Institute of Applied Physics
Friedrich-Schiller-Universität Jena

# Behavior of geometric phase in longitudinally-variant anisotropic materials

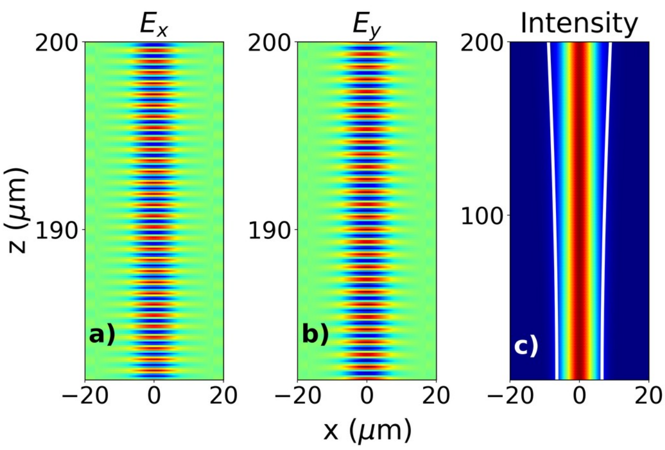
## Theme / Problem definition:

The phase of an optical field is usually changed by modifying the optical path. Basic optical modulators are indeed based upon the control of the refractive index. Rcently a new approach to phase modulation based upon geometric phase has been established. In essence, light propagating in a rotated anisotropic material acquires an additional phase delay proportional to the local rotation angle. Whereas large attention has been dedicated to the case of longitudinally invariant materials, few works discussed the case when the rotation angle varies along the propagation direction.

## Tasks / Aim:

We are looking for a motivated and self-driven candidate who will work in the area of optical modulation based upon the geometric phase. The aim of the project is to explore how longitudinally-dependent rotations affects light propagation, and which new functionalities can be achieved.

- Use FDTD (open access MEEP, python interface) and FEM commercial solver (COMSOL) to simulate light propagation in inhomogeneous anisotropic materials.
- Characterizing the polarization evolution for a CW plane wave propagating in a short anisotropic material rotated in a sinusoidal fashion along the propagation direction.
- Addressing the dispersive properties of this configuration.
- Comparison with the Jones formalism.
- Apply the previous results to the transversal modulation of finite-size beams.
- The candidate is expected to have basic knowledge on optical anisotropic materials.
- Knowledge in Python or any other programming language is desirable.




Light propagation in a twisted anisotropic material subject to a longitudinal rotation along the propagation direction. (a-b) Snapshot of the electric field. (c) Corresponding intensity distribution. In this case the geometric phase induces light confinement.

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*Literature:*


- *Jisha, C.P., Nolte, S. and Alberucci, A., 2021. Geometric phase in optics: From wavefront manipulation to waveguiding. Laser & Photonics Reviews, 15(10), p.2100003.*
- *Jisha, C.P., Arumugam, S.V., Marrucci, L., Nolte, S., and Alberucci, A., 2022. Waveguiding driven by the Panchartnam-Berry phase, arXiv:2209.01918.*
- *Bhandari, R., 1997. Polarization of light and topological phases. Physics Reports, 281(1), pp. 1-64.*