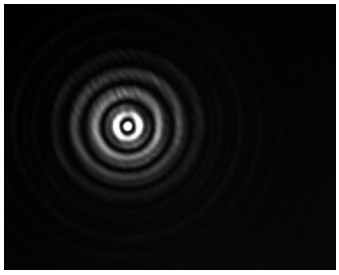
Theme / Problem definition:

Intense ultrashort pulses are capable of permanently modifying transparent materials by triggering a strong nonlinear response via multiphoton absorption, a process sometimes called nonlinear photolithography. The optical properties of a material -e.g. glasses- can then be locally modified at will, for example inscribing refractive index distributions, or even making the material locally anisotropic. On the other side, structured light is the capacity to shape the spatial degrees of freedom of an optical beam, generating for example higher order Gaussian beams, vortex beams, Bessel beams, flat-top beams, and so on. Thus, structured light represents an additional degree of freedom in nonlinear photolithography, potentially improving the yield of the process and also potentially permitting the writing of new kind of structures using ultrashort laser pulses.

Tasks / Aim:

We are looking for a motivated and self-driven candidate who will work in the area of structured light for the laser-based inscription of photonic devices. The aim of the project is to investigate the use and potential impact of complex beam profiles in writing 3D structures in transparent materials.

- Learning to use (automization via a Python-based interface) a liquid-crystal spatial light modulator to shape an optical beam at will.
- Modelling of the propagation of the structured beam in the linear regime.
- Writing waveguides in glass using structured light.
- Inscribing anisotropic structures with controllable orientation and retardation.
- Generalization to the case of polarization-varying beams.
- Knowledge in Python is desirable.



Bessel beam generated using a phase-only spatial light modulator.

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Literature:

- *Forbes, A., de Oliveira, M., Dennis, M.R. 2021. Structured light. Nature Photonics, 15, pp. 253-262*
- *Malinauskas, M., Zukauskas, A., Hasegawa, S., Hayasaki, Y., Mizeikis, V., Buividas, R., Joudkazis, S.. 2016. Ultrafast laser processing of materials: from science to industry. Light: Science & Applications, 5, e16133.*
- *Salter, P.S., Booth, M.J., 2019. Adaptive optics in laser processing. Light: Science & Applications, 8, 110.*