Q 48: QuanTour IV – Building Blocks

Inspired by QuanTour, the traveling quantum-dot light source, the sessions QuanTour I-V focus on the physics of quantum light generation in solid-state systems and applications in quantum networks.

Time: Thursday 11:00–13:00 Location: P 7

Invited Talk Q 48.1 Thu 11:00 P 7

Quantum teleportation with remote quantum dots in a metropolitan hybrid quantum network — A. Laneve[1], G. Ronco[1], M. Beccaceci[1], F. Salusti[2], N. Claro-Rodriguez[2], G. De Pascalis[1], E. Schöll[2], L. Hanschke[4], T. M. Krieger[3], Q. Buchinger[5], S. F. Covre da Silva[6], S. Stroj[7], S. Höfling[5], T. Huber-Loyola[8], M. A. Usuga Castaneda[9], G. Carvacho[1], N. Spagnolo[1], •M. B. Rota[1], F. Basso Basset[10], A. Rastelli[3], F. Sciarrino[1], K. D. Jöns[2], and R. Trotta[1] — [1]Sapienza Università di Roma, Italy — [2]Paderborn University, Germany — [3]Johannes Kepler University, Austria — [4]Technical University of Munich, Germany — [5]University of Würzburg, Germany — [6]Universidade Estadual de Campinas, Brazil — [7]Vorarlberg University of Applied Sciences, Austria — [8]Karlsruhe Institute of Technology, Germany — [9]Single Quantum B.V., Delft, The Netherlands — [10]Politecnico di Milano, Italy

We demonstrate the first all-photonic quantum teleportation protocol using dissimilar semiconductor quantum dot (QD) emitters, deployed in a hybrid fiber + free-space metropolitan link. Two independent GaAs quantum dots, engineered via nanophotonic cavities, piezoelectric strain tuning and magnetic-field control, serve as the sender and entangled-photon source. The emitters are initially spectrally distinct, through tailored tuning we surpass the classical fidelity limit more than ten standard deviations (0.82(1)). This successful demonstration constitutes a key step toward scalable, QD-based quantum relays and repeaters.

Q 48.2 Thu 11:30 P 7

Full photonic quantum teleportation with remote quantum dots — •Simone Luca Portalupi[1], Tim Strobel[1], Michal Vyvlecka[1], Ilenia Neureuther[1], Tobias Bauer[2], Marlon Schäfer[2], Stefan Kazmaier[1], Nand Lal Sharma[3], Raphael Joos[1], Jonas H. Weber[1], Cornelius Nawrath[1], Weijie Nie[3], Ghata Bhayani[3], Caspar Hopfmann[3], Christoph Becher[2], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen, Center for Integrated Quantum Science and Technology (IQST) and SCoPE, University of Stuttgart, Stuttgart, Germany — [2]Fachrichtung Physik, Universität des Saarlandes, Saarbrücken, Germany — [3]Institute for Integrative Nanosciences, Leibniz IFW Dresden, Dresden, Germany

The realization of a multinode quantum network is the first necessary step towards the implementation of the quantum internet. With this target in mind, we will report on a recent experiment where successful full-photonic quantum teleportation has been achieved, employing two remote quantum dots as sources of quantum light. This experiment exploited quantum frequency conversion to enable operation at telecom wavelength. [1] The successful teleportation achieved with two distinct sources lay the foundation to future experiments: it shows scalability of this approach, compatibility with fibre networks, interoperability of different systems (as semiconductor quantum dots and frequency conversion elements), and operation of distinct nodes. All are necessary steps towards the implementation of a realistic quantum network.

[1] T. Strobel, et al., Nat. Commun. 16, 10027 (2025).

Q 48.3 Thu 11:45 P 7

AlGaAs nanowires as a universal platform for GaAs, InGaAs, and InAs quantum dots — •Rohan Radhakrishnan[1], Rodion Reznik[2], Gilles Patriarche[3], George Cirlin[2], and Nika Akopian[1] — [1]DTU Department of Electrical and Photonics Engineering, Technical University of Denmark, 2800 Kongens Lyngby, Denmark — [2]St. Petersburg, Russia — [3]Centre de Nanosciences et Nanotechnologies, Université Paris Saclay, CNRS, 91120 Palaiseau, France

Optical quantum dots are at the core of quantum communication and quantum photonic technologies, requiring precise control over emission wavelengths spanning from 780 nm to 1.55 μm. However, no existing host material enables the full compositional tuning needed to cover the range from GaAs through InGaAs to InAs quantum dots. Here, we demonstrate that embedding InGaAs quantum dots in AlGaAs nanowires provides a universal platform capable of spanning this entire spectral range. By growing 2 s and 5 s long sections of InGaAs, we form quantum dots emitting at 780 nm and 920 nm, respectively, showcasing control of emission wavelength via growth parameters. Unlike previous systems, our approach offers continuous compositional control without compromising optical quality, establishing AlGaAs nanowires as a versatile host for scalable, high-performance quantum light sources.

Q 48.4 Thu 12:00 P 7

Universal super-resolution framework for imaging of quantum dots — Dominik Vašinka[1], Jaewon Lee[2], •Charlie Stalker[2], Victor Mitryakhin[3], Ivan Solovev[3], Sven Stephan[3,4], Sven Höfling[5], Falk Eilenberger[6,7,8], Seth Ariel Tongay[9], Christian Schneider[3], Miroslav Ježek[1], and Ana Predojević[2] — [1]Department of Optics, Faculty of Science, Palacký University, 17. listopadu 12, 77900 Olomouc, Czechia — [2]Department of Physics, Stockholm University, 10691 Stockholm, Sweden — [3]Institut of Physics, University of Oldenburg, D-26129 Oldenburg, Germany — [4]University of Applied Sciences Emden/Leer, 26723 Emden, Germany — [5]Technische Physik, Physikalisches Institut and Würzburg-Dresden Cluster of Excellence ct.qmat, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany — [6]Institute of Applied Physics, Abbe Center of Photonics, Friedrich Schiller University Jena, 07743 Jena, Germany — [7]Fraunhofer-Institute for Applied Optics and Precision Engineering IOF, 07743 Jena, Germany — [8]Max-Planck-School of Photonics, 07743 Jena, Germany — [9]Materials Science and Engineering, School for Engineering of Matter, Transport, and Energy, Arizona State University, Tempe, Arizona 85287, United States

We present a universal deep-learning method that reconstructs super-resolved images of quantum emitters from a single camera frame measurement. This method was then validated experimentally on various quantum dot samples and allows for rapid super-resolution for quantum photonic device fabrication.

Q 48.5 Thu 12:15 P 7

Quantum communication protocols with Quantum Dots as a source of Polarization-entangled photons — Michele Rota[1], Francesco Basso Basset[1,2], Alessandro Laneve[1], •Francesco Salusti[3], Nicolas Claro Rodriguez[3], Giuseppe Ronco[1], Mattia Beccaceci[1], Tobias M. Krieger[4], Quirin Buchinger[5], Saimon F. Covre da Silva[6], Sandra Stroj[7], Mariia Gumberidze[8], Vladyslav Usenko[8], Sven Höfling[5], Tobias Huber-Loyola[5,9,10], Mario A. Usuga Castaneda[11], Armando Rastelli[4], Klaus D. Jöns[3], and Rinaldo Trotta[1] — [1]Department of Physics, Sapienza University of Rome, Rome, Italy — [2]Dipartimento di Fisica, Politecnico di Milano, Milano, Italy — [3]PhoQS Institute, CeOPP, and Department of Physics, Paderborn University, Paderborn, Germany — [4]Institute of Semiconductor and Solid State Physics, Johannes Kepler University, Linz, Austria — [5]Technische Physik, University of Würzburg, Würzburg, Germany — [6]Universidade Estadual de Campinas, Instituto de Fisica Gleb Wataghin, Campinas, Brazil — [7]Research Center for Microtechnology, Vorarlberg University of Applied Sciences, CAMPUS V, Dornbirn, Austria — [8]Department of Optics, Palacký University, Olomouc, Czech Republic — [9]Institute of Photonics and Quantum Electronics, Karlsruhe Institute of Technology, Karlsruhe, Germany — [10]Center for Integrated Quantum Science and Technology (IQST), Karlsruhe Institute of Technology, Karlsruhe, Germany — [11]Single Quantum B.V., Delft, The Netherlands

We demonstrate entanglement swapping exploiting a quantum dot in a cavity, using entangled photons for a modified Ekert91 protocol.

Q 48.6 Thu 12:30 P 7

Mode-engineering in quantum dot single photon sources to increase collection and excitation efficiency — •Samuel Huber[1], Albert Adiyatullin[2], Viviana Villafane[2], Dario A. Fioretto[1], Sebastien Boissier[2], Huong Thi Au[2], and Pascale Senellart[1] — [1]C2N, Palaiseau, France — [2]Quandela, Massy, France

The development of photonic quantum technologies requires high quality single photon sources in terms of brightness, purity, and indistinguishability. In my PhD, I aim to improve these metrics in micropillar quantum dot single photon sources by studying the optical eigenmodes in the micropillar. The eigenmodes spatial overlap with the mode of the collection path directly contributes to the single photon source brightness. Quantifying this coupling efficiency also reveals new pathways to enhance the efficiency of detuned quantum dot excitation protocols. Standard detuned-pulse schemes are fundamentally constrained by the micropillar stopband, which suppresses field penetration into the cavity mode, increasing the required excitation power. To mitigate this limitation, I am exploring the coupling of the detuned pulses to higher-order cavity modes, as well as to auxiliary modes engineered through additional spacer layers within the Bragg-mirror stack. These engineered modes provide improved spectral overlap and field confinement for off-resonant driving, enabling a viable route towards high-efficiency Swing-Up (SUPER) excitation in micropillar resonators.

Q 48.7 Thu 12:45 P 7

Decoy-state quantum key distribution over 227 km with a frequency-converted telecom single-photon source — •Frederik Brooke Barnes[1], Robert Gonzalez-Pousa[2], Christopher L. Morrison[1], Zhe Xian Koong[1], Joseph Ho[1], Francesco Graffitti[1], John Jeffers[2], Daniel K. L. Oi[2], Brian D. Gerardot[1], and Alessandro Fedrizzi[1] — [1]Institute of Photonics and Quantum Sciences, School of Engineering and Physical Sciences, Heriot-Watt Univer- sity, Edinburgh, EH14 4AS, UK — [2]SUPA Department of Physics, University of Strathclyde, Glasgow, G4 0NG, UK

We implement a decoy-state quantum key distribution scheme using a quantum dot frequency-converted to the telecom C-band. The decoy states are created by varying the optical excitation of the quantum emitter to modulate the photon number distribution. We provide an analysis of our scheme based on existing security proofs, allowing the calculation of secret key rates including finite key effects. This enables us to demonstrate, with a realistic single-photon source, positive secret key rates using our scheme over 227~km of optical fibre, equivalent to an increase in loss tolerance greater than one order of magnitude compared to non-decoy schemes, and within 2dB of the tolerable loss when using a single-photon source with similar brightness but perfect single-photon purity. We provide a short perspective on how our methods could be applied to other quantum communication protocols, such as those compatible with quantum memories, to extend secure transmission distances beyond the repeater-less limit.