Q 74: Quantum Information: Quantum Communication III

Time: Friday 14:30–16:00 Location: K/HS1

Q 74.1 Fri 14:30 K/HS1

Interface between path and orbital angular momentum entanglement for high-dimensional photonic quantum information — •Robert Fickler[1,2], Radek Lapkiewicz[1,2], Marcus Huber[3,4], Martin P. J. Lavery[5], Miles J. Padgett[5], and Anton Zeilinger[1,2] — [1]Vienna Center for Quantum Science and Technology, Faculty of Physics, University of Vienna, Vienna, Austria — [2]Institute for Quantum Optics and Quantum Information, Vienna, Austria — [3]Fisica Teorica: Informacio i Fenomens Quantics, Universitat Autonoma de Barcelona, Barcelona, Spain — [4]ICFO-Institut de Ciencies Fotoniques, Barcelona, Spain — [5]School of Physics and Astronomy, University of Glasgow, Galsgow, UK

Photonics has become a mature field of quantum information science, where integrated optical circuits offer a way to scale the complexity of the set-up as well as the dimensionality of the quantum state. On photonic chips, paths are the natural way to encode information. To distribute high-dimensional quantum states over large distances, transverse spatial modes, like orbital angular momentum (OAM) carrying Laguerre Gauss modes, are favorable as flying information carriers. We demonstrate a quantum interface between these two photonic fields. We create three-dimensional path entanglement between two photons and use a mode sorter as the quantum interface to transfer the entanglement to the OAM degree of freedom. Our results show a flexible way to create high-dimensional OAM entanglement and pave the way to implement complex quantum networks where high-dimensionally entangled states could be distributed over distant photonic chips.

Q 74.2 Fri 14:45 K/HS1

Hybrid system of a semiconductor quantum dot and a single ion — •Hendrik-Marten Meyer[1], Rob Stockill[2], Matthias Steiner[2,4], Claire Le Gall[2], Clemens Matthiesen[2], Jakob Reichel[3], Mete Atatüre[2], and Michael Köhl[1] — [1]Physikalisches Institut, Universität Bonn, Wegelerstraße 8, D-53115 Bonn, Germany — [2]Cavendish Laboratory, University of Cambridge, JJ Thomson Avenue, Cambridge, CB3 0HE, United Kingdom — [3]Laboratoire Kastler-Brossel, ENS/UPMC-Paris 6/CNRS, F-75005 Paris, France — [4]Present Address: Centre for Quantum Technologies, National University of Singapore, 3 Science Drive 2, Singapore 117543, Singapore

Coupling of individual quantum systems is a fundamental requirement for building scaleable quantum networks. Interfacing dissimilar quantum systems makes it possible to increase the variety of the individual network constituents and thus offers a strengthening of the system in total. Here we present the first direct photonic coupling between a semiconductor quantum dot and a single trapped atomic ion. We channel single photons generated by the quantum dot via a 50 meter long optical fiber towards the ion, which is trapped inside a high-finesse fiber cavity. We compensate the effect of the sixty-fold mismatch in the radiative linewidths between the quantum dot and the ion with coherent photon generation. In a first step towards quantum state-transfer in such a hybrid network, we present classical correlation between the σ_z-projection of the quantum dot spin and the internal state of the ion.

Q 74.3 Fri 15:00 K/HS1

A two-color entangled photon pair source for interfacing dissimilar quantum systems — •Chris Müller, Thomas Kreissl, Tim Kroh, Otto Dietz, and Oliver Benson — AG Nanooptik, Humboldt-Universität zu Berlin

Entangled photon pairs can mediate entanglement between two distant quantum systems. This is crucial for quantum repeater applications [1], but also for the general purpose of establishing entanglement between dissimilar entities, i.e. for creating quantum hybrids. We set up a two-color, folded-sandwich [2], parametric down conversion source to create entangled photon pairs. This folded-sandwich-configuration is based on a purley geometrical principle, allowing for a broad tuneability of the source.

The photon pair source will be used to establish a hybrid quantum interface with the future goal to demonstrate teleportation [1] of an electronic state of a semiconductor quantum dot [3] to photons at telecom wavelength.

[1] Bussières F., et al. Nature Photonics 8, 775-778 (2014)
[2] Steinlechner F., et al. Optics Express 21, 11943 (2013)
[3] Gao W.B., et al. Nature Comm. 4, 2744 (2013)

Q 74.4 Fri 15:15 K/HS1

Measuring squeezing produced by a type II KTP waveguide downconversion source — •Thomas Dirmeier[1,2], Nitin Jain[1,2], Georg Harder[3], Vahid Ansari[3], Gerd Leuchs[1,2], Christoph Marquardt[1,2], and Christine Silberhorn[2,3] — [1]Institute of Optics, Information and Photonics, University of Erlangen-Nuremberg, Germany — [2]Max Planck Institute for the Science of Light Erlangen, Germany — [3]Applied Physics, Integrated Quantum Optics Group, University of Paderborn, Germany

Squeezed states of light are a basic resource for a number of continuous variable quantum protocols. A commonly used tool to generate such states are sources exploiting the parametric downconversion process as they combine compact source designs with a large number of tuning parameters. ppKTP-based waveguide sources have been shown to be reliable sources of photon pairs and squeezed vacuum states, showing both a well-controlled spatio-spectral mode structure and a reasonable energy efficiency. We present the characterization of our single-mode KTP source and the results of sideband homodyne measurements on the generated squeezed vacuum. Furthermore, we will discuss the progress on the pulse-to-pulse detection and possible applications.

Q 74.5 Fri 15:30 K/HS1

Interfacing various atomic transitions and telecom wavelengths with a single tunable narrowband photon-pair source — •Gerhard Schunk, Ulrich Vogl, Michael Förtsch, Dmitry Strekalov, Florian Sedlmeir, Harald G. L. Schwefel, Gerd Leuchs, and Christoph Marquardt — Max Planck Institute for the Science of Light, Institute for Optics, Information and Photonics, University Erlangen-Nuremberg, Erlangen, Germany

Today, sources of non-classical light do not offer the same performance as classical laser sources in terms of stability, compactness, efficiency, and wavelength tunability. We present a compact source of photon-pairs and squeezed light based on efficient parametric down conversion in a triply resonant whispering-gallery resonator (WGR) made out of lithium niobate. The central wavelength of the emitted light can be tuned over hundreds of nanometer and allows for precise and accurate spectroscopy with single signal and single idler photons of tunable bandwidth. Based on our analysis of the various eigenmodes of the WGR, we employ different wavelength tuning mechanisms, which we combine for continuous tuning. With this we demonstrate tuning to the D1 lines of rubidium (795 nm) and cesium (895 nm) and a scanning over the Doppler-broadened and Doppler-free absorption line of the Cs D1 F4'-F3 transition. The corresponding idler photons are emitted at 1312 nm for cesium and 1608 nm for rubidium. Providing this flexibility in connecting various alkali atoms with telecom wavelengths, this system opens up novel possibilities to realize proposed quantum repeater schemes.

Q 74.6 Fri 15:45 K/HS1

Cascaded parametric down-conversion with seed — •Stephan Krapick, Benjamin Brecht, Vahid Ansari, Harald Herrmann, and Christine Silberhorn — Universität Paderborn, Department Physik, Warburger Str. 100, 33098 Paderborn, Deutschland

We report on the cascading of two type-I parametric down-conversion (PDC) sources, which are monolithically integrated in periodically poled lithium niobate waveguide structures. By seeding the secondary PDC stage with synchronized and strongly attenuated laser pulses, we achieve wavelength tunable, narrowband photonic states.