



PhD on Quantum-enhanced polarization-based sensing

Polarization-resolved light-matter interaction has long been a cornerstone of remote sensing, materials analysis, and biomedical diagnostics. By examining how a sample modifies the polarization state of light, one can access rich structural and functional information such as morphology, chirality, or birefringence with high precision. Advances in quantum photonic sensing are pushing these capabilities far beyond the limits of classical polarimetry [1]. Polarization-based sensing with non-classical state of light offers the potential for enhanced sensitivity, improved signal-to-noise ratio, higher accuracy, and deeper probing into complex or highly scattering media. At the same time, quantum approaches are opening entirely new sensing concepts, where non-classical states of light enable diagnostic metrics that remain inaccessible to classical techniques. This emerging field of quantum polarimetry provides a fertile research landscape for exploring the mechanisms behind the interaction of non-classical states of light with sample under study and developing novel sensing strategies.

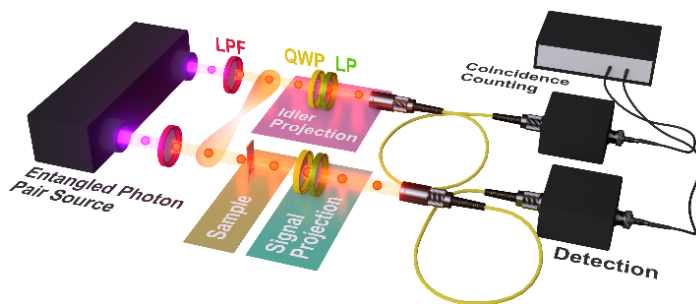
This doctoral project will build on the studies of the group on quantum-enhanced polarization-based sensing [e.g., 2–5] and will aim at experimental realization of quantum-enhanced and quantum-enabled polarization-based sensing scenarios toward achieving quantum advantage in sensing real complex samples.

In this doctoral project the following techniques and tasks will be applied and developed further:

- Design, experimental realization and characterization of different entangled states
- Development and realization of optical setups for quantum-enhanced polarimetric measurements
- Development and realization of sample-tailored sensing protocols

Required qualification:

- Master in physics, photonics, electrical engineering, or comparable.
- Previous experience in optical and /or laser lab would be a clear advantage.
- Additional knowledge in areas such as biology, biophysics, or chemistry would also be beneficial.



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Further information: www.acp.uni-jena.de/besaga

1. L. Zhang, C. Zou, Y. Wang, F. Setzpfandt, V. R. Besaga, "Polarization in quantum photonic sensing [Invited]," *Chin. Opt. Lett.* 23(9), 092701 (2025).
2. V. R. Besaga, L. Zhang, A. Vega, P. S. Chauhan, T. Siefke, F. Steinlechner, T. Pertsch, A. Sukhorukov, F. Setzpfandt, "Nonlocal quantum differentiation between polarization objects using entanglement," *APL Photonics* 9 (4), 041301 (2024).
3. L. Zhang, V. R. Besaga, P. Rühl, C. Zou, S. H. Heinemann, Y. Wang, F. Setzpfandt, "Probing polarization response of monolayer cell cultures with entangled photon pairs," *J. Biophoton.*, e202400018 (2024).
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5. A. Pedram, V. R. Besaga, L. Gassab, F. Setzpfandt, Ö. E. Müstecaplıoğlu, "Quantum estimation of the Stokes vector rotation for a general polarimetric transformation," *New J. Phys.* 26, 093033 (2024).