

Q 2: Quanteninformation (Photonen und nichtklassisches Licht I)

Zeit: Montag 10:30–12:30

Raum: 5L

Q 2.1 Mo 10:30 5L

Polarization squeezing and its simulation — ●RUIFANG DONG¹, JOEL HEERSINK¹, JOEL CORNEY², GERD LEUCHS¹, PETER DRUMMOND², and ULRIK ANDERSEN³ — ¹Institute for Optics, Information and Photonics, Max-Planck Researchgroup, University Erlangen-Nuernberg, Guenther-Scharowsky-Str. 1, 91058, Erlangen, Germany — ²ARC Centre of Excellence for Quantum-Atom Optics, University of Queensland, Brisbane, QLD 4072, Australia — ³Technical University of Denmark, DK-2800 Kongens Lyngby, Denmark

We report on the comparison between experimental and simulation results for the polarization squeezing, anti-squeezing as well as squeezing angle generated using a 13.35m fused silica fiber. Based on the nonlinear Kerr effect ($\chi(3)$) experienced by the ultra-short pulse in the fiber bright polarization squeezing was generated [1]. A first-principles simulation of the quantum time evolution in a many-body system for the polarization squeezing in optical fibers was also made by Joel F. Corney et al [2] which fits very well to the experiments. There they predicted that Raman effects will degrade the squeezing effect as the input energy surpasses the soliton energy. We investigate this prediction in experiment over a range of energies from 2 pJ to 170 pJ and achieve good agreement.

Q 2.2 Mo 10:45 5L

Verschränkung kontinuierlicher Variablen von Seitenbändern optischer Felder — ●AIKO SAMBLOWSKI, BORIS HAGE und ROMAN SCHNABEL — Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Institut für Gravitationsphysik, Leibniz Universität Hannover, Callinstr. 38, 30167 Hannover, Germany

In der Quanteninformation sind verschränkte Zustände von essentieller Bedeutung. Wir demonstrieren Verschränkung zwischen den korrespondierenden Seitenbändern eines gequetschten Dauerstrich-Lichtfeldes, welches mit einem optisch-parametrischen Verstärker (OPA) erzeugt wird. Durch räumliche Trennung dieser Seitenbänder erhält man ein Paar verschränkter Strahlen, wie im Experiment von E.H. Huntington et al. Phys.Rev.A, 71, 041802(R) (2005) gezeigt. Wir folgen jedoch dem Vorschlag von J. Zhang, Phys.Rev.A, 67, 054302 (2003), indem wir für die Detektion in den Homodyndetektoren frequenzverschobene Lokalszillatoren benutzen.

Q 2.3 Mo 11:00 5L

Continuous-variable photonic interfaces using single atoms — ●GIOVANNA MORIGI¹, DAVID VITALI², PRISCILLA CANIZARES^{1,2}, STEFANO MANCINI², and JÜRGEN ESCHNER³ — ¹Dept. de Fisica, Universitat Autònoma de Barcelona, E-08193 Bellaterra, Spain — ²Dipt. di Fisica, Università di Camerino, I-62032 Camerino, Italy — ³ICFO-The Institute of Photonic Sciences, E-08860 Castelldefels (Barcelona), Spain

Single atoms or ions are promising candidates for atom-photon interfaces due to the high degree of control one can achieve on these systems. Control can be gained both on the internal (electronic) as well as on the external (motional) degrees of freedom, which can both be interfaced with light by exchange of angular and linear momentum. We present our recent proposal of realizing an optical parametric amplifier based on a single cold trapped atom inside a high-finesse optical cavity, and we show that this system allows for the controlled, quantum-coherent generation of entangled light by exploiting the mechanical effects of atom-photon interaction [1,2]. Using a similar mechanism, the system also allows for the controlled creation, storage and release of pairs of entangled light pulses mediated by the single atom [1,3]. The efficiency of these schemes is investigated for parameter regimes of current experiments with cold atoms and cavities.

[1] G. Morigi, J. Eschner, S. Mancini, and D. Vitali, Phys. Rev. Lett. 96, 023601 (2006); Phys. Rev. A 73, 033822 (2006).

[2] D. Vitali, G. Morigi, J. Eschner, Phys. Rev. A 74, 053814 (2006).

[3] P. Canizares, D. Vitali, J. Eschner, and G. Morigi, in preparation.

Q 2.4 Mo 11:15 5L

Delayed Light Pulses Using Cesium Vapor — ●DAVID HOECKEL, MATTHIAS SCHOLZ, and OLIVER BENSON — Humboldt-Universität zu Berlin, Institut für Physik, AG Nanooptik, Hausvogteiplatz 5-7, 10117 Berlin

Many physical realizations are currently exploited as interfaces be-

tween single photons and atomic states, and the concept of electromagnetically induced transparency has been introduced as a promising candidate to slow down and store quantum information. We characterize absorption and pulse delays on the D1 transition in Cesium vapor with respect to future storage of narrow-band single photons generated from cavity down-conversion experiments. As a test setup, two phase-locked lasers excite Cesium vapor in a *Lambda* configuration of which one will be replaced by a single-photon source in subsequent experiments. We achieve transparency windows in the MHz regime with pulse delays of a few 100 ns and discuss decoherence mechanisms between the atomic levels.

Q 2.5 Mo 11:30 5L

Towards Storage of Photonic Qubits in Atomic Vapor — ●MATTHIAS SCHOLZ, DAVID HÖCKEL, FLORIAN WOLFGAMM, NILS NEUBAUER, and OLIVER BENSON — Humboldt-Universität zu Berlin, Institut für Physik, AG Nanooptik, Hausvogteiplatz 5-7, 10117 Berlin

Over the years of quantum information research, single photons have held the fort as the primary carriers of quantum bits over long distances. While in the early times polarization was the principal physical property to encode a qubit in a single photon, the which-way information of a photon in an interferometric setup has now become the main player, increasing the robustness against decoherence by dispersion in optical fiber links that are inevitable for the transmission of photons over more than a few kilometers.

Even though single photons have the capability to perform quantum computations on their own using linear optics, their chief application in quantum information science is seen as information carriers between processing nodes in larger quantum networks. These nodes may consist of atomic, ionic, or molecular systems where information is stored or delayed in order to modify it or to make it available at a later time when parallel computational threads have successfully been performed. In this talk, we report on our progress to prepare and store photonic qubits in atomic vapor and subsequently retrieve and decode them to form a relay for quantum information.

Q 2.6 Mo 11:45 5L

Quantum Imaging with Incoherent Photons — ●CHRISTOPH THIEL¹, ENRIQUE SOLANO², THIERRY BASTIN³, JOHN MARTIN³, JOACHIM VON ZANTHIER¹, and GIRISH S. AGARWAL⁴ — ¹Institut für Optik, Information und Photonik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany — ²Physics department, ASC, and CeNS, Ludwig-Maximilians-Universität, Munich, Germany — ³Institut de Physique Nucléaire, Atomique et de Spectroscopie, Université de Liège au Sart Tilman, Liège, Belgium — ⁴Department of Physics, Oklahoma State University, Stillwater, OK, USA

We propose a technique to obtain sub-wavelength resolution with 100% visibility using incoherent light. The method employs N photons spontaneously emitted from N atoms and subsequently detected by N detectors. We demonstrate that for certain detector positions r_2, \dots, r_N the N -th order correlation function as a function of r_1 takes the form $1 + \cos N\delta(r_1)$, resulting in a spatial modulation with a fringe spacing λ/N and a contrast of 100%.

The result corresponds to an N -fold increase in resolution compared to the classical interference pattern, obtained in, e.g., Young's double slit experiment. In our method the photons are created by spontaneous emission. The interference signal with a resolution of λ/N and 100% contrast is thus generated by incoherent light.

Q 2.7 Mo 12:00 5L

Polarization squeezing with photonic crystal fibers — ●JOSIP MILANOVIC¹, ALEXANDER HUCK¹, JOEL HEERSINK¹, CHRISTOPH MARQUARDT¹, ULRIK ANDERSEN^{1,2}, and GERD LEUCHS¹ — ¹Institute of Optics, Information and Photonics, Max-Planck Research Group, University of Erlangen-Nuremberg, Guenther-Scharowsky-Straße 1, 91058, Erlangen, Germany — ²Department 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). Photonic Crystal Fibers (PCFs) represent a promising new approach to reduce this noise.

We report on the generation of polarization squeezed states employing intense, ultrashort light pulses by a single pass method in photonic crystal fibers. We investigated the squeezing behavior near the zero-dispersion wavelength and in the anomalous dispersion regime by using two distinct fibers. We observed a maximal squeezing at 810 nm of -3.3 ± 0.3 dB with an excess noise of $+16.8 \pm 0.3$ dB in the anomalous regime. Correcting for linear and interference losses between the polarization modes, this corresponds to -6 ± 1 dB of squeezing. The ratio of the squeezing to the excess noise indicates the creation of a much purer state in comparison to a standard fiber; this ratio indeed lies an order of magnitude below those of squeezing experiments exploiting traditional fibers.

Q 2.8 Mo 12:15 5L

Quantum reconstruction of the Q -function of an intense polarization squeezed state — •CHRISTOPH MARQUARDT¹, JOEL HEERSINK¹, RUIFANG DONG¹, MARIA CHEKHOVA², ANDREI KLIMOV³, LUIS SANCHEZ-SOTO⁴, ULRIK ANDERSEN¹, and GERD LEUCHS¹ —
¹Institute for Optics, Information and Photonics, Max-Planck Re-

search Group, Universität Erlangen-Nürnberg, Günther-Scharowsky-Str. 1 / Bau 24, 91058 Erlangen — ²Department of Physics, M.V. Lomonosov Moscow State University, 119992 Moscow, Russia — ³Departamento de Física, Universidad de Guadalajara, Revolución 1500, 44420 Guadalajara, Jalisco, Mexico — ⁴Departamento de Óptica, Facultad de Física, Universidad Complutense, 28040 Madrid, Spain

Quantum state reconstruction is an important tool to verify the properties of various quantum states [1]. We present an exact reconstruction formula of the polarization sector of the density matrix, starting from a complete set of Stokes parameters measurements. By using the Q -function as an appropriate quasidistribution and in the case of intense polarization states we show that the reconstruction reduces to an inverse Radon transform. We reconstructed the Q -function of an intense polarization squeezed state, generated by fs-pulses in an optical fiber exploiting the nonlinear Kerr effect [2].

[1] A.I.Lvovsky, M.G.Raymer, quant-ph/0511044

[2] J. Heersink et al., Opt. Lett. 30, 1192(2005)