Q 25: Quantum information: Quantum communication II

Time: Tuesday 11:00–12:15 Location: E 214

Q 25.1 Tue 11:00 E 214

A wavelength tunable quantum light-emitting diode — •Jiaxiang Zhang[1], Fei Ding[1], Eugenio Zallo[1], Santosh Kumar[1], Bianca Höfer[1], Rinaldo Trotta[2], Armando Rastelli[2], and Oliver G. Schmidt[1] — [1]Institute for Integrative Nanosciences, IFW-Dresden, Helmholtzstrasse 20, D-01069 Dresden, Germany — [2]Institute of Semiconductor and Solid State Physics, Johannes Kepler University Linz, Altenbergerstrasse 69, A-4040 Linz, Austria

It is desirable to have trigged quantum light sources that emit single photons with exactly the same wavelength in quamtum communication. Previous work has realized two photon interference of the emission from two remote self-assembled quantum dots (QDs).Here we demonstrate an electrically driven, wavelength tunable single-photon source utilizing self-assembled InAs/GaAs QDs embedded in a p-i-n light-emitting diode (LED). Triggered single-photon emission is realized by applying ultra-short electrical pulses to the LED, while the wavelength of the emitted single photons is precisely controlled (> 10meV) by external biaxial stresses. We also characterize the decay dynamics of the excitonic states and the pulsed single-photon emission [g2(*)] in this device. Our technique therefore presents strong promise for the realization of two photon interference from separated electrically injected single-photon sources.

Q 25.2 Tue 11:15 E 214

Detector efficiency in Communication Complexity and Bell test experiments — •Michael Epping — Institut für Theoretische Physik III, Heinrich-Heine-Universität Düsseldorf, Universitätsstr. 1, 40225 Düsseldorf

Suppose several separated parties need to calculate a function f(x), but each party has only access to one part of the input x. The amount of communication (in bits) necessary for the parties in order to calculate f is the communication complexity of f (see [1] for a survey). Similarly, one can ask for the probability of successful calculation of f if the communication is restricted. The parties can increase this probability if they share a non-local state, while the communication remains classical[2,3]. In this talk a link between the detection efficiency necessary for a quantum advantage in the task described above and the detection loophole of a Bell test experiment is presented. This is, the detection loophole can be closed when the detectors allow for a quantum advantage in the communication complexity task.

[1] H. Buhrman, R. Cleve, S. Massar and R. Wolf, "Non-locality and Communication Complexity", arXiv:0907.3584 (2009)

[2] C. Brukner, M. Zukowski, J. Pan and A. Zeilinger, "Bell's inequalities and quantum communication complexity", Phys. Rev. Lett., 92:127901 (2004)

[3] M. Epping, "Quantenkommunikationskomplexität mit nichtidealen Detektoren", Master's thesis, University of Vienna, Austria (2012)

Q 25.3 Tue 11:30 E 214

Continuous-variable entanglement distillation and non-commutative central limit theorems — •Earl Campbell[1], Marco Genoni[2], and Jens Eisert[1] — [1]Dahlem Center for Complex Quantum Systems, Freie Universitaet Berlin, 14195 Berlin, Germany — [2]QOLS, Blackett Laboratory, Imperial College London, London SW7 2BW, UK

Entanglement distillation transforms weakly entangled noisy states into highly entangled states, a primitive to be used in quantum repeater schemes and other protocols designed for quantum communication and key distribution. In this work, we present a comprehensive framework for continuous-variable entanglement distillation schemes that convert noisy non-Gaussian states into Gaussian ones in many iterations of the protocol. Instances of these protocols include (a) the recursive Gaussifier protocol, (b) the temporally-reordered recursive Gaussifier protocol, and (c) the pumping Gaussifier protocol. The flexibility of these protocols give rise to several beneficial trade-offs related to success probabilities or memory requirements, which that can be adjusted to reflect experimental demands. Despite these protocols involving measurements, we relate the convergence in this protocols to new instances of non-commutative central limit theorems, in a formalism that we lay out in great detail. Implications of the findings for quantum repeater schemes are discussed.

Q 25.4 Tue 11:45 E 214

Air to Ground Quantum Key Distribution — •Markus Rau[1], Sebastian Nauerth[1], Florian Moll[2], Christian Fuchs[2], Joachim Horwath[2], Stefan Frick[1], and Harald Weinfurter[1,3] — [1]Ludwig-Maximilians-Universität, München — [2]Deutsches Zentrum für Luft- und Raumfahrt e.V., Weßling — [3]Max-Planck-Institut für Quantenoptik, München

Quantum key distribution provides a whole new level of information security. However for long range communication, links via satellites or other airborne systems are necessary. Here we report on an experiment combining recent advances in classical and in quantum optical technologies to demonstrate the feasibility of quantum key distribution from an airplane to ground. Major challenges solved in this experiment are the higher pointing requirements compared to classical free-space communication and the integration of the QKD hardware into an existing communication system, including the development of a precise polarization compensation technique to account for the relative rotations of airborne and ground station qubit encoding bases.

The flight tests have been performed linking the optical ground station of the DLR Oberpfaffenhofen with a Donier 228 airplane flying at a distance of 20 km at 290 km/h. The achieved key rate of 145 bits/s with a quantum bit error rate of 4.8 % proves that a BB84 key exchange can be performed with a fast moving airborne platform. Given the high angular speed our demonstration also clearly proves the feasibility of QKD to satellites, high altitude platforms or intercontinental planes.

Q 25.5 Tue 12:00 E 214

Long-distance QKD enhanced by quantum repeaters with atomic ensembles and heralded qubit amplifiers — •Silvestre Abruzzo[1], Sylvia Bratzik[1], Nadja K. Bernardes[2,3], Hermann Kampermann[1], Peter van Loock[2,3,4], and Dagmar Bruss[1] — [1]Institute for Theoretical Physics III, Heinrich-Heine-Universität Düsseldorf, Universitätsstr. 1, 40225 Düsseldorf, Germany — [2]Optical Quantum Information Theory Group, Max Planck Institute for the Science of Light, Günther-Scharowsky-Str. 1/Bau 24, 91058 Erlangen, Germany — [3]Institute of Theoretical Physics I, Universität Erlangen-Nürnberg, Staudtstr. 7/B2, 91058 Erlangen, Germany — [4]Institute of Physics, Johannes-Gutenberg Universität Mainz, Staudingerweg 7, 55128 Mainz, Germany

We analyze in the context of long-distance quantum key distribution a recent quantum repeater proposal based on atomic ensembles and linear optics[1]. We investigate the impact of important experimental parameters on the final secret key rate. These parameters include the source efficiency, detector click probability and the quantum memory retrieval efficiency [2]. Moreover, we investigate the optimal number of repeater stations given a specific fixed value of the imperfections.

[1] J. Minář et al, Phys. Rev. A 85, 032313 (2012)

[2] S. Abruzzo et al, arXiv:1208.2201