Q 18: Quanteninformation: Photonen I

Zeit: Dienstag 10:30–12:30 Raum: VMP 6 HS-D

Q 18.1 Di 10:30 VMP 6 HS-D

Experimental Demonstration of a Heralded Entanglement Source — •Claudia Wagenknecht, Che-Ming Li, Alexander Goebel, Yu-Ao Chen, Xiao-Hui Bao, Qiang Zhang, and Jian-Wei Pan — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany

We present the realisation of a linear optics experiment for heralded preparation of polarisation entangled photon pairs. Our experiment relies on three pair emission from a single parametric down-conversion source, where the conditioned detection of a four photon trigger unambiguously heralds successful preparation of a maximally polarisation entangled photon pair in the output mode, ready to be used in an event ready manner. Since parametric down-conversion is a highly probabilistic process the development of a heralded source of photons will be a important step forward to overcome the randomness in all photon based experiments in quantum information processing.

Q 18.2 Di 10:45 VMP 6 HS-D

Heralded Single Photons from Cavity-Enhanced Parametric Down-Conversion — •Lars Koch, Matthias Scholz, and Oliver Benson — Humboldt-Universität zu Berlin, Institut für Physik, AG Nano Optik, Hausvogteiplatz 5-7, 10117 Berlin

A promising scheme for quantum networks uses single photons and atomic ensembles to interconvert between flying and stationary photonic qubits. Thus, single-photon sources with spectral bandwidths of only a few MHz are required that efficiently couple to atomic resonances.
We demonstrate the generation of narrow-band single photons with a spectral width of only 3 MHz by cavity-enhanced parametric down-conversion in PPKTP. A compensating KTP crystal allows triple-resonance of pump, signal, and idler fields. Locking the cavity via the Hänsch-Couillaud method, we achieve long-term stability and an ultra-high brightness of 14000 biphotons/s per mW pump power and MHz signal bandwidth in the TEM_{00} mode on the cesium D1 line (894.3 nm). Moreover, we give proof of the single-photon character by detection of heralding idler photons that trigger a Hanbury-Brown and Twiss setup for the signal field. Compared to a Poissonian source, the multi-photon emission probability is reduced by a factor of 100.

Q 18.3 Di 11:00 VMP 6 HS-D

Shaping the Phase of a Single Photon — •Holger Specht, Jörg Bochmann, Eden Figueroa, David Moehring, Martin Mücke, Christian Nölleke, Stephan Ritter, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Garching

We report on the controlled phase shaping of a light pulse containing a single photon. The single photon is sent through a fiber electro-optical modulator, and the applied phase change is confirmed via interference with a second unmodulated reference photon. According to Hong et al. [1], coalescence is expected for indistinguishable photons. This effect is insensitive to shot-to-shot phase changes but depends on phase changes that occur during the evolution of the light pulse [2]. For instance, the application of a sudden pi-phase change in the middle of the photon wave packet results in maximally distinguishable photons and, hence, a disappearance of the interference effect. However, a time-resolved evaluation proves that this is caused by averaging over two subgroups that show clear photon coalescence and anticoalescence, respectively. Moreover, our scheme allows for arbitrary phase shapes. For example, a linear phase ramp represents a change in the frequency of the photon, and results in characteristic oscillations in the time-resolved two-photon interference [2].

[1] C. K. Hong et al. Phys. Rev. Lett. 59, 2044 - 2046 (1987)
[2] T. Legero et al. Adv. At., Mol., Opt. Phys. 53, 253 - 289 (2006)

Q 18.4 Di 11:15 VMP 6 HS-D

A High-Temperature Single-Photon Source from Nanowire Quantum Dots — •Thomas Aichele[1], Adrien Tribu[2], Gregory Sallen[2], Catherine Bougerol[2], Régis André[2], Jean-Philippe Poizat[2], Serge Tatarenko[2], and Kuntheak Kheng[2] — [1]Humboldt-Universität zu Berlin, Inst. Physik, Nanooptik, Berlin, Germany — [2]Institut Néel, CEA/CNRS/Univ. J. Fourier, Grenoble, France

We present a high-temperature single-photon source based on a quantum dot inside a nanowire. The nanowires were grown by molecular beam epitaxy in the vapor-liquid-solid growth mode. We utilize a two-step growth process that allows a thin, defect-free ZnSe nanowire to grow on top of a broader, cone-shaped nanowire. Quantum dots are formed by incorporating a narrow zone of CdSe into the nanowire. We observe intense and highly polarized photoluminescence even from a single emitter. Efficient photon antibunching is observed up to 220 K, while conserving a normalized antibunching dip of 7 to at most 36%. This is the highest reported temperature for single-photon emission from a nonblinking quantum-dot source and principally allows compact and cheap operation by using Peltier cooling.

Q 18.5 Di 11:30 VMP 6 HS-D

Characterisation of single photons by photon counting — •Kaisa Laiho, Malte Avenhaus, Katiuscia N. Cassemiro, and Christine Silberhorn — Max Planck Research Group, Günther-Scharowsky-Str. 1/Bau 24, 91058 Erlangen, Germany

Photon counting offers a possibility for direct characterisation of quantum states, and it can be utilised especially in the study of non-Gaussian states. This method is based on the measurement of the averaged photon number parity. The information about the coherences of the state is recovered by investigating the behaviour of the displaced states.

We study the direct characterisation of single photons with recently developed time-multiplexed detection (TMD) of photon statistics. According to our numerical simulations TMD is suitable for state characterisation even in the regime of low detection efficiency and the state reconstruction is possible with good accuracy [1].

We study the preparation of single photons in a waveguided parametric down conversion source in the ultrafast regime. Our experimental results indicate tight spectral correlations between signal and idler. Due to simultaneous excitation of several broadband spectral modes we apply filtering at the state preparation. In order to decorrelate the state and to meet the high demands set by the sensitivity of the characterisation method we employ a filter with 0.7nm bandwidth at the trigger arm. At low power regime our heralded statistics show one photon component of 95% with the preparation rate of 60Hz.

[1] K. Laiho *et al.*, arXiv:quant-ph/0811.0284 (2008).

Q 18.6 Di 11:45 VMP 6 HS-D

Single Photon Source for an Ion Trap Quantum Network — •Jan Huwer, Marc Almendros, Felix Rohde, Carsten Schuck, Nicolas Piro, Markus Hennrich, Francois Dubin, and Jürgen Eschner — ICFO - The Institute of Photonic Sciences, Mediterranean Technology Park, 08860 Castelldefels (Barcelona), Spain

On the way towards the realisation of entanglement between two distantly trapped ions we report the implementation of a high efficiency single photon source based on one of the two ions.

This is achieved by triggering a spontaneous Raman transition between two electronic states of a single $^{40}Ca^{+}$ ion. The ion is trapped in a linear Paul trap which is surrounded by two high numerical aperture laser objectives, allowing us to achieve high photon scattering rates into a single optical mode with detection efficiencies comparable to atom-cavity based systems. By adjusting the triggering laser pulses we can engineer the coherence properties of the generated single photons which thus provide a powerful tool for establishing entanglement between remote particles based on different types of protocols.

Q 18.7 Di 12:00 VMP 6 HS-D

Ion-trap single-photon source for quantum networks — •Helena G. Barros[1,2], Andreas Stute[1,2], Tracy Northup[1], Carlos Russo[1], Piet O. Schmidt[1], and Rainer Blatt[1,2] — [1]Institut für Experimentalphysik, Universität Innsbruck, Technikerstr. 25, A-6020 Innsbruck — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Otto-Hittmair-Platz 1, A-6020 Innsbruck

A deterministic source of single photons represents both a fundamentally nonclassical device and a resource for quantum information protocols. In the setting of cavity QED, the coherent generation of single photons provides an atom-photon interface, the basis for quantum networks. Such an interface could be used to realize atom-photon entanglement or entanglement between distant trapped atoms.

We demonstrate and characterize a single-photon source in a new

ion-trap cavity-QED experiment in which a single trapped $^{40}Ca^{+}$ ion is coupled to the mode of a high-finesse optical cavity. After preparation of the atom in a single Zeeman state, a vacuum-stimulated Raman process transfers the atom to a second Zeeman state, generating one photon in the cavity mode. We evaluate the photon statistics of the source by measurements of the second-order correlation function $g^{(2)}(\tau)$. Furthermore, the temporal profile of the photon exiting the cavity allows us to investigate the dynamics of the Raman transfer. We find strong quantitative agreement with numerical simulations and are thus able to evaluate the coherence of the process.

Q 18.8 Di 12:15 VMP 6 HS-D

A bright source of indistinguishable triggered single photons — •Yves Rezus, Robert Lettow, Alois Renn, Stephan Götzinger, and Vahid Sandoghdar — ETH Zürich, Laboratory of Physical Chemistry (LPC), 8093 Zürich, Switzerland

At cryogenic temperatures (<2 K) single fluorescent dye molecules embedded in an organic matrix display a number of interesting properties, which make them ideally suited to be used as single photon sources for quantum optical experiments. These properties include a quantum yield of nearly 100 %, a lifetime-limited optical linewidth and an almost infinite photo-stability. We demonstrate that by using pulsed laser excitation it is possible to create a triggered stream of bandwidth-limited single photons with a brightness exceeding 10^6 cps. By using the Stark effect we are able to shift the emission frequency of our single photon source and bring it into resonance with a second molecule, which is located in a different cryostat. This makes it possible to produce indistinguishable photons using two independent sources. We discuss the possibilities of employing these indistinguishable photons in two-photon interference experiments. Finally we discuss an experiment in which single photons are channeled from one molecule to a second, thereby using one of the molecules as a source and the second as a detector. This effectively provides a scheme for coupling two single molecules that are separated by a macroscopic distance.