PADERBORN UNIVERSITY

Photonics Lecture

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Sensing with Undetected Photons in the Mid-Infrared

Sensing in the mid-infrared (MIR) holds the promise for new perspectives on problems of scientific and industrial relevance. By harnessing the highly-specific vibrational ‘fingerprints’ of molecules as a contrast mechanism, MIR light offers pathways to label-free microscopy, while the reduced scattering extends the reach of technologies like optical coherence tomography (OCT). The principle limitation, however, remains one of detection, with mid-IR detection being prohibitively expensive, technically demanding and suffering from poor sensitivity, high noise and low resolution. Additionally, MIR light sources are typically complex and costly, further hindering the development of these technologies.

In this talk, I will provide a comprehensive overview of our research on ‘sensing with undetected photons’, which is aimed at overcoming these limitations. This technique leverages quantum nonlinear interferometry to decouple th0e probe and detection wavelengths, allowing samples to be probed with MIR light while benefiting from the comparative maturity of silicon-based detection technology. Our research demonstrates the application of this method to a variety of sensing tasks in the MIR, including the spectroscopy of plastics and gases, OCT of highly scattering layered structures and imaging and microscopy of biological specimens. These advancements suggest a promising future for the deployment of sensing with undetected photons in practical settings, potentially transforming the landscape of MIR sensing technology.

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