

Q 35: Poster Quantenkommunikation

Zeit: Dienstag 16:30–18:30

Raum: Poster C

Q 35.1 Di 16:30 Poster C

Long-distance atom-photon entanglement — ●FREDRIK HOCHE¹, FLORIAN HENKEL¹, MICHAEL KRUG¹, WENJAMIN ROSENFELD¹, JÜRGEN VOLZ¹, MARKUS WEBER¹, and HARALD WEINFURTER^{1,2} — ¹Department für Physik der LMU, 80799 München — ²Max-Planck-Institut für Quantenoptik, 85748 Garching

Entanglement is a key element of quantum information and communication applications. For future applications as e.g. the realization of quantum networks or the quantum repeater, entanglement between different species like atoms and photons is necessary, because it provides an interface between atomic quantum memories and photonic quantum communication channels.

In our experiment, a single optically trapped ⁸⁷Rb-atom is excited to a state with two decay channels in a Λ -type configuration. In the following spontaneous decay the spin state of the atom is entangled with the polarization of the emitted photon[1]. So far, we have demonstrated this atom-photon entanglement over distances of a few meters. However, for future applications in quantum communication the spatial separation has to be extended to macroscopic distances.

Here we report first experimental steps towards long-distance atom-photon entanglement (with a distance of a few 100 meters) using fiber-based quantum communication channels.

[1] J. Volz et al., Phys. Rev. Lett. 96, 030404 (2006)

Q 35.2 Di 16:30 Poster C

Simultaneous retrieval of single photons from two atomic ensembles — ●MARKUS KOCH¹, SHUAI CHEN¹, YU-AO CHEN¹, THORSTEN STRASSEL¹, ZHEN-SHENG YUAN¹, BO ZHAO¹, JÖRG SCHMIEDMAYER², and JIAN-WEI PAN¹ — ¹Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, Germany — ²Atominstitut österreichischer Universitäten, TU Wien, Stadionallee 2, 1020 Wien, Austria

Duan, Lukin, Cirac and Zoller have proposed a scheme for long distance quantum communication based on atomic ensembles and linear optical elements [Duan et al., Nature 414, 413, 2001].

Here we demonstrate that one single cloud of atoms can serve as two independent ensembles. A cloud of cold ⁸⁷Rb atoms was prepared in a magneto optical trap. Two independent, non overlapping write beams were used to create collective excitations in two spatially separated regions of the cloud. The excitations can be read out independently. A violation of the Cauchy-Schwartz inequality proves the non classical character of the photons from each ensemble. Using a feed forward circuit we can simultaneously recover single photons from each ensemble and we will demonstrate their indistinguishability for different degrees of freedom by their interference on a beam splitter. Our next goal is to extend the storage time in order to demonstrate entanglement of two atomic ensembles as it is required for the DLCZ protocol.

Q 35.3 Di 16:30 Poster C

Optical free-space quantum key distribution — ●SEBASTIAN SCHREINER¹, HENNING WEIER¹, MARTIN FÜRST¹, TOBIAS SCHMITT-MANDERBACH², CHRISTIAN KURTSIEFER³, and HARALD WEINFURTER^{1,2} — ¹Department für Physik der LMU München, Schellingstr 4/III, 80799 München — ²Max Planck Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching — ³Department of Physics, National University of Singapore, 2, Science Drive 3, Singapore 117542

Based on fundamental laws of quantum mechanics, it is possible to generate and to distribute cryptographic keys in a provable safe way. A potential eavesdropper will necessarily disturb the communication by his quantum measurement. This leads to an error rate in the generated keys which allows to evaluate an upper bound on the information eavesdropped.

Here we evaluate the performance of a down town demonstration system operating over a distance of about 500 m. It uses the BB84 protocol with polarized photons from attenuated laser pulses as qubits. The remote controlled system allows for continuous QKD and implements several design and electronic improvements. Furthermore with this new setup the utilization of decoy states as well as daylight operation shall be enabled. We report on experiments that investigate the limits of free-space transmission and discuss the requirements for the

development of a compact, fully integrated QKD system.

Q 35.4 Di 16:30 Poster C

Comparison of Quantum Communication Protocols — ●WOLFGANG MAUERER and CHRISTINE SILBERHORN — University Erlangen-Nuremberg, Max-Planck Research Group IOIP, Integrated Quantum Optics Group

Quantum key distribution (QKD) is presently among the most popular applications of quantum mechanics. A multitude of protocols has been proposed and security proofs have been provided which show that secret keys can be distributed between two parties even when experimental imperfections are taken into account. Solving the resulting equations for bounds on the key rates is usually not possible analytically, but requires numerical methods. We present an extensive comparison between different protocols implemented using different experimental components.

We provide a numerical tool which allows to compute many aspects of quantum key distribution systems which are of interest, especially bounds on the key generation rate. Experimental imperfections like misalignment and dark counts of detectors or channel losses are included. The analysis includes the optimisation of experimental parameters, e.g., the source intensity, to achieve the best possible results. It highlights the performance gain if improved equipment becomes available, and thus serves as a guideline as to which parts of an experiment are most beneficial to be enhanced. For most protocols, both one- and two-way communication are considered.

Q 35.5 Di 16:30 Poster C

robust creation of entanglement between remote memory qubits — ●BO ZHAO¹, ZENG BING CHEN^{1,2}, YU AO CHEN¹, JOERG SCHMIEDMAYER¹, and JIAN WEI PAN^{1,2} — ¹physikalisches institut, universitaet heidelberg, philosophenweg 12, 69120 heidelberg — ²hefei national laboratory for physical sciences at microscale and department of modern physics, university of science and technology of china, hefei, anhui 230026, china

we propose a robust quantum repeater using similar sources as DLCZ scheme, i.e. atomic ensembles and linear optics. Our protocol entails the advantage of two photon interference and requires stable interferometry over only the coherence length of photons which is about 8 orders of magnitude more robust than single photon interference used in DLCZ scheme. Our proposal provides an exciting possibility for robust and realistic long distance quantum communication.

Q 35.6 Di 16:30 Poster C

Asymptotic correctability of Bell-diagonal qudit states and lower bounds on tolerable error probabilities in quantum cryptography — ●KEDAR RANADE and GERNOT ALBER — Institut für Angewandte Physik, Technische Universität Darmstadt

The concept of asymptotic correctability of Bell-diagonal quantum states is generalised to elementary quantum systems of higher dimensions. Based on these results basic properties of quantum state purification protocols are investigated which are capable of purifying tensor products of Bell-diagonal states and which are based on B -steps of the Gottesman-Lo-type with the subsequent application of a Calderbank-Shor-Steane quantum code. Consequences for maximum tolerable error rates of quantum cryptographic protocols are discussed.

Q 35.7 Di 16:30 Poster C

Quantum processing photonic states in optical lattices — ●CHRISTINE MUSCHIK, INES DE VEGA, DIEGO PORRAS, and IGNACIO CIRAC — Max Planck Institute for Quantumoptics, Garching, Germany

The mapping of photonic states to collective excitations of atomic ensembles is a powerful tool which finds a useful application in the realization of quantum memories and quantum repeaters. In this work we show that cold atoms in optical lattices can be used to perform an entangling unitary operation on the transferred atomic excitations. After the release of the quantum atomic state, our protocol results in a deterministic two qubit gate for photons. The proposed scheme is feasible with current experimental techniques and robust against the dominant sources of noise.