Q 66: Quantum Information: Photons and Nonclassical Light III

Time: Friday 14:00–16:00 Location: E 214

Q 66.1 Fr 14:00 E 214

Squeezing in Radially and Azimuthally Polarized Doughnut Modes — •Christian Gabriel[1,2], Wenjia Zhong[1,2], Andrea Aiello[1,2], Peter Banzer[1,2], Dominique Elser[1,2], Michael Förtsch[1,2], Ulrik L. Andersen[1,2,3], Christoph Marquardt[1,2], and Gerd Leuchs[1,2] — [1]Max Planck Institute for the Science of Light, Guenther-Scharowsky-Str. 1, 91058 Erlangen, Germany — [2]Institute for Optics, Information and Photonics, University Erlangen-Nuremberg, Staudtstr. 7/B2, 91058 Erlangen, Germany — [3]Department of Physics, Technical University of Denmark, 2800 Kongens Lyngby, Denmark

So far experiments in quantum imaging have solely concentrated on taking advantage of the spatial properties of light. However, exploiting more than one degree of freedom, such as the spatial mode as well as the polarization, offers new opportunities to improve continuous variable quantum information processing protocols. We present a theoretical investigation of squeezed states in an azimuthally and radially polarized doughnut mode. These not only have a complex spatial but also a complex polarization structure. Squeezing in these modes is a manifestation of entanglement between two other spatio-polarization modes which are symmetric and antisymmetric superpositions of the initial modes; for example the vertically polarized TEM01 mode and the horizontally polarized TEM10 mode in the case of a quantum noise reduction of a radially polarized doughnut mode and its counter part.

Q 66.2 Fr 14:15 E 214

Recent Results and Future Challenges of Photonic Quantum Computation — •Stefanie Barz[1,2], Gunther Cronenberg[1,2], Anton Zeilinger[1,2], and Philip Walther[1,2] — [1]Faculty of Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria — [2]Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Boltzmanngasse 3, 1090 Vienna, Austria

Entangled photons are a crucial resource for quantum communication and linear optical quantum computation. Therefore the controlled generation of these fundamental states attracts a worldwide effort. The majority of current experiments is based on the production of photon pairs in the process of spontaneous parametric down-conversion, where the entangled photon pair is concluded from post-selection of randomly occurring coincidences. Here we present the heralded generation of photon states that are maximally entangled in polarization with linear optics and standard photon detection from spontaneous parametric down-conversion. We utilize the down-conversion state corresponding to the generation of three pairs of photons, where the coincident detection of four auxiliary photons unambiguously heralds the successful preparation of the entangled state. This controlled generation of entangled photon states is a significant step towards the applicability of a linear optics quantum network, in particular for entanglement distribution, entanglement swapping, quantum teleportation, quantum cryptography and scalable approaches towards photonics-based quantum computing schemes.

Q 66.3 Fr 14:30 E 214

Efficient error-proof Bell measurements for photons by coupling to a single emitter — •Dirk Witthaut[1,2], Mikhail D. Lukin[3], and Anders S. Sørensen[1] — [1]QUANTOP, Niels Bohr Institute, University of Copenhagen, Denmark — [2]Max-Planck-Institute for Dynamics and Self-Organisation, Göttingen, Germany — [3]Department of Physics, Harvard University, Cambridge, USA

We present an efficient error-proof Bell state analyzer composed of linear optical elements and a non-linear element provided by the coupling to a single emitter, which can be realized in a photonic microcavity or a surface plasmon polariton mode on a nanowire. The setup is error-proof in the sense that every detection event projects unambiguously onto one of the Bell states, and losses may lead to inconclusive, but never to wrong measurement outcomes. Even more, a large class of errors results in a full transmission of all photons, so that they can be recycled for another attempt. Efficiencies exceeding the best possible performance with linear optics are shown to be achievable with modest atom-field coupling and a simple optical setup.

Q 66.4 Fr 14:45 E 214

Engineered photon-pair generation in standard birefringent optical fibers — •Christoph Söller[1], Offir Cohen[2], Brian J. Smith[2,3], Ian A. Walmsley[2], and Christine Silberhorn[1] — [1]IQO Group, MPI for the Science of Light, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany — [2]University of Oxford, Clarendon Laboratory, Parks Road, Oxford, OX1 3PU, UK — [3]Centre for Quantum Technologies, National University of Singapore, 3 Science Drive 2, 117543 Singapore, Singapore

Photon-pair sources are a vital building block for many applications in quantum optics, e.g. quantum-communication and computation schemes. We present a photon-pair source based on spontaneous four-wave mixing in standard birefringent optical fibers. Pumping the fiber source with a pulsed Ti:sapphire laser allows generation of highly non-degenerate pair photons that can be efficiently detected with standard silicon-based single-photon detectors. By changing the bandwidth of the pump pulses we are able to control the amount of spectral entanglement and thus of spectral correlations present between the photons of a pair. This feature offers the possibility of creating completely factorable two-photon states, an important resource for linear optical quantum computing.

Q 66.5 Fr 15:00 E 214

Accessing higher order correlations by time-multiplexing — •Malte Avenhaus[1], Kaisa Laiho[1], Maria V. Chekhova[1,2], and Christine Silberhorn[1] — [1]Max Planck Institute for the Science of Light, Günther-Scharowsky-Straße 1/Bau 24, 91058 Erlangen — [2]Department of Physics, M. V. Lomonosov Moscow State University, Leninskie Gory, 119992 Moscow, Russia

The characterization of optical quantum states poses an important prerequisite for many applications like the security of quantum key distribution or the analysis of quantum sources. Here, we focus on normalized correlation functions which yield information about a state without any assumption about optical losses, rendering an intriguing approach for Fock state measurements with lossy detectors.

We experimentally measured higher order normalized correlation functions of pulsed light with a time-multiplexing-detector. We demonstrate excellent performance of our device by verifying a unity valued up to the eighth order for coherent light, and factorial dependence for pseudo-thermal light. Further, we applied our measurement technique to a type-II parametric downconversion source to investigate mutual two-mode correlation properties and ascertain non-classicality.

Q 66.6 Fr 15:15 E 214

Three-color entanglement — Antonio Coelho[1], Felippe Barbosa[1], Katiuscia Cassemiro[2], •Alessandro Villar[2,3], Marcelo Martinelli[1], and Paulo Nussenzveig[1] — [1]Instituto de Física, Universidade de São Paulo, Post Office Box 66318, São Paulo, SP 05314-970, Brazil — [2]Max Planck Institute for the Science of Light, Günther-Scharowsky-Strasse 1/Bau 24, 91058 Erlangen, Germany — [3]University of Erlangen-Nuremberg, Staudtstrasse 7/B2, 91058 Erlangen, Germany

Entanglement is an essential quantum resource for the acceleration of information processing as well as for sophisticated quantum communication protocols. Quantum information networks are expected to convey information from one place to another by using entangled light beams. We demonstrated the generation of entanglement among three right beams of light, all of different wavelengths (532.251, 1062.102, and 1066.915 nanometers). We also observed disentanglement for finite channel losses, the continuous variable counterpart to entanglement sudden death.

Q 66.7 Fr 15:30 E 214

A versatile source of polarization-entangled photons — Andreas Maser, Ralph Wiegner, Uwe Schilling, Christoph Thiel, and •Joachim von Zanthier — Institut für Optik, Information und Photonik, Universität Erlangen-Nürnberg, 91058 Erlangen

We propose a method for the generation of a large variety of entangled states, encoded in the polarization degrees of freedom of N photons, within the same experimental setup. Starting with uncorrelated photons, emitted from N arbitrary single photon sources, and using linear optical tools only, we demonstrate the creation of all symmetric states, e.g., GHZ- and W-states, as well as all (symmetric and non-symmetric) total angular momentum eigenstates of the N qubit compound. Amongst others, the scheme also enables to generate all canonical states representing the possible entanglement families of symmetric states inequivalent under SLOCC as recently defined in [1]. The technique thus comes close to the ideal of a single apparatus “that tunes in any wanted multipartite entangled state by simply turning a knob” [2].

[1] T. Bastin, S. Krins, P. Mathonet, M. Godefroid, L. Lamata, and E. Solano, PRL 103, 070503 (2009).

[2] M. Aspelmeyer and J. Eisert, Nature 455, 180 (2008).

Q 66.8 Fr 15:45 E 214

Diffraction at a blazed grating as a tool for characterizing the degree of spatial entanglement of different biphoton sources

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Correlations between photons are interesting for a number of applications and concepts in metrology, in particular for resolution improvements in different methods of quantum imaging. We demonstrate the application of a blazed grating for the characterization of the degree of spatial correlations of biphotons. For spatially correlated biphotons a new order of diffraction (OD) is observed in the far field distribution of the two photon rate behind the grating. This new OD appears at a far field angle, expected for single photons of half the original wavelength [1]. The higher the degree of spatial correlation of the biphotons, the stronger becomes this new OD. Thus the diffraction distribution behind the blazed grating can be used to characterize the spatial correlations of the biphotons. This characterization process is carried out for different biphoton sources, including spontaneous parametric down conversion in bulk crystals as well as in periodically poled MgO doped stoichiometric Lithium Tantalat (PP-MgO:SLT).

[1] M.Ostermeyer, D. Puhlmann, D. Korn, JOSA-B 26, 2347 (2009)