PhD on Quantum polarimetry with structured light

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. One of the key directions in this emerging field lies in identifying measurement strategies that maximize the information extractable from samples, where in particular structured states of light [2–3] promise advantageous sensing performance.

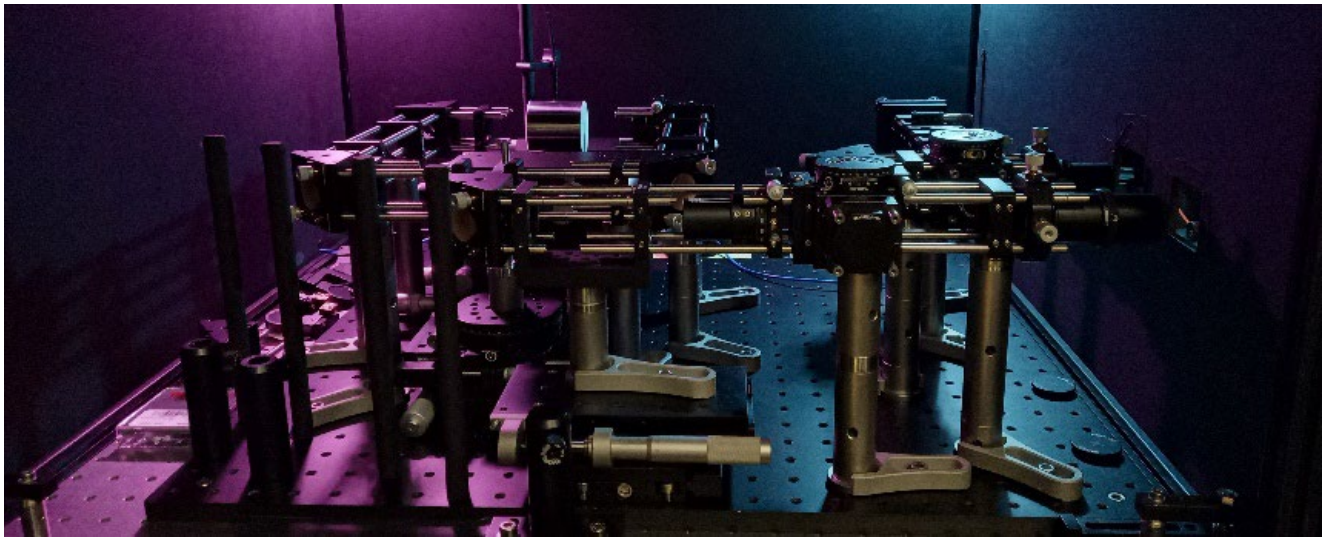
This doctoral project will explore the plethora of non-classical states of light combined with features of structured light – to assess their potential advantages in different sensing scenarios [4–5].

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

- Design, modelling and experimental realization of structured states of light at the level of few photons
- Comprehensive investigation of the properties of such states of light
- Development and realization of sensing scenarios for quantum-enhanced polarimetry using structured light in combination with quantum resources

Required qualification:

- Master in physics, photonics, electrical engineering, or comparable.
- Previous experience in optical and /or laser lab would be a clear advantage.
- Skills in computational physics methods would also be beneficial.



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2. A. Forbes, M. De Oliveira, and M. R. Dennis, “Structured light,” Nat. Photonics 15, 253 (2021).
3. C. He, Y. Shen, and A. Forbes, “Towards higher-dimensional structured light,” Light Sci. Appl. 11, 205 (2022).
4. 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).
5. A. Pedram, V. R. Besaga, F. Setzpfandt, Ö. E. Müstecaplıoğlu, “Nonlocality enhanced precision in quantum polarimetry via entangled photons,” Adv Quantum Technol., 2400059 (2024).