Q 61: Quanteninformation (Photonen und nichtklassisches Licht II)

Zeit: Freitag 14:00–15:30 Raum: 1A

Q 61.1 Fr 14:00 1A

Spectral decomposition of quantum light — •Wolfgang Mauerer and Christine Silberhorn — University Erlangen-Nuremberg, Max-Planck Research Group IOIP, Integrated Quantum Optics Group

A growing number of applications for quantum mechanics in both computation and communication has been devised during the last years. The experimental realisation is usually performed with optical technologies. Most concepts are well understood theoretically, but they are usually based on a single-mode description. This is not the case in reality, especially when fast pulsed sources are employed. Contributions from many spectral modes are unavoidable in such regimes and need to be accounted for by the models.

Following initial work presented in Ref. [1], we develop various techniques for the analysis of multi-mode states. Special emphasis is put on how to find simple and effective multi-mode descriptions for a number of recent experiments. We demonstrate that noise which has previously been accounted to experimental imperfections can emerge from spectral effects.

We also show how to derive the Bogoliubov transformations for quadratic nonlinear interactions (e.g., parametric downconversion) from a fully quantum mechanical spatio-spectral model. This is used as a basis for further structural analysis of multi-mode quantum states with various techniques, for instance Bloch-Messiah decomposition.

[1] P. P. Rohde, W. Mauerer, and Ch. Silberhorn, New Journal of Physics **9**, 91(2007)

Q 61.2 Fr 14:15 1A

Improved methods for Polarization squeezing with photonic crystal fibers — •Josip Milanovic[1], Alexander Huck[2], Joel Heersink[1], Christoph Marquardt[1], Ulrik L. Andersen[2], and Gerd Leuchs[1] — [1]Institute of Optics, Information and Photonics, Max-Planck Research Group, University of Erlangen-Nuremberg, Guenther-Scharowsky-Straße 1, 91058, Erlangen, Germany — [2]Department of Physics, Technical University of Denmark, Fysikvej, 2800, Kgs. Lyngby, Denmark

Squeezing or quantum noise reduction of optical states in glass fibers has been chronically afflicted by the large phase noise from Guided Acoustic Wave Brillouin Scattering (GAWBS). This excess noise is one of the main effects that decrease the purity of the quantum states. In previous experiments we have already shown that Photonic Crystal Fibers (PCFs) represent a promising new approach to reduce this noise.

At a squeezing level of -3.3 ± 0.3 dB at 810 nm the purity of the squeezed state was three times higher than in experiments with standard telecom fibers. A major problem is that the dispersion properties for different axes are not identical. Due to the different spectral evolution of the pulses in the PCFs the interference of squeezed pulses is very low which implies a large loss in the detectable squeezing. We present improved methods which can be used to increase and detect higher levels of polarization squeezing.

Q 61.3 Fr 14:30 1A

Modal Properties of Parametric Down-conversion in the High Gain Regime — •Kaisa Laiho, Malte Avenhaus, and Christine Silberhorn — Max Planck Junior Research Group, Günther-Scharowsky-Str. 1 / Bau 24, D-91058 Erlangen

Parametric down-conversion (PDC) is widely used in the low gain regime as a source of photon pairs. It is also a promising candidate for Non-Gaussian state engineering [1]. Recently, bright waveguided PDC sources have become available. In this high gain regime it is possible to generate pairs of pairs, which can be understood as quadrature squeezing in the continuous variable picture.

The photon pairs generated in the PDC process are spectrally correlated. Although we use a broadband, ultrafast pump, the phase-matching is a limiting factor. In order to be able to define the state as a broadband single mode squeezer, it needs to be decorrelated [2]. We have studied the spectral correlations in the ultrafast regime for a 10mm long type II PP-KTP waveguide and spectrally resolved the tilted correlation function. Our measured photon statistics indicate strong multimodal behaviour. To modify the spectral correlations we have cut down the waveguide to 2.5mm length and study the modal properties by spectral filtering. Ultimately, we aim at Non-Gaussian state preparation where it is crucial to drive the state towards single mode characteristics to ensure the purity.

[1] A. I. Lvovsky *et al.*, Phys. Rev. Lett. **87**, 050402 (2001)
[2] P. P. Rohde *et al.*, New J. Phys. **9**, 91 (2007)

Q 61.4 Fr 14:45 1A

Linear optics unleashed — •Konrad Kieling[1,2] and Jens Eisert[1,2] — [1]QOLS, Blackett Laboratory, Imperial College London, Prince Consort Road, London SW7 2BW, UK — [2]Institute for Mathematical Sciences, Imperial College London, Prince's Gate, London SW7 2PE, UK

Linear optical architectures for quantum information processing are based on single-photon sources, photon-number preserving optical elements, and photon (number resolving) detectors. Due to the allowed set of tools being narrowed down, specific problems can often be cast into a mathematical framework that allows for the assessment of possible state manipulation, measurement and preparation. The measurement based nature of optical gates and the issue of encoding qubits in a way to easily access them experimentally leads to a rich structure of problems. In this talk, we will discuss issues of resource consumption in optical state preparation, optimal success probabilities, and prescriptions of how to build linear optical quantum gates and measurement devices.

Q 61.5 Fr 15:00 1A

Is the role of beam-splitters in quantum optics any different from that in classical optics? — •Daniela Denot, Lev Plimak, and Wolfgang P. Schleich — Institute of Quantum Physics, Ulm University, 89069 Ulm, Germany

A statement is often made that the role of beam-splitters in quantum optics is fundamentally different from that in classical optics [1]. This statement is based on the paper by Mandel et al [2] showing that the action of a beam-splitter on a single-photon state is turning it into an entangled state of two modes. The question we ask if there exists an experimental proof of this statement. We show that the answer is negative for all photodetection measurements with two beams involving local oscillators. To prove this we devise a Gedanken-experiment where the joint photocurrent statistics of the two detectors is fully imitated in a measurement where the incident beam is detected directly. This statement is easily proven for arbitrary classical states of the incident beam while its validity for quantum states follows from the optical equivalence theorem by Sudarshan [3].

[1] G. S. Agarwal, a talk given at the Institute of Quantum Physics, Ulm, Sept. 2007, unpublished.
[2] C. K. Hong, Z. Y. Ou, and L. Mandel, Phys. Rev. Lett., 59(18), 2044, 1987.
[3] E. C. G. Sudarshan. Phys. Rev. Lett., 10(7), 277, 1963.

Q 61.6 Fr 15:15 1A

Experimental demonstration of anyonic statistics with multiphoton entanglement — •Witlef Wieczorek[1,2], Jiannis Pachos[3], Christian Schmid[1,2], Nikolai Kiesel[1,2], Reinhold Pohlner[1,2], and Harald Weinfurter[1,2] — [1]Max-Planck-Institut für Quantenoptik, D-85748 Garching — [2]Department für Physik, Ludwig-Maximilians-Universität München, D-80799 München — [3]School of Physics & Astronomy, University of Leeds, Leeds LS2 9JT, UK

Particles in nature appear as two distinct types according to their statistics: bosons and fermions. However, if one considers only two spatial dimensions statistical behaviour ranging from bosonic to fermionic is found. Particles exhibiting such a behaviour are called anyons. Our experimental demonstration of their statistics is based on a particular two-dimensional model: the toric code proposed by Kitaev [1]. There, anyons arise as excitations that are generated by local operations. We show that for this model anyonic behaviour is revealed for as little as four qubits. This allowed us to experimentally demonstrate anyonic statistics in a quantum simulation using four-photon entanglement [2].

[1] A.Y. Kitaev, Ann. Phys. (N.Y.) 303, 2-30 (2003).
[2] J.K. Pachos *et al.*, e-print arXiv: 0710.0895 (2007).