Q 23: Quanteninformation: Photonen II

Zeit: Dienstag 14:00–16:00 Raum: VMP 6 HS-D

Q 23.1 Di 14:00 VMP 6 HS-D

Violation of Bell's inequalities by light radiated from two independent sources — •Ralph Wiegner[1], Christoph Thiel[1], Joachim von Zanthier[1], and Girish S. Agarwal[2] — [1]Institut für Optik, Information und Photonik, Universität Erlangen-Nürnberg, Germany — [2]Department of Physics, Oklahoma State University, Stillwater, OK, USA

We study quantum interference effects of light scattered by two uncorrelated single photon sources, e.g. two trapped ions. By looking at the far-field region of the emitters we find non-classical signatures in the second order correlation function of the emitted light. First, we obtain a two-photon signal with a visibility greater than 50% [1] and, second, we can proof that our signal violates Bell-type (CH74') inequalities [2]. Since both emitters scatter incoherently, this violation gives rise to some stunning questions which we will adress.

[1] L. Mandel, Phys. Rev. A **28**, 929 (1983).

[2] J. F. Clauser, M. A. Horne, Phys. Rev. D **10**, 526 (1974).

Q 23.2 Di 14:15 VMP 6 HS-D

Experimental observation of an entire family of four-photon entangled states — •Witlef Wieczorek[1,2], Christian Schmid[1,2], Nikolai Kiesel[1,2], Reinhold Pohlner[1,2], Otfried Gühne[3,4], and Harald Weinfurter[1,2] — [1]Max-Planck-Institut für Quantenoptik, D-85748 Garching — [2]Department für Physik, LMU München, D-80799 München — [3]Institut für Quantenoptik und Quanteninformation, A-6020 Innsbruck — [4]Institut für Theoretische Physik, Universität Innsbruck, A-6020 Innsbruck

The experimental observation and characterization of multi-partite entangled states aids the development of quantum information applications and helps to gain a deeper understanding of quantum mechanical systems. Spontaneous parametric down conversion in combination with linear optics is widely and successfully used for observing these states. However, so far, experimental set-ups based on that approach were usually tailored for a single state only, see e.g. [1]. Here, we report on the experimental observation and analysis of an entire family of highly entangled four-photon states, which is given by the superposition of a four photon GHZ state and the product of two Bell states. We demonstrate how these states can be obtained within a single set-up by the tuning of a single, experimentally easily accessible parameter and analyze particular entanglement properties [2].

[1] D. Bouwmeester *et al.*, Phys. Rev. Lett. 82, 1345 (1999); Z. Zhao *et al.*, Nature 430, 54 (2004); P. Walther *et al.*, Nature 434, 169 (2005); B. P. Lanyon *et al.*, Phys. Rev. Lett. 100, 060504 (2008)

[2] W. Wieczorek *et al.*, Phys. Rev. Lett. 101, 010503 (2008)

Q 23.3 Di 14:30 VMP 6 HS-D

A Novel Method for Polarization Squeezing and Polarization Entanglement with Photonic Crystal Fibers — •Josip Milanovic[1], Mikael Lassen[1,2], Christoph Marquardt[1], Ulrik L. Andersen[1,2], and Gerd Leuchs[1] — [1]Max Planck Institute for the Science of Light, University of Erlangen-Nuremberg, Guenther-Scharowsky-Str. 1, 91058 Erlangen, Germany — [2]Department of Physics, Technical University of Denmark, 2800 Kongens Lyngby, Denmark

Photonic Crystal Fibers (PCF) can be tailored to introduce a high nonlinear Kerr effect likewise showing that it is possible to create lower amounts of excess noise compared to standard fibers. Taking advantage of these features and using ultrashort pulses we create polarization squeezed states with notably higher purity than obtained in standard fibers. The squeezed states are produced by pulses of equal polarization counter propagating along the same fiber axis undergoing nearly identical spectral and temporal changes. Overlapping these pulses in modes of mutually orthogonal polarization enables the production of polarization squeezing. By exploiting both polarization axes of the polarization maintaining PCF we can generate two independent polarization squeezed beams thereby creating polarization entanglement. We present results of the PCF squeezer and discuss the progress in creating entanglement with this novel setup.

Q 23.4 Di 14:45 VMP 6 HS-D

Photon Pair Generation in Photonic Crystal Fibres — •Benjamin Brecht, Christoph Söller, Peter J. Mosley, Leyun Zang, Alexander Podlipensky, Philip St.J. Russell, and Christine Silberhorn — Max Planck Research Group IOIP, Günther-Scharowsky-Strasse 1 / Bau 24, 91058 Erlangen

Spontaneous four-wave mixing in Photonic Crystal Fibres (PCF) is a promising approach to creating a heralded single photon source suitable for quantum computation and communication. The possibility of tailoring the dispersion profile of a PCF allows for a high degree of control over the spectral properties of the generated photons.

We are working on a fibre-based heralded single photon source. The heralding signal photon is emitted in the visible wavelength regime, thus allowing for an efficient detection utilising silicon avalanche photodiodes (APDs). The idler photon is generated at 1.55μm and is therefore suitable for a low-loss transmission by standard telecommunication fibres. Spectral decorrelation of the photon pair ensures the indistinguishability of corresponding photons emitted from different sources and permits quantum interference without narrow bandpass filtering.

We report on the current state of the project.

Q 23.5 Di 15:00 VMP 6 HS-D

Erzeugung gequetschter Lichtfelder mit hoher Bandbreite — •Stefan Ast, Aiko Samblowski, Boris Hage, Nicolai Grosse, Nico Lastzka und Roman Schnabel — Institut für Gravitationsphysik, Leibniz Universität Hannover, Albert-Einstein-Institut, Callinstraße 38, 30167 Hannover

Gequetschte Lichtfelder liefern die nichtklassische Resource der Quantenkommunikation mit kontinuierlichen Variablen. Mögliche Anwendungen von 1-Moden gequetschten wie auch 2-Moden gequetschten Feldern, z.B. in der Quantenkryptographie, sind bereits häufig diskutiert worden. Zur Übertragung von Quanteninformation mit hohen Datenraten mittels gequetschter Lichtfelder ist es erforderlich, eine Lichtquelle mit breitbandig gequetschtem Spektrum zu realisieren. Anders als bei der diskreten Detektion von Photonen, bei denen die Bandbreite typischerweise nur einige 10 MHz beträgt, kann bei der Detektion von kontinuierlichen Variablen, also Amplituden- und Phasenquadratur, eine sehr viel höhere Bandbreite erreicht werden. Darauf aufbauend, werden erste Ergebnisse zur breitbandigen Quetschung des Lichtfeldes von mehreren 100 MHz diskutiert. Die Detektion der kontinuierlichen Variablen des gequetschten Feldes wird mittels Homodyndetektion realisiert.

Q 23.6 Di 15:15 VMP 6 HS-D

Gequetschtes Licht bei 1550 nm — •Sebastian Steinlechner, Jessica Dück, Tobias Eberle, Moritz Mehmet, Karsten Danzmann und Roman Schnabel — Max-Planck-Institut für Gravitationsphysik (AEI) und Institut für Gravitationsphysik, Leibniz Universität Hannover

Ein weltweites Netzwerk interferometrischer Detektoren versucht den direkten Nachweis von Gravitationswellen zu erbringen. Verbesserungen der ersten Detektorengeneration werden derzeit installiert, während sich die nächste Generation bereits in der Entwicklung befindet. Die Nachweisgrenze wird durch thermisches Rauschen sowie durch Quantenrauschen limitiert und kann durch Kühlung der Interferometer-Testmassen bzw. den Einsatz von gequetschtem Licht verbessert werden. Silizium ist aussichtsreichster Kandidat für kryogene Testmassen, benötigt jedoch einen Wechsel der Laserwellenlänge von 1064 nm hin zur Telekommunikationswellenlänge 1550 nm. Wir stellen eine PPKTP-Quetschlichtquelle bei 1550 nm vor, mit der eine nichtlineare Rauschunterdrückung von 5,3 dB erzielt wurde. Damit steht gequetschtes Licht als Schlüsseltechnologie zum Erreichen von Empfindlichkeiten jenseits des Schrotrauschlimits für zukünftige, kryogene Gravitationswellendetektoren zur Verfügung.

Q 23.7 Di 15:30 VMP 6 HS-D

Fs-pulsed UV enhancement cavity used as a high power entanglement source — •Roland Krischek[1,2], Witlef Wieczorek[1,2], Akira Ozawa[1], Nikolai Kiesel[1,2], Patrick Michelberger[1,2], Thomas Udem[1], and Harald Weinfurter[1,2] — [1]Max-Planck-Institut für Quantenoptik, D-85748 Garching, Germany — [2]Departement für Physik, Ludwig-Maximilians-Universität München, D-80799 München, Germany

The process of pulsed spontaneous parametric down conversion in combination with linear optics is successfully used for observing polarization entangled multi-photon states. However, when using commercial high power mode locked lasers, such experiments are limited by very low count rates resulting in very long measurement times for six-photon states already.

Here, we present the first UV femtosecond enhancement cavity designed to boost the photon count rate of down conversion experiments. To this end, the circulating pulses inside the cavity are resonantly enhanced by up to a factor of 18, which gives more than 10W UV power (at lambda = 390nm). Compared to today's available mode locked lasers this is one order of magnitude improvement. Due to the relatively low detection efficiency, our experiments are now only limited by additional noise from higher order emissions. The next step is thus to utilize the intrinsic spatial mode filter of the cavity to improve the collection efficiency above current state of the art values. We demonstrate the performance of our experiment with first results on the Dicke-state with six-photons.

Q 23.8 Di 15:45 VMP 6 HS-D

Noise properties of a whispering gallery mode resonator —

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We investigate nonlinear interactions in a Lithium Niobate whispering gallery mode (WGM) resonator. The WGM resonator has very high Q-factors as well as small optical mode volume. This greatly enhances the effective nonlinearity. Therefore nonlinear processes become very efficient for very low optical powers and ultimately for individual photons, e.g. in second harmonic generation and parametric down-conversion. In this regime, the non-classical nature of the generated light fields is revealed. We present our latest results with frequency conversion and noise measurements.