TRR 142
Tailored Nonlinear Photonics

TRR Guest Scientist Lecture / Seminar

Date/Time: 10.06.2021 / 15:00 o'clock
Location: Online - Zoom

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Complex Structuring of Light for High-Speed Spectroscopy and High-Dimensional Quantum Optics

Abstract:

Shaping light in the spatial, temporal and spectral domain has led to many fruitful applications within the entire spectrum of optics. In this seminar, I will present two of our recent studies in this thriving branch of optics. In the first part of the presentation, I will introduce a recent investigation of classical states of light that possess a different polarization state for every wavelength, i.e. light with a complex spectral polarization structure. Modulating a femtosecond laser pulse in the time domain with a birefringent crystal, enables the generation of different polarization patterns across the frequency bandwidth in flexible and controlled manner. This correlation can then be exploited in spectroscopic measurements using only polarization analysis (see Figure 1a), which is in general simpler and faster compared more conventional spectroscopic methods. In our experiments, we track spectral modulations with read-out rates of up to 6 MHz, which is mainly limited by the speed of our frequency modulation scheme. In general, our method is capable of tracking pulse-to-pulse variations in the frequency spectrum, i.e. high-speed spectroscopic measurements with GHz read-out rates are feasible with current technologies. In the second part of the presentations, I will focus on the transverse spatial domain of light, i.e. spatial modes that are used as physical realizations of high-dimensional quantum states beneficial to various quantum information tasks. In recent studies, we demonstrated that using multi-plane light-conversion techniques enables the performance of complex unitary transformations between multiple input-modes and output-modes in the quantum regime (see Figure 1b). Using this scheme, we demonstrate various two-photon interferences, where the interference occurs along a single beamline and a photon-bunching is observed in multiple spatial modes, which is in contrast to many previous studies, where the two photons are bunching into different paths. Finally, we show that the ability to generate OAM-carrying NOON-states, which are known to offer phase super-sensitivity, translates to angular super-sensitivity, which not only scales with the OAM value but also the number of involved photons

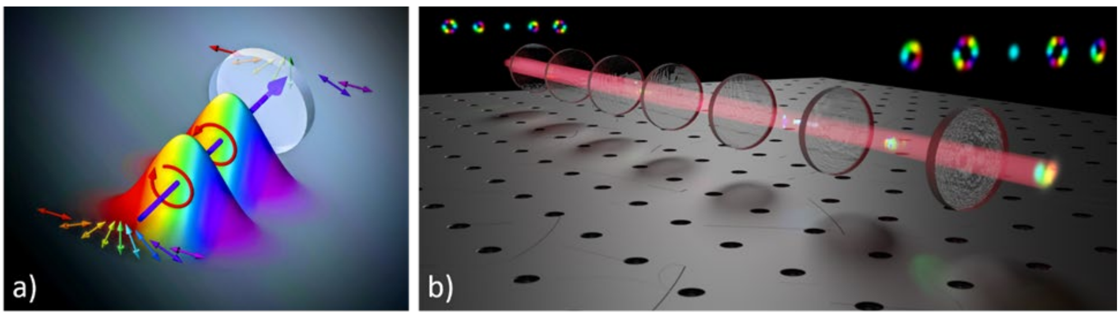

Figure 1: a) A coherent superposition of two pulses, each with orthogonal circular polarization, leads to a polarization change across the frequency spectrum, which enables spectroscopic sensing. b) Using multiple consecutive phase modulation allows complex unitary modulations on a set of spatial modes along a single beam line.

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