Plenary, Invited and Oral Presentations

Thursday 4 April

Aula Magna Rettorato
09:45 -- 10:30
T1A • Plenary Session I

T1A.1 • 09:45 -- 10:30 (Plenary)
Benchmarking NISQ-era Quantum Processors, Jay Gambetta[1]; *[1]IBM TJ Watson Research Center, USA.*

As the field marches towards quantum advantage with near-term quantum processors, it becomes imperative to characterize, verify, and validate performance. An outstanding scientific challenge in the community is a scalable set of metrics or experiments which can shed light on the usability of a device for near-term algorithms. Moreover, it becomes critical to explore techniques to extend the computational reach of noisy systems, be it through understanding underlying non-idealities, or more efficient circuit compilation. In this talk I will review the work we are doing at IBM to develop a software framework for this and our recent results.

Aula Magna Rettorato
11:00 -- 12:30
T2A • Plenary Session II

T2A.1 • 11:00 -- 11:45 (Plenary)
Quantum Leap: From Tests of Quantum Foundations to New Quantum Technologies, Jian-Wei Pan[1]; *[1]Univ of Science and Technology of China, China.*

We generated, manipulated and detected the atomic spin entanglement in optical lattices. We observed four-body ring-exchange interactions, and the topological properties of anionic excitations within this ultracold atom system.

F1A.1 • 11:45 – 12:30 (Plenary)
Realizing Feynman's Dream of a Quantum Simulator, Immanuel Bloch[1,2]; *[1]Max-Planck-Institut fur Quantenoptik, Germany; [2]Ludwig-Maximilians-Universität München, Germany.*

Ultracold atoms in optical lattice form versatile quantum simulators for solving a diverse range of problems ranging from condensed matter, over statistical physics to high-energy physics. In many cases such atomic quantum simulators perform simulations in computationally intractable regimes, thereby demonstrating a practical quantum advantage.

Aula Magna Rettorato
13:45 -- 14:45
T3A • Quantum Information I

T3A.1 • 13:45 -- 14:15 (Invited)
Communicating via Ignorance & Imaging via Counting, Andrew G. White[1]; *[1]Univ. of Queensland, Australia.*

We use quantum technologies to improve communication and imaging. Significant information is transmitted through a completely noisy channel using indefinite causal order. Imaging remote bodies via photon-counting is an order-of-magnitude more precise than traditional methods.

T3A.2 • 14:15 -- 14:30
Macroscopic entangled states by delocalized single-photon addition, Nicola Biagi[1,2], Luca S. Costanzo[1,2], Marco Bellini[1], Alessandro Zavatta[1]; *[1]Istituto Nazionale di Ottica, Italy; [2]LENS, Italy.*

We report an experimental realization of macroscopic entangled states obtained by applying delocalized single-photon creation operations on two uncorrelated temporal modes populated by coherent states. Entanglement is preserved as the mean photon number increases

T3A.3 • 14:30 – 14:45
Quantum Information Experiments with Multiple Photons in One and High-Dimensions: Concepts and Experiments, Manuel Erhard[1], Mario Krenn[1], Anton Zeilinger[1], Xumei Gu[1], Mehul Malik[2]; *[1]IQOQI Vienna, Austria; [2]Inst. of Photonics and Quantum Sciences (IPaQS), Heriot-Watt Univ., UK.*

We show the first experimental generation of a Greenberger-Horne-Zeilinger entangled state in three-dimensions and show how to describe photonic quantum experiments using graph theory. This novel link promises exciting applications such as special-purpose quantum simulation.

Aula Magna Regina Elena
13:45 -- 14:45
T3B • Quantum Optics

T3B.1 • 13:45 -- 14:15 (Invited)
Generating Multi-photon Entangled States from a Single Deterministic Single-photon Source, Daniel Istrati[1], Yehuda Pilnyak[1], Lior Cohen[1], Hagai Eisenberg[1], Carlos Anton-Solanas[2], Juan Loredo[2], Paul Hilaire[2], Clément Millet[2], Aristide Lemaitre[2], Isabelle Sagnes[2], Abdelnoumain Harouri[2], Loic Lanco[2], Pascale Senellart[2]; *[1]Hebrew Univ. of Jerusalem, Israel; [2]Center for Nanosciences and Nanotechnology CNRS, Univ. Paris-Saclay, France.*

We present a new compact fiber optic system which together with a high brightness single-photon source facilitates the generation of multi-photon entangled states. Two and three entangled photon states have been prepared and measured.

T3B.2 • 14:15 -- 14:30
Quantifying High-Dimensional Entanglement with only Two Measurement Settings, Mehul Malik[1,2], Jessica Bavaresco[2,3], Natalia Herrera[1,3], Claude Klockl[2,4], Paul Erker[2,4], Matej Pivoluska[2,5], Nicolai Friis[2], Marcus Huber[2]; *[1]Heriot-Watt Univ., Edinburgh, UK; [2]IQOQI Vienna, Austria; [3]Centre de Saint-Jerome, Universite d'Aix-Marseille, France; [4]Inst. of Computer Science, Masaryk Univ., Czechia; [5]Inst. of Physics, Slovak Academy of Sciences, Slovakia.*

We develop and experimentally demonstrate a method for certifying high-dimensional entanglement that uses carefully constructed measurements in two bases. We are able to certify a record 9-dimensional entangled state in an assumption-free manner.

T3B.3 • 14:30 -- 14:45

Quantum interference enables constant-time quantum information processing, Magdalena Stobinska[1]; [1]*Inst. of Theoretical Physics, Univ. of Warsaw, Poland.*

We report a one-step computation of a fractional Kravchuk-Fourier transform well-suited to finite string processing. Our architecture involves only one gate which exploits a generalized Hong-Ou-Mandel effect, the basis for quantum-photonic applications.

Aula Organi Collegiali
13:45 -- 14:45
T3C • Atomic Quantum Sensors

T3C.1 • 13:45 -- 14:15 (Invited)

Atomic Quantum Sensors for Precision Gravitational Physics, Guglielmo M. Tino[1,2]; [1]*Universita degli Studi di Firenze, Italy;* [2]*INFN, Italy.*

The ability to control the quantum degrees of freedom of atoms using laser light opened the way to precision measurements of fundamental physical quantities. I will describe experiments for precision tests of gravitational physics using ultracold atoms, namely, atom interferometers and optical clocks. I will report on the measurement of the gravitational constant G with a Rb Raman interferometer, on experiments based on Bloch oscillations of Sr atoms confined in an optical lattice for gravity measurements and on new tests of the Einstein equivalence principle. I will also discuss prospects to use atoms as new detectors for gravitational waves and for experiments in space.

T3C.2 • 14:15 -- 14:30

High-precision atom interferometry using optimal quantum control, Vladimir S. Malinovsky[1], Michael H. Goerz[1], Paul D. Kunz[1], Mark A. Kasevich[2]; [1]*US Army Research Laboratory, USA;* [2]*Physics, Stanford Univ., USA.*

We apply optimal control theory to design laser pulse sequences implementing the mirrors and beamsplitters of an atomic fountain interferometer. The goal is to enhance the fidelity and the robustness of the interferometer.

T3C.3 • 14:30 -- 14:45

A femtotesla quantum-noise-limited pulsed gradiometer at finite fields, Vito Giovanni Lucivero[1], Wonjae Lee[1], Mark Limes[2], Elizabeth Foley[2], Tom Kornack[2], Michael Romalis[1]; [1]*Princeton Univ., USA;* [2]*Twinleaf, USA.*

We describe an optically pumped atomic gradiometer operating at finite fields, including Earth's field, with 14 fT/Hz^(1/2) sensitivity. We demonstrate its quantum-noise-limited behaviour in the presence of quantum spin noise and atomic diffusion.

Aula Magna Rettorato
15:15 -- 16:00
T4A • Plenary Session III

T4A.1 • 15:15 -- 16:00 (Plenary)
Gravitational Wave Detectors, Nergis Mavalvala[1]; [1]*Massachusetts Inst. of Technology, USA.* Abstract not available.

Aula Magna Rettorato
16:00 -- 17:30
T4B • Special Session on National Quantum Initiatives
Session Chair: Gregory Quarles, *OSA Chief Scientist*

Discussants
Yasuhiko Arakawa, *University of Tokyo, Japan*
Tommaso Calarco, *University of Ulm, Germany*
Claire Cramer, *U.S. Department of Energy*
Thomas Jennewein, *University of Waterloo, Canada*
Jian-Wei Pan, *USTC, China*
Ian Walmsley, *Imperial College London, UK*
Andrew G. White, *The University of Queensland, Australia*

Friday 5 April

Aula Magna Rettorato
09:00 -- 10:30
F1A • Plenary Session IV

T2A.2 • 09:00 -- 09:45 (Plenary)
Multi-dimensional Quantum Systems Based on Integrated Optics and Pulsed Light, Christine Silberhorn[1]; [1]*Paderborn Univ., Germany.*

Photonic networks with many modes and quantum input states have been proposed for various quantum applications. We present three approaches to overcome current limitations for their implementation: non-linear integrated quantum optics, temporal modes and time-multiplexing.

F1A.2 • 09:45 -- 10:30 (Plenary)
Quantum Controlling Levitated Solids: A Novel Probe for the Gravity-quantum Interface, Markus Aspelmeyer[1]; [1]*Universitat Wien, Austria.*

Abstract not available.

Aula Magna Rettorato
11:15 -- 12:45
F2A • Plenary Session V

F2A.1 • 11:15 -- 12:00 (Plenary)
Quantum Control of Atomic and Molecular Ions at NIST, Dietrich Leibfried[1]; [1]*National Inst of Standards & Technology, USA.*

This presentation will give an overview of recent work on quantum information processing, quantum state control and precision spectroscopy on different species of atomic or molecular ions at NIST.

F2A.2 • 12:00 -- 12:45 (Plenary)
Quantum Simulation Using Hybrid Computing, Dieter Jaksch[1]; [1]*Univ. of Oxford, UK.*

Abstract not available.

Aula Magna Rettorato
14:15 -- 15:15
F3A • Boson Sampling

F3A.1 • 14:15 -- 14:45 (Invited)
Toward “quantum supremacy” with photons, Chaoyang Lu[1]; [1]*Univ of Science and Technology of China, China.*

We develop single-photon sources that simultaneously combines high purity, efficiency, and indistinguishability. We demonstrate entanglement among 12 single photons. We construct high-performance multi-photon boson sampling machines to race against classical computers.

F3A.2 • 14:45 -- 15:00
Probabilistic Fault-Tolerant Universal Quantum Computation and Sampling Problems in Continuous Variables, Giulia Ferrini[1]; [1]*Chalmers, Sweden.*

We define a quantum computational model with continuous variables composed of vacuum input states, a finite set of gates and homodyne detection. We prove universality, fault tolerance and, as a sampling problem, quantum advantage.

F3A.3 • 15:00 -- 15:15
Boson Sampling with Linear Loss is Classically Simulable, Jelmer Renema[1], Valery Shchesnovich[2], Raul Garcia-Patron[3]; [1]*Universiteit Twente, Netherlands;* [2]*Centro de Ciências Naturais e Humanas, Universidade Federal do ABC,, Brazil;* [3]*Centre for Quantum Information and Communication, Ecole Polytechnique de Bruxelles, Belgium.*

We show that boson sampling is classically simulable in the presence of linear loss (constant per-photon transmission). We discuss the impact that this has on experimental efforts to demonstrate a quantum advantage.

Aula Magna Regina Elena
14:15 -- 15:15
F3B • Quantum Simulation and Computing I

F3B.1 • 14:15 -- 14:45 (Invited)
Multilayer Coaxial Superconducting Circuits with Integrated 3D Wiring, Peter Leek[1]; [1]*ETH Zuerich, Switzerland.*

Superconducting circuits are one of the leading candidates for the realization of quantum computers, in particular for near-term applications which may already be reached with circuits consisting of a few hundred qubits, provided they are operated at high fidelity. Until recently, the topology of superconducting circuits has typically been constrained to two dimensions, which becomes difficult to scale as the number of qubits increases and control and measurement wiring is needed for qubits in the middle of large arrays. It is natural to explore new circuit topologies that incorporate wiring in the third dimension to solve this problem. In this talk I will present an overview of an approach that builds on a coaxially-symmetric circuit QED unit cell with out-of-plane wiring [1] that provides a simple route to scaling to grids of many qubits. In this approach, arrays of qubits and resonators can be fabricated on opposing sides of a substrate and capacitively coupled, while control and readout are achieved via off-chip coaxial wires which run perpendicular to the chip plane and are built into a precision micro-machined enclosure that provides a high-quality microwave environment for the circuit.

F3B.2 • 14:45 -- 15:00
Spin ensembles in diamond for sensing and many-body physics, Demitry Farufnik[1], Nir Bar-Gill[1]; [1]*Hebrew Univ. of Jerusalem, Israel.*

In this work, we enhance the coherence properties and spin concentrations of ensembles of Nitrogen-Vacancy centers in diamond towards efficient magnetic sensing and the studies of many-body dipolar dynamics

F3B.3 • 15:00 -- 15:15
Embedding Silicon Spin Qubits in Superconducting Circuits, Guoji Zheng[1,2], Nodar Samkharadze[1,2], Marc Noordam[1,2], Nima Kalhor[1,2], Delphine Brousse[3,2], Amir Sammak[3,2], Udson C. Mendes[4], Alexandre Blais[4,5], Giordano

Scappucci[1,2], Lieven M. Vandersypen[1,2]; [1]*Delft Univ. of Technology, Netherlands;* [2]*QuTech, Netherlands;* [3]*TNO, Netherlands;* [4]*Université de Sherbrooke, Canada;* [5]*Canadian Inst. for Advanced Research, Canada.*

We demonstrate the strong coupling between a single electron spin in silicon and a single photon in a superconducting microwave cavity. Using the same cavity we perform rapid high-fidelity single-shot readout of two-electron spin states.

Aula Organi Collegiali
14:15 -- 15:15
F3C • Single-photon Sources I

F3C.1 • 14:15 -- 14:45 (Invited)
Generation and manipulation of quantum frequency states of light with AlGaAs chips, Giorgio Maltese[1], Saverio Francesconi[1], Félicien Appas[1], Arnault Raymond[1], Aristide Lemaître[2], Maria Ines Amanti[1], Florent Baboux[1], Sara Ducci[1]; [1]*Université Paris Diderot, France;* [2]*Centre de Nanosciences et de Nanotechnologies, France.*

We demonstrate the generation and manipulation of frequency quantum states of light with AlGaAs integrated devices. The manipulation of the spectral wavefunction symmetry allows to obtain both bosonic and fermionic behaviors opening the way to the utilization of our platform in a large variety of quantum information tasks.

F3C.2 • 14:45 -- 15:00
Semiconductor-Superconductor Quantum Optoelectronics, Dmitry Panna[1], Shlomi Bouscher[1], Krishna Balasubramanian[1], Shimon Cohen[1], Dan Ritter[1], Alex Hayat[1]; [1]*Technion, Israel.*

We demonstrated experimentally Cooper-pair injection and enhanced light emission in super-semiconductor structures, proposed by us for enhanced two-photon gain, electrically-driven entangled-photon generation and Bell state analyzers. We also demonstrated high-T_c superconductor-semiconductor devices

F3C.3 • 15:00 -- 15:15
Quantum Calligraphy: Writing Single-Photon Emitters in a Two-Dimensional Materials Platform, Chandriker K. Dass[1,2], Matthew R. Rosenberger[3], Hsun-Jen Chuang[3], Saujan V. Sivaram[3], Kathleen M. Mccreary[3], Joshua R. Hendrickson[1], Berend T. Jonker[3]; [1]*Air Force Research Laboratory, USA;* [2]*KBRwyle, USA;* [3]*Naval Research Laboratory, USA.*

We present an AFM-based method for direct writing of single-photon emitters in WSe_2 monolayers on deformable polymer substrates. High quality emitters are observed with emission rates of 10^5 photons/second and single emission behavior up to 60 K.

Aula Magna Rettorato
16:00 -- 17:30
F4A • Integrated Photonics I

F4A.1 • 16:00 -- 16:30 (Invited)
Synchronizing Remote Quantum Network Stations Using an All-optical Method, Virginia D'Auria[1], Bruno Fedrici[1], Florian Kaiser[1], Laurent Labonté[1], Olivier Alibart[1], Sebastien Tanzilli[1]; [1]*CNRS, Institut de Physique de Nice, Université Côte d'Azur, France.*

We present an all-optical method for synchronizing remote quantum network stations dedicated to the generation or the storage of photonic entanglement. We apply our method to the connection of two sources emitting pairs of photons at telecom wavelengths. Our experimental setup is based on a pulsed telecom fiber laser operating at 2.5 GHz that pumps, after frequency doubling, two nonlinear waveguide photon-pair sources. Our synchronization scheme is validated via the implementation of a two-photon interference experiment performed at the relay station, i.e. where the Bell state measurement takes place. We show a raw visibility greater than 90%, obtained in the 4-fold coincidence counts, for a separation distance of 100 km between the photon-pair sources. This result demonstrates the relevance of our approach.

F4A.2 • 16:30 -- 16:45

Quantum dynamics of a few-photon microwave parametric oscillator, Zhaoyou Wang[1], Marek Pechal[1], Patricio Arrangoiz-Arriola[1], E. Alex Wollack[1], Amir Safavi-Naeini[1], Jeremy D. Witmer[1]; *[1]Stanford Univ., USA.*

We investigate quantum dynamics of a nonlinear superconducting parametric oscillator. We modulate a resonator's inductance to generate oscillation with only a 1-5 photons present. We perform tomography on the nonclassical states generated.

F4A.3 • 16:45 -- 17:00

Hamiltonian learning for the estimation of magnetic fields with nanoscale quantum sensors, Raffaele Santagati[1], Andrea Gentile[1], Sebastian Knauer[4], Simon Schmitt[2], Stefano Paesani[1], Christopher Granade[3], Nathan Wiebe[3], Christian Osterkamp[2], Liam McGuinness[2], Jianwei Wang[1], Mark Thompson[1], John Rarity[1], Fedor Jelezko[2], Anthony Laing[1]; *[1]School of Physics - QETLabs, Univ. of Bristol, UK; [2]Inst. of Quantum Optics, Ulm Univ., Germany; [3]Quantum Architectures and Computation Group, Microsoft Research, USA; [4]Centre of Excellence for Quantum Computation and Communication Technology, School of Physics, Univ. of New South Wales, Australia.*

Hamiltonian learning can be used to efficiently characterise quantum systems. Here we apply it to the estimation of magnetic fields with quantum sensors, achieving experimentally, room temperature sensing performance comparable to those of cryogenic set-ups.

F4A.4 • 17:00 -- 17:15

Chip-based squeezing at a telecom wavelength, François Mondain[2,1], Tommaso Lunghi[2,1], Alessandro Zavatta[3,4], Élie Gouzien[2,1], Florent Doutre[2,1], Marc de Micheli[2,1], Sebastien Tanzilli[2,1], Virginia D'Auria[2,1]; *[1]Institut de Physique de Nice (INPHYNI) CNRS UMR 7010, France; [2]Université Côte d'Azur, France; [3]Istituto Nazionale Di Ottica (INO-CNR), Italy; [4]Lens and Dept. of Physics Universita Di Firenze, Italy.*

We demonstrate a plug-and-play squeezing experiment entirely based on lithium-niobate integrated optics and commercial fiber components. We achieve -2 dB of squeezing confirming the validity of this original approach that opens to out-of-the-lab continuous-variable experiments.

F4A.5 • 17:15 -- 17:30

Scalable quantum optics with nanowires, Iman Esmaeil Zadeh[1], Ali Elshaari[2], Johannes W. Los[3], Ronan Gourgues[3], Julien Zichi[2], Klaus Joens[2], Sander N. Dorenbos[3], Val Zwiller[2], Silvania F. Pereira[1]; *[1]Applied Sciences, Delft Univ. of Technology, Netherlands; [2]Dept. of Applied Physics, Royal Inst. of Technology (KTH), Sweden; [3]Single Quantum B.V., Netherlands.*

Single-photon generation, processing, and detection are the three main components of any quantum optical circuit. We present our results on integration of semiconducting nanowire quantum dots, dielectric waveguides, and ultrahigh performance superconducting nanowire single-photon detectors.

Aula Magna Regina Elena
16:00 -- 17:30
F4B • Quantum Simulation and Computing II

F4B.1 • 16:00 -- 16:30 (Invited)
Engineering synthetic quantum systems with ultracold atoms and light, Leonardo Fallani[1]; [1]*European Lab for Non-Linear Spectroscopy, Italy.*

Abstract not available.

F4B.2 • 16:30 -- 16:45
Experimental realization of a bosonic version of the Su-Schrieffer-Heeger (SSH) model with Rydberg atoms, Vincent Lienhard[1], Sylvain de Léséleuc[1], Pascal Scholl[1], Daniel Barredo[1], Thierry Lahaye[1], Antoine Browaeys[1]; [1]*Institut d'Optique Graduate School, France.*

We report the realization of a symmetry protected topological phase of interacting bosons. Our setup is based on single atoms trapped in an array of optical tweezers, and excited to Rydberg states.

F4B.3 • 16:45 -- 17:00
Towards a new atom-ion experiment in Italy, Elia Perego[1,3], Amelia Detti[4], Lucia Duca[1], Marco Pomponio[3], Claudio E. Calosso[1], Marco De Pas[4,2], Carlo Sias[1,2]; [1]*INRIM, Italy;* [2]*LENS, Italy;* [3]*Politecnico di Torino, Italy;* [4]*Dipartimento di Fisica e Astronomia, Università degli Studi di Firenze, Italy.*

We report on an experiment that aims at realizing a novel atom-ion quantum mixture. Specifically, we focus on two main technical advancements: a scalable control system and a new radiofrequency drive for Paul traps.

S4D.1 • 17:00 -- 17:15
Simulating Universal Gaussian Circuits with Linear Optics, Levon Chakhmakhchyan[1], Nicolas Cerf[2]; [1]*Univ. of Bristol, UK;* [2]*Université libre de Bruxelles, Belgium.*

We develop a universal procedure for simulating sampling from arbitrary non-linear photonic Gaussian circuit with passive linear optics only, provided two-mode squeezed vacuum states are available as a prior resource.

F4B.5 • 17:15 -- 17:30
Topological quantum walks in the two-dimensional space of the transverse momentum of light, Alessio D'Errico[1], Filippo Cardano[1], Maria Maffei[1,2], Alexandre Dauphin[2], Raouf Barboza[1], Chiara Esposito[1], Bruno Piccirillo[1], Maciej Lewenstein[2,3], Pietro Massignan[2,4], Lorenzo Marrucci[1,5]; [1]*Univ. degli Studi di Napoli Federico II, Italy;* [2]*ICFO, Spain;* [3]*ICREA, Spain;* [4]*Universitat Politecnica de Catalunya, Spain;* [5]*CNR-ISASI, Italy.*

A new photonic platform allows implementing 2D Quantum Walks in the space of transverse wavevector components of a single light beam. Detection of an anomalous velocity demonstrates that this system simulates a Quantum Hall Insulator.

Aula Organi Collegiali
16:00 -- 17:30
F4C • Light-atom Interfaces

F4C.1 • 16:00 -- 16:30 (Invited)
Multiplexed Spin Photon Interfaces in Solid State Quantum Memories, Hugues de Riedmatten[1,2]; *[1]ICFO -Institut de Ciencies Fotoniques, Spain; [2]ICREA, Spain.*

We report experiments demonstrating entanglement between a single photon and a multimode solid-state spin wave quantum memory with on demand read-out. We also demonstrate a frequency multiplexed integrated quantum storage device.

F4C.2 • 16:30 -- 16:45
Quantum optics of cold atomic ensembles trapped in evanescent fields, Jérémy Raskop[1], Vladimir Corzo[1], Jérémy Berroir[1], Aveek Chandra[1], Alexandra sheremet[1], Baptiste Gouraud[1], Julien Laurat[1]; *[1]Laboratoire Kastler Brossel, France.*

By trapping cold atoms in the evanescent field of an optical nanofiber, we store and reflect guided pulses at the single-photon level. We also herald, store and read out a single waveguide-coupled collective atomic excitation.

F4C.3 • 16:45 -- 17:00
Cavity Quantum Electrodynamics with Dressed States of a Superconducting Artificial Atom, Watson Kuo[1], Yu-Han Chang[1], Dmytro Dubyna[1], Wei-Chen Chien[1], Chien-Han Chen[2], Cen-Shawn Wu[2]; *[1]Dept. of Physics, National Chung Hsing Univ., Taiwan; [2]Dept. of Physics, National Changhua Univ. of Education, Taiwan.*

We experimentally studied the microwave response of a transmon coupled to a co-planar waveguide resonator, which has two closely split resonance. Dressed states formed by driving one of the modes strongly interact with the other mode to present multiple photon processes with the cavity mode.

F4C.4 • 17:00 -- 17:15
Storage of single photons in a highly nonlinear medium based on Rydberg atoms, María Auxiliadora Padrón Brito[1], Pau Farrera[1], Emanuele Distante[1], David Paredes Barato[1], Georg Heinze[1], Hugues de Riedmatten[1,2]; *[1]ICFO - The Inst. of Photonic Sciences, Spain; [2]ICREA - Institució Catalana de Reçerca i Estudis Avançats, Spain.*

We demonstrate a medium with single-photon non-linearity based on cold Rydberg atoms, suitable for the mapping of a paired single photon. This opens the door to quantum interactions between single photons.

F4C.5 • 17:15 -- 17:30
Coherent excitation of a spin wave in an optically cooled nuclear ensemble, Dorian Gangloff[1], Gabriel Éthier-Majcher[1], Constantin Lang[1], Emil Denning[1,2], Jonathan Bodey[1], Daniel Jackson[1], Claire Le Gall[1], Mete Atature[1]; *[1]Cambridge Univ., UK; [2]Photonics, DTU, Denmark.*

We implement an all-optical access to the quantized electronic-nuclear spin transitions in a semiconductor quantum dot, and we perform coherent rotations of a collective nuclear spin excitation corresponding to a spin-wave called a nuclear magnon.

Saturday 6 April

Aula 3
09:00 -- 10:30
S1A • Quantum information II

S4B.1 • 09:00 -- 09:30 (Invited)
Two Qubit Control of Single Electron Spin Qubits in Silicon, David Zajac[1]; *[1]IBM Research Center, USA.*

Realizing robust two qubit gates has been one of the major hurdles for semiconductor spin qubits. Extremely long coherence times and high fidelity single qubit gates have been realized in spin qubits, but conventional exchange based two qubit couplings have suffered from a high sensitivity to charge noise. I will demonstrate a two qubit CNOT gate based on a conditional spin transition in a regime where the magnitude of the exchange interaction is small compared to the other terms in the two qubit Hamiltonian. Single qubit Rabi frequencies greater than 10 MHz are achieved by modulating the position of the two electrons in a spatially non-uniform magnetic field, while two qubit coupling is enabled by controlling the overlap of the two electron wavefunctions. Entanglement is verified by measuring the two qubit density matrix, with a CNOT operation time of ~200 ns.

S1A.2 • 09:30 -- 09:45
Selection and Amplification of Orbital Momentum Modes of Bright Squeezed Vacuum Light for High Resolution Quantum Measurements, Roman V. Zakharov[1], Olga V. Tikhonova[1]; *[1]M. V. Lomonosov Moscow State Univ., Russian Federation.*

Methods of selection and controllable amplification of modes with different orbital angular momentum of bright squeezed light are developed. Minimization of correlation losses is demonstrated. Ultrahigh resolution measurements using selected correlated twisted beams are discussed.

S1A.3 • 09:45 -- 10:00
Using Entanglement for Quantum-Optimal Loss Estimation, Ranjith Nair[1]; *[1]National Univ. of Singapore, Singapore.*

We study ancilla-assisted schemes for estimating multiple optical loss parameters under energy constraints and derive an optimal class of probe states and quantum measurements. Probes and measurements realizable using current technology are also presented.

S1A.4 • 10:00 -- 10:15
Robust reconstruction of the joint spectral phase of two photons, Ilaria Gianani[1]; *[1]Science, Università di Roma Tre, Italy.*

We discuss a novel multi-shear approach to reconstruct the joint spectral phase of two entangled photons. We report on simulations for the phase reconstruction and propose an experiment using a Franson-like modified interferometer.

S1A.5 • 10:15 -- 10:30
Restoring Heisenberg scaling in noisy quantum metrology by monitoring the environment, Francesco Albarelli[2,3], Matteo Rossi[1], Dario Tamascelli[3], Marco Genoni[3]; *[1]Univ. of Turku, Finland; [2]Dept. of Physics, Univ. of Warwick, UK; [3]Dipartimento di Fisica, Università degli Studi di Milano, Italy.*

We study quantum frequency estimation for qubits subjected to independent Markovian noise, via time-continuous monitoring of the environment, showing, among other things, that perfectly efficient detection allows for restoring Heisenberg limit.

Aula 4
09:00 -- 10:30
S1B • Quantum Protocols

S1B.1 • 09:00 -- 09:30 (Invited)
Quantum Machine Learning of Quantum Properties, Vittorio Giovannetti[1]; [1]*Scuola Normale Superiore di Pisa, Italy.*

Abstract not available.

S1B.2 • 09:30 -- 09:45
An experimental quantum Bernoulli factory, Raj Patel[1,2], Terry Rudolph[3], Geoff J. Pryde[1]; [1]*Griffith Univ., Australia;* [2]*Dept. of Physics, Univ. of Oxford, UK;* [3]*Dept. of Physics, Imperial College London, UK.*

Randomness processing in a Bernoulli factory has been identified as an area where a quantum advantage may exist. We report two quantum photonic implementations of a Bernoulli factory which demonstrate large reductions in resources over their classical counterpart.

S1B.3 • 09:45 -- 10:00
Quantum random number generation with partially characterised devices based on bounded energy, Davide Rusca[2], Thomas Van Himbeeck[1], Jonatan Brask[3], Anthony Martin[2], Stefano Pironio[1], Nicolas Brunner[2], Hugo Zbinden[2]; [1]*Université libre de Bruxelles, Belgium;* [2]*Université de Genève, Switzerland;* [3]*Technical Univ. of Denmark, Denmark.*

We demonstrate quantum random number generation with partially characterised devices based on a natural, physical assumption { a bound on the energy transmitted between preperations and measurements. We achieve a random bit rate above 1 MHz.

S1B.4 • 10:00 -- 10:15
Quantum violation of an Instrumental test, Rafael Chaves[1], Gonzalo Carvacho[2], Iris Agresti[2], Valerio Di Giulio[2], Leandro Aolita[3], Sandro Giacomini[2], Fabio Sciarrino[2]; [1]*International Inst. of Physics, Brazil;* [2]*La Sapienza Univ. of Rome, Italy;* [3]*Instituto de Física, Universidade Federal do Rio de Janeiro, Brazil.*

Causal inference aims to determine, from collected data, what are the casual relations among the observables. Here, we investigate the simplest scenario that exhibits a discrepancy between classical and quantum predictions, i.e. the *instrumental process*.

S1B.5 • 10:15 -- 10:30
Seedless ultrafast source-device independent quantum random number generator, Marco Avesani[1], Davide G. Marangon[1], Giuseppe Vallone[1,2], Paolo Villoresi[1,2]; [1]*Information Engineering, Univ. of Padova, Italy;* [2]*CNR, Istituto di Fotonica e Nanotecnologie, Italy.*

We present a new source-device-independent protocol for quantum random number generation valid for arbitrary POVM. We experimentally implemented it using heterodyne detection reaching more than 17 Gbps of secure generation rate.

Aula Cabibbo
09:00 -- 10:30
S1C • Quantum Technology I

S1C.1 • 09:00 -- 09:30 (Invited)
Generation of quantum light in a photon-number superposition, Pascale Senellart[1], Juan Loredo[1], Carlos Anton[1], Bogdan Reznychenko[2], Paul Hilaire[1], Abdelnoumain Harouri[1], Clement Millet[1], Hélène Ollivier[1], Niccolo Somaschi[3], Lorenzo De Santis[1], Aristide Lemaitre[1], Loic Lanco[1], Alexia Auffeves[2], Olivier Krebs[1]; *[1]CNRS-C2N, France; [2]Institut Neel, France; [3]QUANDELA -SAS, France.*

We report on the generation of pure quantum light states in a photon-number superpositions of zero-, one-, and even two-photons from the spontaneous emission of a single semiconductor quantum dot.

S1C.2 • 09:30 -- 09:45
Optical Back-action Evading Measurement of Mechanical Oscillator, Liu Qiu[1], Itay Shomroni[1], Daniel Malz[2], Andreas Nunnenkamp[2], Tobias J. Kippenberg[1]; *[1]École Polytechnique Fédérale de Lausanne, Switzerland; [2]Cavendish Laboratory, Univ. of Cambridge, UK.*

Quantum mechanics sets a limit on continuous position measurement of a harmonic oscillator, due to quantum backaction from quantum fluctuations in the measurement field. We demonstrate continuous optical two-tone backaction-evading measurement of a mechanical mode of a photonic crystal nanobeam.

S1C.3 • 09:45 -- 10:00
Current tests of collapse models: How far can we push the limits of quantum mechanics?, Matteo Carlesso[1,2], Angelo Bassi[1,2]; *[1]Univ. of Trieste, Italy; [2]INFN, Italy.*

Collapse models implement a progressive loss of quantum coherence when the mass and the complexity of quantum systems increase. We will review such models and the current attempts to test their predicted loss of quantum coherence.

S1C.4 • 10:00 -- 10:15
Quantum Measurement and Control of a Mechanical Resonator, Massimiliano Rossi[1,2], David Mason[1,2], Junxin Chen[1,2], Yeghishe Tsaturyan[1], Albert Schliesser[1,2]; *[1]Niels Bohr Inst., Univ. of Copenhagen, Denmark; [2]Center for Hybrid Quantum Networks (Hy-Q), Niels Bohr Inst., Univ. of Copenhagen, Denmark.*

We measure mechanical displacements within 35% of the Heisenberg limit, allowing to both track the quantum trajectory of the highly pure (purity 80%) mechanical state conditioned on this measurement, and ground-state cool via quantum feedback.

S1C.5 • 10:15 -- 10:30
Quantum noise limited microwave to optics conversion, Robert Stockill[1], Moritz Forsch[1], Andreas Wallucks[1], Igor Marinkivic[1], Claus Gaertner[2], Richard A. Norte[1], Frank van Otten[3], Andrea Fiore[3], Kartik Srinivasan[4], Simon Groeblacher[1]; *[1]TU Delft, Netherlands; [2]Vienna Center for Quantum Science and Technology, Austria; [3]Dept. of*

Applied Physics and Inst. for Photonic Integration, Netherlands; [4]Center for Nanoscale Science and Technology, National Inst. of Standards and Technology, USA.

We present coherent conversion between microwave and optical signals with an electro-optomechanical device close to its quantum groundstate, such that less than a single quantum of noise is added to the converted signal.

Aula 7
09:00 -- 10:30
S1D • Quantum Networks I

S1D.1 • 09:00 -- 09:30 (Invited)

Entanglement-Based Quantum Networking, Rob Thew[1]; *[1]Universite de Geneve, Switzerland.*

We discuss some of the challenges for the generation, distribution, control, measurement, and certification of quantum resources like entanglement in quantum communication networks. This spans integrated photonic devices to certifying multi-partite entanglement.

S1D.2 • 09:30 -- 09:45

Atom-to-Photon Quantum State Mapping into the Telecom Range, Stephan Kucera[1], Matthias Bock[1], Pascal Eich[1], Christoph Becher[1], Jürgen Eschner[1]; *[1]Saarland Univ., Germany.*

We demonstrate direct mapping of an atomic qubit onto the polarization qubit of a single 854-nm photon and subsequent high-fidelity, polarization-preserving quantum frequency conversion to the low-loss 1310-nm telecom range for fiber-based quantum communication.

S1D.3 • 09:45 -- 10:00

Direct measurement of the recovery time of SNSPDs and its application for quantum communication, Claire Autebert[1], Matthieu Perrenoud[1], Misael Caloz[1], Gaëtan Gras[1,2], Emna Amri[1,2], Hugo Zbinden[1], Félix Bussières[1,2]; *[1]Université de Genève - GAP, Switzerland; [2]Id Quantique, Switzerland.*

In this paper we demonstrate a simple and highly sensitive method to characterize the recovery time of efficiency for different kind of superconducting nanowire single-photon detectors. We also describe several applications of these detectors.

S1D.4 • 10:00 -- 10:15

Quantum memory decoherence-mitigating architecture for quantum repeaters, Siddhartha Santra[1], Liang Jiang[2], Vladimir Malinovsky[1]; *[1]US Army Research Laboratory, USA; [2]Yale Univ., USA.*

We propose a nested quantum repeater architecture that mitigates quantum memory decoherence by optimizing the memory access time. This maximizes the distillable entanglement rate in the remote entangled state for technologically feasible repeater parameter regimes.

S1D.5 • 10:15 -- 10:30

Towards broadband optical spin-wave quantum memory, Alexey Tiranov[1], Moritz Businger[1], Sacha Welinski[2], Alban Ferrier[2,3], Philippe Goldner[2], Nicolas Gisin[1], Mikael Afzelius[1]; *[1]Univ. of Geneva, Switzerland; [2]Chimie ParisTech, PSL Univ., CNRS, Institut de Recherche de Chimie Paris, France; [3]Sorbonne Universite, France.*

Here we demonstrate a spin-wave storage realized in ^{171}Yb:YSO crystal, with storage times beyond 1 ms thanks to the simultaneous clock condition for optical and microwave transitions. These results represent a step towards realizing a long-lived, broadband and multimode solid-state quantum memory.

Aula 3
11:15 -- 13:15
S2A • Quantum Communication

S2A.1 • 11:15 -- 11:45 (Invited)

Space Quantum Communication with Higher Orbits, Luca Calderaro[1,2], Costantino Agnesi[1,2], Daniele Dequal[3], Francesco Vedovato[1,2], Matteo Schiavon[1,2], Alberto Santamato[1], Vincenza Luceri[4], Giuseppe Bianco[3], Giuseppe Vallone[1,2], Paolo Villoresi[1,2]; *[1]Dipartimento di Ingegneria dell'Informazione, Universita di Padova, Italy; [2]Istituto Nazionale di Fisica Nucleare (INFN) - sezione di Padova, Italy; [3]Matera Laser Ranging Observatory, Agenzia Spaziale Italiana, Italy; [4]e-GEOS SpA, Italy.*

Exchanging qubits from MEO orbits allows extending secure communications to critical infrastructures as well as enable the investigation of the interplay of Quantum and Gravitational Physics. The experimental demonstration of feasibility and perspectives are reported.

S2A.2 • 11:45 -- 12:15 (Invited)

Towards a Global Quantum Communication Network Using Ground to Space Quantum Links, Thomas Jennewein[1]; *[1]Univ. of Waterloo, Canada.*

Abstract not available.

S2A.3 • 12:15 -- 12:30

High-Dimensional Quantum Cryptography using Twisted Photons: from the Laboratory to realistic conditions, Frederic Bouchard[1], Alicia Sit[1], Felix Hufnagel[1], Robert Fickler[1], Khabat Heshami[2], Robert Boyd[1], Ebrahim Karimi[1]; *[1]Univ. of Ottawa, Canada; [2]National Research Council of Canada, Canada.*

We investigate various high-dimensional quantum cryptographic protocols using twisted photons and their feasibility in realistic conditions. In particular, we perform quantum key distribution in an intra-city free-space link and an underwater channel.

S2A.4 • 12:30 -- 12:45

Quantum teleportation using coherent emission from telecom C-band quantum dots, Tina Muller[3], Matthew Anderson[3], Jan Huwer[3], Joanna Skiba-Szymanska[3], Andrey Krysa[1], Mark Stevenson[3], Jon Heffernan[1], David Ritchie[2], Andrew Shields[3]; *[1]Univ. of Sheffield, UK; [2]Cavendish Laboratory, Univ. of Cambridge, UK; [3]Quantum information group, Toshiba Research Europe, UK.*

We demonstrate that InP based quantum dots emitting near the telecom Cband can provide photons with coherence times exceeding 1 ns, enabling near optimal two-photon interference as well as teleportation of a C-band laser qubit.

S2A.5 • 12:45 -- 13:00

Entanglement between Nitrogen-Vacancy spin in diamond and Telecom frequency photon, Sophie Hermans[1], Anna Tchebotareva[2], Peter Humphreys[1], Ronald Hanson[1]; *[1]TU Delft, Netherlands; [2]TNO, Netherlands.*

We experimentally demonstrate the preservation of entanglement between an NV spin and a photon upon quantum frequency conversion to the Telecom band. This is a crucial step in realizing long-distance quantum networks.

S2A.6 • 13:00 -- 13:15

All-photonic quantum teleportation and entanglement swapping using on-demand solid-state quantum emitters, Davide Tedeschi[1], Francesco Basso Basset[1], Michele Rota[1], Christian Schimpf[2], Katharina Zeuner[3], Marcus Reindl[2], Daniel Huber[2], Saimon F. da Silva[2], Huiying Huang[2], Val Zwiller[3], Klaus Joens[3], Armando Rastelli[2], Rinaldo Trotta[1]; *[1]Università di Roma La Sapienza, Italy; [2]Inst. of Semiconductor and Solid State Physics, Austria; [3]Dept. of Applied Physics, Sweden.*

Quantum teleportation and entanglement swapping represent pivot concepts in quantum information science. Here, we show that entangled photon pairs generated on-demand by quantum-dots can be used to implement successfully quantum teleportation and entanglement swapping protocols

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Aula 4
11:15 -- 13:15
S2B • Continuous-variables Quantum Information

S2B.1 • 11:15 -- 11:45 (Invited)

A time-domain multiplexed measurement-based large-scale optical quantum computer, Akira Furusawa[1]; *[1]Univ. of Tokyo, Japan.*

I will explain the methodology of a time-domain multiplexed measurement-based optical quantum computer. It can be large-scale and fault-tolerant in principle.

S2B.2 • 11:45 -- 12:15 (Invited)

Quantum Frequency Comb for Quantum Complex Networks, Luca La Volpe[1], Syamsundar De[1], Tiphaine Kouadou[1], Thibault Michel[1], Young-Sik Ra[1], Mattia Walschaers[1], Claude Fabre[1], Nicolas Treps[1], Valentina Parigi[1]; *[1]Laboratoire Kastler Brossel, France.*

The experimental implementation of large multipartite entangled state in the time and frequency domain is realised via optical frequency comb and parametric process. We discuss the implementation of quantum complex networks and their non-Gaussian features

S2B.3 • 12:15 -- 12:30

Quantum non-Gaussian multiphoton light, Radim Filip[1], Lukáš Lachman[1], Ivo Straka[1], Josef Hloušek[1], Miroslav Jezek[1]; *[1]Palacky Univ., Czechia.*

We propose a faithful hierarchy of genuine n-photon quantum non-Gaussian light for connections between quantum devices and for diagnostic of multiphoton sources and processes in quantum technology. We experimentally witnessed 3-photon quantum non-Gaussian light.

S2B.4 • 12:30 -- 12:45

Frequency-dependent squeezed states for gravitational-wave detection through EPR entanglement, Jan Gniesmer[1], Mikhail Korobko[1], Sebastian Steinlechner[1], Roman Schnabel[1]; *[1]Institut für Laserphysik, Germany.*

Here, we show the status of a table-top setup to generate frequency-dependent phase rotation of detuned squeezed vacuum states utilizing cavity reflection. This setup simulates a gravitational-wave detector.

S2B.5 • 12:45 -- 13:00

Photon-Subtracted Continuous-Variable Graph States, Mattia Walschaers[1], Valentina Parigi[1], Nicolas Treps[1]; *[1]Laboratoire Kastler Brossel, France.*

Mode-selective photon subtraction is a viable method to introduce non-Gaussian features in continuous-variable graph states. Non-Gaussian properties are shown to spread up to next-to-nearest neighbours of the graph's vertex in which the photon was subtracted.

S4D.2 • 13:00 -- 13:15

Quasiprobability Representation for Quantum Correlations and Measurements, Jan Sperling[1], E. Meyer-Scott[1], J. Tiedau[1], M. Bohmann[2], S. Barkhofen[1], B. Brecht[1], T. Bartley[1], W. Vogel[3], I. A. Walmsley[4], Christine Silberhorn[1]; *[1]Univ. of Paderborn, Germany; [2]INO-CNR and LENS, QSTAR, Italy; [3]Univ. of Rostock, Germany; [4]Univ. of Oxford, UK.*

Quasiprobabilities provide an intuitive means for characterizing quantum states. Here we present a unified framework that combines recent theoretical advances, and we discuss experimental implementations, such as the first reconstruction of entanglement quasiprobabilities.

Aula Cabibbo
11:15 -- 13:15
S2C • Integrated Photonics II

S2C.1 • 11:15 -- 11:45 (Invited)

Manipulation of quantum information in fs-laser-written photonic circuits, Roberto Osellame[1]; *[1]Inst. for Photonics and Nanotechnologies (IFN), National Research Council (CNR), Italy.*

The use of integrated photonics in quantum optics has introduced dramatic improvements in terms of stability and scalability. In particular, femtosecond laser direct writing of photonic circuits has enabled advanced quantum simulation and computation tasks.

S2C.2 • 11:45 -- 12:15 (Invited)

Quantum simulations in integrated photonics, Anthony Laing[1]; *[1]Univ. of Bristol, UK.*

Modelling and simulating the dynamics of quantum mechanical systems, such as molecules, is a key application of quantum information processing technologies. Here we discuss recent progess in demonstrating integrated photonics as a quantm simulation platform.

S2C.3 • 12:15 -- 12:30

High-dimensional one-way quantum processing enabled by optical *d*-level cluster states, Michael Kues[1,2], Christian Reimer[2,3], Stefania Sciara[2,5], Piotr Roztocki[2], Mehedi Islam[2], Luis Romero Cortés[2], Yanbing Zhang[2], Bennet Fischer[2], Sébastien Loranger[4], Raman Kashyap[4], Alfonso Cino[5], Sai T. Chu[6], Brent E. Little[7], David J. Moss[8], Lucia Caspani[9], William J. Munro[10,11], José Azaña[2], Roberto Morandotti[2,12]; *[1]Univ. of Glasgow, UK; [2]Institut National de la Recherche Scientifique (INRS-EMT), Canada; [3]Harvard Univ., USA; [4]Polytechnique Montreal, Canada; [5]Univ. of Palermo, Italy; [6]City Univ. of Hong Kong, Hong Kong; [7]Chinese Academy of Science, China; [8]Swinburne Univ. of Technology, Australia; [9]Univ. of Strathclyde, UK; [10]NTT Corporation, Japan; [11]National Inst. of Informatics, Japan; [12]ITMO Univ., Russian Federation.*

By introducing and modifying two-photon hyper-entangled states in the time-frequency domain using an on-chip micro-cavity, we succeed in generating high-dimensional cluster states, demonstrate *d*-level measurement-based quantum processing and show the state's higher noise tolerance.

S2C.4 • 12:30 -- 12:45

Interference in multi-photon emission from photon pair sources with shaped spectral amplitudes, Bryn Bell[2], Gil Triginer Garces[2], Chris Wade[2], Benjamin J. Eggleton[1], Ian A. Walmsley[2]; *[1]Univ. of Sydney, Australia; [2]Physics, Univ. of Oxford, UK.*

Multi-photon interference is observed between frequency channels in the higher-order emission from individual photon pair sources, using pulse shaping of the pump laser. I will also discuss applications to phase-sensitive spectral characterisation of pair sources.

S2C.5 • 12:45 -- 13:00

Si_3N_4 Reconfigurable Linear Optical Network for Quantum Information Processing, Caterina Taballione[1], Tom A. Wolterink[2], Jasleen Lugani[2], Andreas Eckstein[2], Bryn Bell[2], Robert Grootjans[3], Ilka Visscher[3], Dimitri Geskus[3], Chris G. Roeloffzen[3], Jelmer Renema[1], Ian A. Walmsley[2], Pepijn W. Pinkse[1], Klaus-Jochen Boller[1]; *[1]Univ. of Twente, Netherlands; [2]Univ. of Oxford, UK; [3]LioniX International, Netherlands.*

Integrated universal linear optical networks are essential for the development of quantum information processing (QIP). We demonstrate a universal, reconfigurable, 8×8 photonic processor based on waveguides showing a variety of QIP primitives.

S2C.6 • 13:00 -- 13:15

Validation of multi-photon interference in photonic boson sampling, Taira Giordani[3], Fulvio Flamini[3], Matteo Pompili[3], Niko Viggianiello[3], Nicolò Spagnolo[3], Andrea Crespi[1,2], Roberto Osellame[1,2], Nathan Wiebe[4], Mattia Walschaers[5,6], Andreas Buchleitner[6], Fabio Sciarrino[3]; *[1]Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche (IFN-CNR), Italy; [2]Dipartimento di Fisica, Politecnico di Milano, Italy; [3]Dipartimento di Fisica, Sapienza Università di Roma, Italy; [4]Station Q Quantum Architectures and Computation Group, Microsoft Research, USA; [5]Laboratoire Kastler Brossel, UPMC-Sorbonne Universités, CNRS, ENS-PSL Research Univ., Collège de France, CNRS, France; [6]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Germany.*

Multi-photon interference is believed to have a fundamental role for obtaining a quantum advantage. In this work we discuss a reliable and efficient technique to find a signature of its presence in boson sampling experiments.

Aula 7
11:15 -- 13:15
S2D • Quantum Simulation and Computing III

S2D.1 • 11:15 -- 11:45 (Invited)

Networking Trapped-ion Quantum Computers, Christopher J. Ballance[1], Laurent Stephenson[1], David Nadlinger[1], Bethan Nichol[1], Shuoming An[1], Joseph Goodwin[1], Peter Drmota[1], David M. Lucas[1]; *[1]Univ. of Oxford, UK.*

We discuss a scalable approach to networking trapped-ion quantum processors. We present initial networking results, showing that we can connect registers of near-perfect trapped-ion data qubits via a flexible photonic link.

S2D.2 • 11:45 -- 12:15 (Invited)

Quantum Computing and Simulation with Trapped Atomic Ions, Guido Pagano[1], Patrick Becker[1], Allison Carter[1], Marko Cetina[1], Kate Collins[1], Clay Crocker[1], Laird Egan[1], Michael Goldman[1], Alexey Gorshkov[1], Antonis Kyprianidis[1],

Harvey Kaplan[1], Kevin Landsman[1], Martin Lichtman[1], Norbert Linke[1], Fangli Liu[1], Drew Risinger[1], Ksenia Sosnova[1], Wen Lin Tan[1], Daiwei Zhu[1], Christopher R. Monroe[1,2]; [1]*Univ. of Maryland, USA;* [2]*IonQ, Inc, USA.*

I will review some of the latest results in both gate-based quantum computing and analog quantum simulation, speculating on how this platform can realistically be scaled in the near future.

S2D.3 • 12:15 -- 12:30

Quantum Computing with Radiofrequency-driven Trapped Atomic Ions, Theeraphot Sriarunothai[1], Sabine ^. Wölk[2,1], Gouri Giri[1], Nicolai Friis[3,2], Vedran Dunjko[2,4], Hans Briegel[2,5], Peter Kaufmann[1], Timm Gloger[1], Delia Kaufmann[1], Michael Johanning[1], Christof Wunderlich[1]; [1]*Universität Siegen, Germany;* [2]*Univ. of Innsbruck, Austria;* [3]*Austrian Academy of Sciences, Austria;* [4]*Max Planck Inst. for Quantum Optics, Germany;* [5]*Univ. of Konstanz, Germany.*

A programmable quantum computer based on trapped ions interacting via magnetic gradient induced coupling (MAGIC) is used for reinforcement learning. Quantum information encoded in hyperfine qubits is preserved with 99.9994(+6-7)% fidelity during ion transport.

S2D.4 • 12:30 -- 12:45

Spatial entanglement and Einstein-Podolsky-Rosen steering in a Bose-Einstein condensate, Tilman Zibold[1], Matteo Fadel[1], Boris Decamps[1], Philipp Treutlein[1]; [1]*Dept. of Physics, Univ. of Basel, Switzerland.*

We investigate the spatial entanglement in a spin squeezed Bose-Einstein condensate. The spin correlations found between different spatial regions go beyond classical correlations and reveal spatial non-separability and Einstein-Podolsky-Rosen steering in this many-body system.

S2D.5 • 12:45 -- 13:00

Repeated multi-qubit readout and feedback with a mixed-species trapped-ion register, Matteo Marinelli[1], Jonathan Home[1]; [1]*ETH Zurich, Switzerland.*

Using a mixed-species ion chain, we demonstrate up to 50 sequential parity measurements between two beryllium ion qubits coupled to a co-trapped ancillary calcium ion. With feedback on the beryllium qubits conditioned on the ancilla readout we stabilize Bell states and parity subspaces.

S2D.6 • 13:00 -- 13:15

Experimental Quantum Darwinism simulator using photonic cluster states, Mario Arnolfo Ciampini[2,1], Giorgia Pinna[2], Mauro Paternostro[3], Paolo Mataloni[2]; [1]*Univ. of Vienna, Austria;* [2]*Dipartimento di Fisica, La Sapienza Univ. of Rome, Italy;* [3]*Centre for Theoretical Atomic, Molecular and Optical Physics, Queen's Univ., UK.*

We investigate the emergence of Quantum Darwinism in a photonic cluster as simulator of interactions between a quantum system and its environment. We demonstrate experimentally the effect of correlations in the emergence of objective reality.

Aula 3
14:30 -- 16:00
S3A • Quantum Measurements

S3A.1 • 14:30 -- 15:00 (Invited)

Indistinguishability as a quantum information resource by localized measurements, Alessia Castellini[1], Bruno Bellomo[2], Giuseppe Compagno[1], Rosario Lo Franco[3]; *[1]Dipartimento di Fisica e Chimica, Università degli Studi di Palermo, Italy; [2]Institut UTINAM - UMR 6213, CNRS, Université Bourgogne Franche-Comté, France; [3]Dipartimento di Energia, Ingegneria dell'Informazione e Modelli Matematici, Università degli Studi di Palermo, Italy.*

Quantum networks are typically made of identical subsystems. Exploiting indistinguishability as a direct quantum resource would thus be highly desirable. We show this is achievable by spatially localized measurements, enabling teleportation and entanglement swapping protocols.

S3A.2 • 15:00 -- 15:15
Quantum measurements of time, Lorenzo Maccone[1,2]; *[1]Universita degli Studi di Pavia, Italy; [2]infn, Italy.*

We propose a time-of-arrival operator in quantum mechanics by conditioning on a quantum clock. This allows us to obtain a time of arrival operator which has a clear physical interpretation.

S3A.3 • 15:15 -- 15:30
Airborne and underground matter-wave interferometers: geodesy, navigation and general relativity, Devang Naik[1], Andrea Bertoldi[1], Baptiste Batteleir[1], Benjamin Canuel[1], Philippe Bouyer[1]; *[1]Institut d'Optique - CNRS, France.*

Matter-wave interferometers are today at forefront of precision inertial measurements. They provide the best precision for precise monitoring of gravity or for precise tests of general relativity. I present here some recent advances in these fields.

S3A.4 • 15:30 -- 15:45
The quantum measurement problem: a dynamical approach, Antonella De Pasquale[1], Caterina Foti[1], Alessandro Cuccoli[1], Vittorio Giovannetti[2], Paola Verrucchi[3]; *[1]Physics and Astronomy, Univ. of Florence, Italy; [2]Scuola Normale Superiore, Italy; [3]Istituto dei Sistemi Complessi, Consiglio Nazionale delle Ricerche, Italy.*

We provide a generalization of the von Neumann dynamical model for quantum projective measurements to the case of arbitrary POVMs.

S3A.5 • 15:45 -- 16:00
Quantum sensing using Rydberg atoms, Arthur Larrouy[1]; *[1]Laboratoire Kastler Brossel, France.*

We prepare non-classical states of Rydberg atoms and use them as probes to measure electric and magnetic fields with a sensitivity below the standard quantum limit.

Aula 4
14:30 -- 16:00
S3B • Quantum Information III

S3B.1 • 14:30 -- 15:00 (Invited)
Quantum-Assisted Machine Learning in Near-Term Quantum Devices, Alejandro Perdomo[1]; *[1]Zapata Computing, USA.*

With quantum computing technologies nearing the era of commercialization and quantum advantage, machine learning (ML) has been proposed as one of the promising killer applications. Despite significant effort, there has been a disconnect between most quantum ML proposals, the needs of ML practitioners, and the capabilities of near-term quantum devices towards a conclusive demonstration of a meaningful quantum advantage in the near future. In this talk, we provide concrete examples of intractable ML tasks that could be enhanced with near-term devices. We argue that to reach this target, the focus should be on areas where ML researchers are struggling, such as generative models in unsupervised and semi-supervised learning, instead of the popular and more tractable supervised learning tasks. We focus on hybrid quantum-classical approaches and illustrate some of the key challenges we foresee for near-term implementations. We will present as well recent experimental implementations of these quantum ML models in both, superconducting-qubit and ion-trap quantum computers.

S3B.2 • 15:00 -- 15:15
Characterizing large-scale quantum devices, Joel J. Wallman[1,2], Joseph Emerson[1,2]; [1]*Univ. of Waterloo, Canada;* [2]*Quantum Benchmark Inc., Canada.*

Characterizing large-scale quantum devices is challenging because quantum noise processes are complex. We present a method for efficiently characterizing general operations in quantum devices with signal-to-noise ratios independent of the system size.

S3B.3 • 15:15 -- 15:30
Experimental Entanglement of Temporal Orders, Lee Rozema[1], Giulia Rubino[1], Francesco Massa[1], Mateus Araújo[2], Magdalena Zych[3], Caslav Brukner[1], Philip Walther[1]; [1]*Univ. of Vienna, Austria;* [2]*Univ. of Cologne, Germany;* [3]*Univ. of Queensland, Australia.*

Various physical systems have been entangled, never the temporal order between events. Here we do just that, and then use the entanglement to create and characterize a process with genuinely indefinite temporal order.

S3B.4 • 15:30 -- 15:45
Sensitivity Limits for Multiparameter Quantum Metrology, Manuel Gessner[2,1], Luca Pezzè[1], Augusto Smerzi[1]; [1]*QSTAR, INO-CNR, and LENS, Italy;* [2]*Département de Physique, École Normale Supérieure, France.*

We present sensitivity limits for a multimode interferometer as matrix bounds for the covariance matrix. Quantum strategies to improve the precision beyond classical limits may consist in entanglement among the modes or among the particles.

S3B.5 • 15:45 -- 16:00
Joint Entanglement Between Topology and Polarization Ensures Noise-Resistant Quantum Information Processing, Alexander V. Sergienko[1], David S. Simon[2,1], Shuto Osawa[1]; [1]*Boston Univ., USA;* [2]*Stonehill College, USA.*

Linear-optical photonic quantum walks are used to jointly entangle polarization and winding number. The joint entanglement between distributed and localized parameters ensures quantum information processing tasks enjoy a high degree or error protection.

Aula Cabibbo
14:30 -- 16:00
S3C • Quantum Technology II

S3C.1 • 14:30 -- 15:00 (Invited)
Solid-state quantum interfaces of spins and photons, Mete Atature[1]; [1]*Cambridge Univ., UK.*

I will present an overview of the current progress and challenges of solid-state spin-photon interfaces highlight the diamond group-IV vacancy centres and the semiconductor quantum dots.

S3C.2 • 15:00 -- 15:15
Optimal control of diamond spin qubits for quantum sensing in noisy environments, Francesco Poggiali[1,2], Santiago Hernández-Gómez[1,2], Paola Cappellaro[3,1], Nicole Fabbri[1,2]; *[1]European Laboratory for Non linear Spectroscopy, Università degli Studi di Firenze, Italy; [2]CNR-INO Istituto Nazionale di Ottica del Consiglio Nazionale delle Ricerche, Italy; [3]Dept. of Nuclear Science and Engineering, Massachusetts Inst. of Technology, USA.*

We devise a robust quantum sensing scheme based on optimal control. We experimentally demonstrate sensitivity enhancement of diamond spin-qubits sensors to measure ultraweak time-varying magnetic fields in noisy environments.

S3C.3 • 15:15 -- 15:30
Entanglement and Force Sensing with Massive Mechanical Oscillators, Matt Woolley[1]; *[1]UNSW Canberra, Australia.*

We describe the first demonstrations of the measurement of mechanical motion in a negative-mass reference frame and stabilisation of the entanglement between massive mechanical oscillators [C. F. Ockeloen-Korppi et al., Nature 556, 478-482 (2018)].

S3C.4 • 15:30 -- 15:45
Nanophotonic near-field levitated optomechanics, Lorenzo Magrini[1], Richard A. Norte[2], Ralf Riedinger[1], Igor Marinkivic[2], David Grass[1], Uros Delic[1], Simon Groeblacher[2], Sungkun Hong[1], Markus Aspelmeyer[1]; *[1]Univ. of Vienna, Austria; [2]TU Delft, Netherlands.*

Optical levitation of dielectric particles is a promising platform for room temperature quantum optomechanics. The challenge is to control the mechanical motion at the Heisenberg uncertainty limit. We present a nanophotonic interface enabling strong and efficient measurements.

S3C.5 • 15:45 -- 16:00
Measuring Motion Below the Standard Quantum Limit by Strong Optomechanical Quantum Correlations, Junxin Chen[1], David Mason[1], Massimiliano Rossi[1], Yeghishe Tsaturyan[1], Albert Schliesser[1]; *[1]Niels Bohr Inst., Denmark.*

In interferometric displacement and force measurement, the tradeoff between imprecision noise and quantum backaction sets the standard quantum limit (SQL). By exploiting quantum correlations in an optomechanical system, we demonstrate the first sub-SQL interferometric measurement.

Aula 7
14:30 -- 16:00
S3D • Quantum Sensors

S3D.1 • 14:30 -- 15:00 (Invited)
Single-Ion Clocks for Tests of Fundamental Physics and Applications in Quantum Technology, Nils Huntemann[1], Christian Sanner[1], Richard Lange[1], Moustafa Abdel-Hafiz[1], Jiehang Zhang[1], Hu Shao[1], Christian Tamm[1], Ekkehard Peik[1]; *[1]Physikalisch-Technische Bundesanstalt, Germany.*

From long-term frequency comparisons of our two $^{171}Yb^{+}$ single-ion optical frequency standards with a millihertz uncertainty we improve previous limits for violations of Local Lorentz Invariance by two orders of magnitude. In addition, recent improvement in the clock performance will be discussed and our contribution to the opticlock project that will be a robust, high-availability and easy-to-use optical clock, which can be operated outside of specialized laboratories.

S3D.2 • 15:00 -- 15:15

Quantum-chaotic sensors, Daniel Braun[1], Lukas Fiderer[1]; *[1]tubingen Univ., Germany.*

We show that sensitivity and robustness to noise of quantum sensors can be largely increased by rendering them chaotic, while avoiding the challenge of preparing and protecting large-scale entanglement. We apply the method to spin-precession magnetometry.

S3D.3 • 15:15 -- 15:30

Quantum Metrology for Fiber Laser Applications, Florent Mazeas[1], Romain Dauliat[2], Rachel Cannon[1], Djeylan Aktas[3], Mattis Reimer[1], Florian Kaiser[4], Philippe Roy[2], Raphael Jamier[2], Laurent Labonte[1], Sébastien Tanzilli[1]; *[1]INPHYNI, Université Côte d'Azur, CNRS, France; [2]XLIM, CNRS, Université de Limoges, France; [3]Quantum Engineering Technology Labs, Univ. of Bristol, UK; [4]Physics Inst. of Physics, Univ. of Stuttgart, Germany.*

We report on a quantum-based measurement of index difference for fiber laser applications. Based on an interferometric setup, we demonstrate a state-of-the-art high-accurate measurement of $\Delta n = (1.67\ \pm 0.07) \times 10^{-4}$.

S3D.4 • 15:30 -- 15:45

Quantum-limited time-frequency estimation through mode-resolved measurements, Vahid Ansari[1], John M. Donohue[1], Jaroslav Rehacek[2], Zdenek Hradil[2], Bohumil Stoklasa[2], Martin Paur[2], Luis L. Sánchez-Soto[3], Christine Silberhorn[1]; *[1]Paderborn Univ., Germany; [2]Dept. of Optics, Palacky Univ., Czechia; [3]Universidad Complutense, Spain.*

We employ time-frequency projective measurements to estimate arbitrarily small separations between objects with quantum-limited precision. We experimentally resolve temporal and spectral separations between incoherent mixtures of single-photon level signals ten times smaller than their bandwidths.

S3D.5 • 15:45 -- 16:00

Quantum-enhanced interferometric timing measurement with a squeezed optical frequency comb, Xiao Xiang[1], Ruifang Dong[1], Shaofeng Wang[1], Nicolas Treps[2], Claude Fabre[2], Tao Liu[1], Shougang Zhang[1]; *[1]National Time Service Center, CAS, China; [2]Sorbonne Univ., France.*

The first quantum-enhanced interferometric timing measurement with a squeezed optical frequency comb was demonstrated. The timing resolution at 2 MHz was improved from a shot-noise limited value of $(2.8\pm0.1)\times10^{-20}$ s to $(2.4\pm0.1)\times10^{-20}$ s.

Aula 3
16:30 -- 17:30
S4A • Single Photon Sources II

S4D.5 • 16:30 -- 16:45

Multipartite Einstein-Podolsky-Rosen steering sharing with separable states, Yu Xiang[1,2], Xiaolong Su[2], Ladislav Mista[3], Gerardo Adesso[4], Qiongyi He[1]; *[1]State Key Laboratory for Mesoscopic Physics and Collaborative Innovation*

Center of Quantum Matter, School of Physics, Peking Univ., China; [2]Centre for the Mathematics and Theoretical Physics of Quantum Non-Equilibrium Systems (CQNE), School of Mathematical Sciences, The Univ. of Nottingham, UK; [3]Dept. of Optics, Palacky Univ., Czechia.
We show that EPR steering can be established between two and more distant parties by transmission of a system being separable from all the parties. The protocols are allowed to distribute rich steerability properties including one-way steering, one-to-multimode steering and collective steering.

S3B.5 • 16:45 -- 17:00
Sensitivity enhancement by mode entanglement in distributed phase sensing, Xueshi Guo[1], Johannes Borregaard[2], Casper Breum[1], Shuro Izumi[1], Mikkel Larsen[1], Jonas Neergaard-Nielsen[1], Ulrik Andersen[1]; *[1]Department of Physics, Technical University of Denmark, Lyngby, Denmark; [2]Department of Mathematical Sciences, University of Copenhagen, Copenhagen, Denmark.*

We investigate the sensitivity of distributed phase sensing with squeezed state probes. By creating mode entanglement between probes with a beam-splitter network, sensitivity enhancement over independent probes is observed experimentally for the first time.

S4A.2 • 17:00 -- 17:15
Influence of Electron-Phonon Interactions on the Spectral Properties of Defects in Hexagonal Boron Nitride, Ozan Ari[1], Nahit Polat[1], Volkan Firat[1], Ozgur Cakir[1], Serkan Ates[1]; *[1]Izmir Inst. of Technology, Turkey.*

We present temperature-dependent micro-PL studies on a single defect in hexagonal boron nitride. A zero-phonon line emission accompanied by Stokes and anti-Stokes phonon sidebands (6.5~meV) with a Debye-Waller factor of 0.59 is observed.

S4A.3 • 17:15 -- 17:30
Optimal Coherent Filtering for Single Photons, Shaobo Gao[1], Oscar Lazo-Arjona[1], B. Brecht[1,2], Krzysztof Kaczmarek[3,1], Patrick Ledingham[1], Sarah Thomas[1,4], Joshua Nunn[5,1], Dylan Saunders[1], Ian A. Walmsley[4,1]; *[1]Univ. of Oxford, UK; [2]Universität Paderborn, Germany; [3]Université de Genève, Switzerland; [4]Imperial College London, UK; [5]Univ. of Bath, UK.*

We propose a quantum buffer which optimally filters the temporal-spectral mode of single photon source. We theoretically show that using a Cs vapour, an increase of indistinguishably with minimal loss of brightness can be achieved.

Aula 4
16:30 -- 17:30
S4C • Quantum Networks II

S4C.1 • 16:30 -- 17:00 (Invited)
Towards a quantum internet, David Elkouss[1]; *[1]QUTech, Netherlands.*

I will introduce a roadmap towards the development a quantum internet. Then, I will describe our program for designing and evaluating the performance of large quantum networks via NetSquid, a discrete event quantum network simulator.

S4C.2 • 17:00 -- 17:15

Hong-Ou-Mandel interference in the spin-wave domain, Michal Parniak[1], Mateusz Mazelanik[1], Adam Leszczynski[1], Michal Lipka[1], Michal Dabrowski[1], Wojciech Wasilewski[1]; [1]*Univ. of Warsaw, Poland.*

We demonstrate a Hong-Ou-Mandel interferometer in the domain of spin waves inside a multimode quantum memory. The ac-Stark-modulation-based protocol constitutes a bedrock for a multiplexed photon generator or a quantum repeater with error correction.

S4C.3 • 17:15 -- 17:30
Optical Locking of a Solid State Electron Spin Qubit, Jonathan Bodey[1], Robert Stockill[1], Claire Le Gall[1], Emil Denning[1], Dorian Gangloff[1], Mete Atature[1]; [1]*Univ. of Cambridge, UK.*

Fully exploiting the outstanding optical properties of self-assembled InGaAs quantum dots requires highly sophisticated spin control. We develop and implement such control for optical spin locking, protecting a quantum state for much longer than T_2^*.

Aula Cabibbo
16:30 – 17:45
S4B • Quantum Technology III

S4B.2 • 16:30 -- 16:45
Quantum-State Tomography with Photon-Number-Resolving Homodyne Detection, Stefano Olivares[4], Alessia Allevi[2], Matteo Paris[3], Maria Bondani[1]; [1]*CNR - Consiglio Nazionale delle Ricerche, Italy;* [2]*Univ. of Insubria, Italy;* [4]*Univ. of Milan, Italy.*

A homodyne-like detection scheme based on photon-number-resolving and low-intensity a local oscillator is exploited to reconstruct optical quantum states by applying the same tomographic reconstruction procedures originally developed for standard homodyne detection based on photodiodes.

S4B.3 • 16:45 -- 17:00
A versatile quantum detector based on homodyne detection with photon-number resolution, Guillaume S. Thekkadath[1], David S Phillips[1], Jacob Bulmer[1], William R Clements[1], Andreas Eckstein[1], Jasleen Lugani[1], Christopher G. Wade[1], Tom A. Wolterink[1], Adriana E. Lita[2], Sae W. Nam[2], Thomas Gerrits[2], Ian A. Walmsley[1]; [1]*Univ. of Oxford, UK;* [2]*National Inst. of Standards and Technology, USA.*

We interfere weak coherent states with heralded Fock states on a balanced beam splitter and detect the output with photon-number-resolving detectors. Our setup constitutes a versatile detector that can perform both Gaussian and non-Gaussian measurements.

S4B.4 • 17:00 -- 17:15
Microwave-driven high-fidelity quantum logic with $^{43}Ca^+$, Ryan K. Hanley[1], Jochen Wolf[1], Clemens Loschnauer[1], Marius Weber[1], Joseph Goodwin[1], Thomas Harty[1], Andrew Steane[1]; [1]*Oxford Univ., UK.*

We present the design and initial characterisation of a next-generation surface-electrode ion-trap designed for room-temperature or cryogenic operation that will aim to improve both the fidelity and speed achieved in microwave-driven quantum gates.

S4D.6 • 17:15 -- 17:30
Supervised Quantum Learning as Quantum Channel Simulation, Leonardo Banchi[1]; [1]*Univ. of Florence, Italy.*

We propose a formal mapping between supervised quantum learning and the information theoretic notion of channel simulation. The mapping is exploited to define a universal learning machines that can learn from quantum data.

S4D.4 • 17:30 -- 17:45

Non-equilibrium quantum thermometry, Luca Mancino[1], Vasco Cavina[2], Antonella De Pasquale[3,4], Michele M. Feyles[5], Marco Sbroscia[1], Ilaria Gianani[1], Emanuele Roccia[1], Robert I. Booth[6], Roberto Raimondi[7], Vittorio Giovannetti[2], Marco Barbieri[1,8]; *[1]Dipartimento di Scienze, Università degli Studi Roma Tre, Italy; [2]NEST, Scuola Normale Superiore and Istituto Nanoscienze - CNR, Italy; [3]Dipartimento di Fisica, Università degli Studi di Firenze, Italy; [4]INFN Sezione di Firenze, Italy; [5]Dipartimento di Fisica, Sapienza, Università di Roma, Italy; [6]Institut de Physique, Sorbonne Université, France; [7]Dipartimento di Matematica e Fisica, Università degli Studi Roma Tre, Italy; [8]INO, Istituto Nazionale di Ottica, Italy.*

Quantum Thermometry represents a milestone for the forthcoming quantum technology. Our endeavors have been addressed here to understand the way their non-equilibrium thermodynamic properties are affected by quantum quirks, introducing dynamical, geometrical and metrological considerations.

Poster presentations

Thursday 4 April

Poster Area
17:30 -- 18:30
T5A • Poster Session I

T5A.2
Free Spectral Range Electrical Tuning of a Double Disk Microcavity, Christiaan Bekker[1], Christopher Baker[1], Rachpon Kalra[1], Han-Hao Cheng[1,2], Bei-Bei Li[1], Varun Prakash[1], Warwick Bowen[1]; [1]*School of Mathematics and Physics, The Univ. of Queensland, Australia;* [2]*Centre for Microscopy and Microanalysis, The Univ. of Queensland, Australia.* We report free-spectral-range tuning in a high-quality on-chip microcavity requiring less than 15 V and 1 nW of power to maintain optical resonance with an arbitrary frequency: an important component for achieving reconfigurable photonic circuits.

T5A.3
High visibility Hong-Ou-Mandel interference from weak-coherent pulses generated by III—V on silicon waveguide integrated lasers, Costantino Agnesi[1], Beatrice Da Lio[2], Daniele Cozzolino[2], Lorenzo Cardi[2], Badhise Ben Bakir[3], Karim Hassan[3], Adriano Della Frera[4], Alessandro Ruggeri[4], Andrea Giudice[4], Giuseppe Vallone[1], Paolo Villoresi[1], Alberto Tosi[5], Karsten Rottwitt[2], Yunhong Ding[2], Davide Bacco[2]; [1]*Dipartimento di Ingegneria dell'Informazione, Universita degli Studi di Padova, Italy;* [2]*Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark;* [3]*CEA-Leti, France;* [4]*Micro Photon Devices S.r.l., Italy;* [5]*Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Italy.* Gain-switched III—V on silicon waveguide integrated lasers are used to generate weak-coherent pulses compatible with high rate Quantum Key Distribution (QKD) and, by exhibiting Hong-Ou-Mandel interference with 46±2% visibility, suitable for Measurement-Device-Independent-QKD.

T5A.4
Observation of Quantum Decay Dynamics in an Integrated Photonic Chip, Andrea Crespi[1,2], Francesco V. Pepe[3], Paolo Facchi[4,3], Fabio Sciarrino[5], Paolo Mataloni[5,2], Hiromichi Nakazato[6], Saverio Pascazio[4,7], Roberto Osellame[2,1]; [1]*Dipartimento di Fisica, Politecnico di Milano, Italy;* [2]*Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche, Italy;* [3]*INFN, Sezione di Bari, Italy;* [4]*Dipartimento di Fisica and MECENAS, Università di Bari, Italy;* [5]*Dipartimento di Fisica, Sapienza Università di Roma, Italy;* [6]*Dept. of Physics, Waseda Univ., Japan;* [7]*Istituto Nazionale di Ottica, Consiglio Nazionale delle Ricerche, Italy.* Waveguide arrays, fabricated by femtosecond laser pulses and excited by coherent light, are used to study quantum decay phenomena. By tailoring the system properties, we observe different regimes including quadratic Zeno and power-law decay.

T5A.5
Pseudo energy representation of multi-photon states in photonic tight-binding lattices, Konrad Tschernig[2], Armando Perez-Leija[2], Kurt Busch[2,1]; [1]*Humboldt-Universität zu Berlin, Germany;* [2]*Max-Born-Institut Berlin, Germany.* We introduce the concept of pseudo-energy in multi-photon processes occurring in photonic networks. Through this framework we demonstrate the existence of high-dimensional lattice-like non-local structures in Fock-Space thereby shining new light onto many-photon interference effects.

T5A.6
All optical actively tunable quantum signal de-multiplexer based on sum frequency generation, Zhi-Yuan Zhou[1], Bao-Sen Shi[1], Yin-Hai Li[1]; [1]*Univ.of Sci. and Techn. of China, China.* an actively tunable quantum signal de-multiplexer for multi-channel energy-time entangled state based on sum frequency generation is reported. Such device can de-multiplex any signal frequency and preserves entanglement after up-conversion

T5A.7
Low-loss Integrated Lithium Niobate Photonics for Quantum Light Generation, Timothy P. McKenna[1], Wentao Jiang[1], Jeremy Witmer[1], Bingyi Wang[1], Marc Jankowski[1], Raphael Van Laer[1], Carsten Langrock[1], Martin Fejer[1], Amir Safavi-Naeini[1]; *[1]Stanford Univ. , USA.* We demonstrate high quality factor optical resonators fabricated in thin-film lithium niobate on a sapphire substrate. These devices can enable on-chip quantum light generation which is important for integrated photonic quantum information processing.

T5A.8
Integrated source of entangled photon pair at telecom wavelength, Simone Atzeni[3,2], Adil S. Rab[1], Giacomo Corrielli[3,2], Emanuele Polino[1], Mauro Valeri[1], Paolo Mataloni[1], Nicolò Spagnolo[1], Andrea Crespi[3,2], Fabio Sciarrino[1], Roberto Osellame[3,2]; *[1]Sapienza Università di Roma, Italy; [2]Istituto di Fotonica e Nanotecnologie, Italy; [3]Politecnico di Milano, Italy.* A compact, robust and high quality on-chip source of entangled photons pair in telecom wavelength is presented. The entangled output state can be changed by means of the chip reconfigurability and its hybrid structure.

T5A.9
Detuning-modulated composite pulses for integrated photonic circuits, Hadar Greener[1,2], Elica Kyoseva[3,1], Haim Suchowski[1,2]; *[1]Tel Aviv Univ. , Israel; [2]Center for Light Matter Interaction, Israel; [3]Inst. of Solid State Physics, Bulgarian Academy of Sciences, Bulgaria.* We introduce a detuning-modulated composite pulses control method for robust QIP and implement our solutions in integrated photonic systems. These correct for errors in various parameters, achieving fidelity above the QI threshold 10^{-4}.

T5A.10
On-Chip Microwave-to-Optical Photon Conversion for Quantum Networks, Jeremy D. Witmer[1], Timothy P. McKenna[1], Wentao Jiang[1], Patricio Arrangoiz-Arriola[1], E. Alex Wollack[1], Raphael Van Laer[1], Amir Safavi-Naeini[1]; *[1]Stanford Univ., USA.* We present progress towards a quantum-efficient microwave-to-optical transducer for quantum networks. We fabricate lithium niobate optical ring resonators with quality factors above 1 million and microwave LC resonators with simulated electro-optic coupling exceeding 0.8 GHz/V.

T5A.11
Towards MIR heralded photons via intermodal four wave mixing in silicon waveguides, Stefano Signorini[1], Sara Piccione[1], Giorgio Fontana[1], Mher Ghulinyan[2], Georg Pucker[2], Lorenzo Pavesi[1]; *[1]Univ. of Trento, Italy; [2]Bruno Kessler Foundation, Italy.* We generate correlated photons with 600 nm spectral distance via intermodal four wave mixing in silicon. We want to demonstrate on-silicon-chip heralded single photons, beyond 2 μm, without post spectral filtering.

T5A.13
Quantum-optical Converter for Squeezed Light, Vladislav Sukharnikov[1], Olga V. Tikhonova[1]; *[1]Physics Dept., Lomonosov Moscow State Univ., Russian Federation.* We propose a scheme based on sum frequency generation seeded by multimode squeezed vacuum light. It provides manipulation of seeding mode weights, tailoring output spectral and temporal signal, generation of squeezed vacuum in sum frequency.

T5A.14
Engineering Multiphoton Quantum States using Conditional Measurements, Roberto d. Leon Montiel[1], Omar Magaña-Loaiza[2], Armando Perez-Leija[3], Alfred U'Ren[1], Kurt Busch[3], Adriana E. Lita[2], Sae W. Nam[2], Richard P. Mirin[2], Thomas Gerrits[2]; *[1]National Autonomous Univ. of Mexico, Mexico; [2]NIST, USA; [3]Max-Born-Institut, Germany.* We experimentally demonstrate that the simultaneous subtraction of photons from a two-mode squeezed vacuum state leads to the generation of entangled states with increasingly larger average photon number.

T5A.15
Time/frequency high-dimensional entanglement via engineered parametric downconversion, Francesco Graffitti[1], Alexander Pickston[1], Peter Barrow[1], Massimiliano Proietti[1], Dmytro Kundys[1], Agata Branczyk[2], Alessandro Fedrizzi[1]; *[1]Heriot-Watt Univ., UK; [2]Perimeter Inst., Canada.* We introduce and experimentally benchmark a new

scheme for generating frequency-entangled photon pairs in engineered parametric downconversion processes. We discuss how this technique can be used to easily generate high-dimensional entangled bi-photon states.

T5A.16

Simulating the photon spatial distribution in spontaneous parametric down conversion (SPDC), Sivan Trajtenberg-Mills[1], Aviv Karnieli[1], Noa Voloch-Bloch[2], Giuseppe Di Dominico[1], Eli Megidish[2], Hagai Eisenberg[2], Ady Arie[1]; [1]*TAU, Israel;* [2]*HUJI, Israel.* We present a method for simulating the spatial distribution of the SPDC generated state based on classical equations. This enables the design of nonlinear crystals and pumping conditions for generating non-classical light with desired properties.

T5A.17

Role of quantum non-Gaussian distance in entropic uncertainty relations, Wonmin Son[1]; [1]*Sogang, Korea.* We derived new generalized entropic uncertainty relation whose additional factor quantifies the quantum non-Gaussianity. Additionally, the lower bound becomes stronger with the purity. The optimality of specific state has been investigated and identified.

T5A.18

Coherent manipulation of a three-dimensional maximally entangled state, Bao-Sen Shi[1]; [1]*Key Lab. of Quantum Information, China.* A scheme to generate three dimensional OAM-maximally-entangled photon-pairs via spontaneous-parametric-down-conversion is demonstrated, which can perform both amplitude and phase modulations of the generated state and shows great advantages over traditional post-selection method.

T5A.19

Second-Harmonic Generation as a Source of Nonclassical Light, Giovanni Chesi[1], Alessia Allevi[1], Maria Bondani[2]; [1]*Univ. of Insubria - Como, Italy;* [2]*CNR-IFN, Italy.* We investigate the transformation of light statistics due to a second-harmonic generation process and address a quantum perturbative approach to retrieve the moments of the output light distribution for given input light states.

T5A.20

Generation of two-mode squeezed states from a single temporally multiplexed squeezing source, Mikkel V. Larsen[1], Xueshi Guo[1], Casper Breum[1], Jonas Neergaard-Nielsen[1], Ulrik Andersen[1]; [1]*Dept. of Physics, Technical Univ. of Denmark, Denmark.* In this work, EPR-states are generated from a single squeezing source by temporal multiplexing using optical switching and delay. With switching and delay being key components, we demonstrate a platform suitable for scalable quantum computation.

T5A.21

The Effect of Electron Spin Dephasing on Nuclear Frequency Focusing in Quantum Dots, William A. Dixon[2,1], Dara P. McCutcheon[1], Tom Nutz[1,3]; [1]*Quantum Engineering Technology Labs, Univ. of Bristol, UK;* [2]*Quantum Engineering Centre for Doctoral Training, Univ. of Bristol, UK;* [3]*Controlled Quantum Dynamics Theory Group, Imperial College London, UK.* We investigate how dephasing of a central electron spin in a quantum dot affects protocols designed to polarise the nuclear spin bath. We find that dephasing imposes significant constraints on the viability of such protocols.

T5A.23

Detecting quantum features in the real world, Alessia Allevi[1], Giovanni Chesi[1], Luca Nardo[1], Maria Bondani[2]; [1]*Univ. of Insubria, Italy;* [2]*Inst. for Photonics and Nanotechnologies, Italy.* Quantum resources embedded in physical systems can be destroyed by noisy transmission channels and/or by nonidealities of detectors. Here, we face such a problem by considering some nonclassicality criteria in the mesoscopic intensity domain.

T5A.24

Generation of non-classical states of photons from metal-dielectric interface: a novel architecture for quantum information processing, Karun Mehta[1], Shubhrangshu Dasgupta[1]; [1]*Indian Inst. of Technology Ropar, India.* Photons emitted from quantum emitters on a metal-dielectric interface exhibit anti-coalescence in free space - a clear signature of nonclassicality. Such a system can also be employed as a building block for a distributed quantum network.

T5A.25
On the physical conclusion of the Heisenberg-Uncertainty-Relation, Jascha Zander[1], Roman Schnabel[1]; *[1]Insitut für Laserphysik, Universität Hamburg, Germany.* The fundamental limit of precision on a measurement is set by the Heisenberg-Uncertainty-Relation. We experimentally demonstrate the EPR-Gedankenexperiment by the simultaneous measurement the phase and amplitude of a weak coherent field with a variance product of Var(X)Var(Y) ≈ 0.1.

T5A.26
Huge plasmon-enhanced Third Harmonic Generation with graphene nanoribbons, Alessandro Trenti[1], Irati Alonso Calafell[1], Lee Rozema[1], David Alcaraz Iranzo[2], Joel D. Cox[2], Hlib Bieliaiev[1], F.J. Garcia de Abajo[2,3], F.H.L. Koppens[2], Philip Walther[1]; *[1]Univ. of Vienna, Austria; [2]The Barcelona Institut of Science and Technology, Spain; [3]Institució Catalana de Recerca I Estudis Avançats, Spain.* Graphene's strong third-order nonlinearity could allow single-photon level interactions. Towards this goal, we report on a 3 orders of magnitude resonant plasmon-enhancement Third Harmonic Generation in graphene nanoribbons compared to planar graphene.

T5A.27
Spatially Selective Hydrogen Irradiation/Removal of Dilute Nitrides: A Versatile Nanofabrication Tool for Photonic Applications, Marco Felici[1]; *[1]Sapienza - Univ. of Rome, Italy.* The possibility to locally incorporate/remove hydrogen atoms in/from dilute-nitride semiconductors is demonstrated. This method can be applied to the fabrication of site-controlled single-photon emitters but also to the optimization/fabrication of photonic devices, via refractive-index engineering.

T5A.28
Reversible Energy Transfer Between a Single Defect in hBN and Graphene, Elif Ozceri[1], Ozan Ari[1], Sinal Balci[1], Coskun Kocabas[2], Serkan Ates[1]; *[1]Izmir Inst. of Technology, Turkey; [2]Univ. of Manchester, UK.* We present a reversible energy transfer between a single defect in hBN and graphene. Dynamic control of Fermi level of graphene results in switching on and off single photon emission from a single quantum emitter.

T5A.29
Spectral Modulation Effect suppression and Compensation of Phase-Error-Induced-Micromotion in Ion Trap, Yi Xie[1], Ting Chen[1], Jie Zhang[1], Baoquan Ou[1], Wei Wu[1], Pingxing Chen[1]; *[1]National Univ. of Defense Technolog, China.* We have suppressed the spectral modulation effect and the motional effect itself of the phase-error-induced-mocromotion by extra modulation. Based on this, we investigated the heating effect of micromotion under the condition of low temperature.

T5A.30
Quantum-enhanced rotation measurements about unknown axes, Aaron Z. Goldberg[1], Daniel F. James[1]; *[1]Univ. of Toronto, Canada.* Precise rotation measurements have broad applications. Some quantum states dramatically enhance sensitivities in estimating rotation angles around known axes. We present states that increase sensitivities in estimating both the orientation of an unknown rotation axis and the angle rotated about it.

T5A.31
Experimental demonstration of weak value amplification in trapped ion system, Chun-Wang Wu[1], Jie Zhang[1], Yi Xie[1], Wei Wu[1]; *[1]Natl Univ Defense Tech, China.* The first proof-of-principle experimental demonstration of purely atomic weak value amplification using a single trapped $^{40}Ca^{+}$ ion is presented. We achieve an amplification factor as large as 50 for the position displacement of the ion.

T5A.32
Towards a quantum-enhanced trapped-atom clock on a chip, Meng-Zi Huang[1,2], Tommaso Mazzoni[2], Carlos L. Garrido Alzar[2], Jakob Reichel[1]; *[1]Laboratoire Kastler Brossel, ENS - Université PSL, Sorbonne Université, CNRS, CdF,*

France; [2]LNE-SYRTE, Observatoire de Paris - Université PSL, CNRS, Sorbonne Université, France. We report preliminary results of a quantum-enhanced atom chip clock. Using ultracold rubidium atoms inside an on-chip optical cavity, we investigate light-induced spin squeezing and non-destructive measurements at 10E-13 level of relative frequency stability.

T5A.33
Towards real-time optical quantum sensors, Valeria Cimini[1], Ludovica Ruggiero[1], Ilaria Gianani[1], Marco Sbroscia[1], tecla gasperi[1], Emanuele Roccia[1], Luca Mancino[1], Daniela Tofani[1], Fabio Bruni[1], Maria Antonietta Ricci[1], Marco Barbieri[1]; *[1]Università degli Studi Roma Tre, Italy.* Quantum sensors must be robust against noise even when non-stationary. Here we study a dynamic process using a Multiparameter approach that gives us control of our setup instabilities.

T5A.34
Towards multiparameter estimation - based quantum sensing, Marco Sbroscia[1], Emanuele Roccia[1], Ilaria Gianani[1], Valeria Cimini[1], Luca Mancino[1], Ludovica Ruggiero[1], Fabrizia Somma[1], Marco Genoni[2], Maria Antonietta Ricci[1], Marco Barbieri[1]; *[1]Università degli Studi Roma Tre, Italy; [2]Università degli Studi di Milano, Italy.* Sensor development can benefit from using exquisitely quantum resources, although quantum metrological performances can be irremediably wrecked in the presence of unmonitored noise. Multiparameter estimation figures out as an essential tool towards reliable devices.

T5A.35
Theoretical description of a multimode SU(1,1) interferometer, Alessandro Ferreri[1], Polina Sharapova[1], Kai Hong Luo[1], Harald Herrmann[1], Christine Silberhorn[1]; *[1]Univ. of Paderborn, Germany.* The phase sensitivity and the spectral properties of a multimode SU(1,1) interferometer were investigated using both matrix approach and basis transformation.

T5A.36
Experimental Multi-Qubit Robustness by Local Encoding, Massimiliano Proietti[1], Martin Ringbauer[1], Francesco Graffitti[1], Peter Barrow[1], Alexander Pickston[1], Dmytro Kundys[1], Rafael Chaves[4], Leandro Aolita[3], Daniel Cavalcanti[2], Alessandro Fedrizzi[1]; *[1]Heriot Watt Univ., UK; [2]ICFO-Institut de Ciencies Fotoniques, The Barcelona Inst. of Science and Technology, Spain; [3]Instituto de Fisica, Universidade Federal do Rio de Janeiro, Brazil; [4]International Inst. of Physics, School of Science and Technology, Federal Univ. of Rio Grande do Norte, Brazil.* We experimentally demonstrate on photonic four-qubit graph states, robust noise protection without requiring any additional physical qubits. Our method is tested in a realistic scenario as phase estimation in highly noisy environment.

T5A.37
Quantum-Enhanced Magneto-optic Measurements in a Dissipative Medium, Youhei Okawa[1,2], Shiho Morimoto[1], Yuhsuke Yasutake[1], Susumu Fukatsu[1]; *[1]Graduate School of Arts and Sciences, Univ. of Tokyo, Komaba, Japan; [2]Systems Photonics Laboratory, Toyota Technological Inst., Japan.* Precision phase estimation of interferometry can benefit from a quantum enhancement by using multi-photon entangled states. Magneto-optic measurements in a lossy medium demonstrate the need for optimization of interaction so that "quantum" outperforms "classical."

T5A.38
Quantum Description of Single Photon Detectors Including Timing-Jitter Effects, Élie Gouzien[1], Bruno Fedrici[1], Alessandro Zavatta[2,3], Sebastien Tanzilli[1], Virginia D'Auria[1]; *[1]Institut de Physique de Nice, Université Côte d'Azur, France; [2]Istituto Nazionale di Ottica (INO-CNR), Italy; [3]LENS and Dept. of Physics, Universitá di Firenze, Italy.* We model single photon detectors by explicitly taking into account their timing-jitter, finite efficiency and dead-time effects. Our model represents the first operational and full description of temporal limitations of those detectors.

T5A.40
Approximated Canonical Phase Measurement for Single-Photon Polarization Detection, Nicola Dalla Pozza[1], Matteo Paris[2]; *[1]Univ. of Florence, Italy; [2]Univ. of Milan, Italy.* We obtain an approximated canonical phase

measurement from its POVM formulation employing the Naimark theorem, and we use it to design an optical scheme to detect the polarization of a single photon.

T5A.41
Machine Learning For Experimental Single Shot Phase Estimation, Emanuele Polino[1], Alessandro Lumino[1], Adil S. Rab[1], Giorgio Milani[1], Nicolò Spagnolo[1], Nathan Wiebe[2], Fabio Sciarrino[1]; *[1]La Sapienza Univ. of Rome, Italy; [2], Microsoft Research, Quantum Architectures and Computation Group, USA.* We implement adaptive machine learning techniques to enhance the sensitivity in the estimation of a relative phase shift between two paths of an interferometer. The estimation is realized through single photons measured shot by shot.

T5A.42
Quantum weak measurement with power recycling, Qinglin Wu[1]; *[1]Central China Normal Univ., China.* We represent an experimental scheme combining an interferometric weak value based velocity measurement with a power recycling technique in order to improve the signal to noise ratio (SNR) of the measurement.

T5A.43
Cavity-enhanced quantum metrology with internal squeezed light generation, Mikhail Korobko[1], Yiqiu Ma[2], Roman Schnabel[1], Yanbei Chen[2]; *[1]Univ. of Hamburg, Germany; [2]California Inst. of Technology, USA.* Optical cavities allow to increase the sensitivity in quantum metrology, at a price of reduced detection bandwidth. We propose a way to overcome these limitations by squeezing the quantum uncertainty in a parametric process directly inside the detector cavity.

T5A.44
Photon coincidence measurement of time-correlated photons using an oscilloscope, Jorge Arturo Rojas Santana[1]; *[1]ITESM, Mexico.* We provide the technical considerations for using an oscilloscope as a photon counter. The histogram of coincidences is extracted after a little signal processing.

T5A.45
Compressed Sensing of Twisted Photons, Dominik Koutny[1], Jaroslav Rehacek[1], Zdenek Hradil[1], Frederic Bouchard[2], Felix Hufnagel[2], Ebrahim Karimi[2,3], Luis L. Sánchez-Soto[4,3], Yong Siah Teo[5], Hyunseok Jeong[5], Daekun Ahn[5], Gerd Leuchs[3]; *[1]Dept. of Optics, Palacky Univ., Czechia; [2]Dept. of Physics, Univ. of Ottawa, Canada; [3]Max-Plank-Institut für die Physik des Lichts, Germany; [4]Dept.o de Optica, Universidad Complutense, Spain; [5]Dept. of Physics and Astronomy, Seoul National Univ., Korea.* Full characterization of quantum system is necessary and overwhelming task. In our letter we propose a simple experimental scheme based on compressed sensing to characterize many-level quantum systems accurately. Our technique could efficiently characterize quantum sources, channels and systems.

T5A.46
Multi-bit quantum digital signature based on temporal quantum ghost imaging, Xin Yao[1], Xu Liu[1], Wei Zhang[1], Yidong Huang[1]; *[1]Tsinghua Univ., China.* Based on the temporal ghost imaging with security test, we propose and demonstrate a multi-bit quantum digital signature scheme, in which a multi-bit message can be signed at a time.

T5A.47
Phase Uncertainty in Quantum Linear Amplifiers Beyond the Small-Noise Approximation, Andy Chia[1], Michal Hajdusek[1], Rosario Fazio[2,4], Leong-Chuan Kwek[1,5], Vlatko Vedral[1,3]; *[1]Centre for Quantum Technologies, Singapore; [2]ICTP, Italy; [3]Physics, Univ. of Oxford, UK; [4]NEST, Scuola Normale Superiore and Instituto Nanoscienze-CNR, Italy; [5]Majulab, CNRS-UNS-NUS-NTU International Joint Research Unit, UMI 3654, Singapore.* We estimate the output phase uncertainty of linear amplifiers in a practical regime (weak input, ideal amplification, and large gain) without the small-noise assumption. Furthermore, the small-noise assumption is shown to fail in this regime.

T5A.49
On the Hyperdense Coding and Proposal of Hyperdense Coding Quantum Secure Communication Protocol, Georgi P. Bebrov[1]; *[1]Technical Univ. of Varna, Bulgaria.* The work proposes hyperdense coding - a combination of

superdense coding and optimal quantum channel compression (a type of data encoding). Based on the hyperdense coding, an efficient quantum secure direct communication protocol is introduced.

T5A.50

Modal, Truly Counterfactual Communication with On-Chip Demonstration Proposal, Jonte R. Hance[1,2], Will McCutcheon[2], Patrick Yard[2], John Rarity[2]; *[1]Dept. of Physics, Univ. of Bristol, UK; [2]Quantum Engineering Technology Laboratories, Univ. of Bristol, UK.* We formalize Salih et al's Counterfactual Communication Protocol (arXiv2018), which allows it not only to be used in with other modes than polarization, but also for interesting extensions (e.g. sending superpositions from Bob to Alice).

T5A.51

Integrated Photonics for Counterfactual Communication, Teodor Stromberg[1], Irati Alonso Calafell[1], David Arvidsson-Shukur[2,5], Lee Rozema[1], Valeria Saggio[1], Chiara Greganti[1], Nicholas Harris[3], Mihika Prabhu[3], Jacques Carolan[3], Michael Hochberg[4], Tom Baehr-Jones[4], Dirk Englund[3], Crispin Barnes[2], Philip Walther[1]; *[1]Univ. of Vienna, Austria; [2]Dept. of Physics, Cavendish Laboratory, UK; [3]Quantum Photonics Group, RLE, Massachusetts Inst. of Technology, USA; [4]Elenion Technologies, USA; [5]Dept. of Mechanical Engineering, Massachusetts Inst. of Technology, USA.* In contrast to standard communication, counterfactual communication (CFC) counterintuitively allows information exchange without particle exchange. In this paper we use advances in integrated photonics to implement a CFC protocol that does not rely on post-selection.

T5A.53

Distribution of Gaussian Einstein-Podolsky-Rosen steering by separable states, Meihong Wang[1], Yu Xiang[2], Haijun Kang[1], Yang Liu[1], Dongmei Han[1], Qiongyi He[2], Xiaolong Su[1], Changde Xie[1], Kunchi Peng[1]; *[1]Shanxi Univ., China; [2]Peking Univ., China.* Distribution of quantum correlations among remote users is a key precedure for quantum information processing. We propose and demonstrate the distribution of Gaussian Einstein-Podolsky-Rosen steering by separable states.

T5A.55

Composable security of two-way continuous-variable quantum key distribution without active symmetrization, Shouvik Ghorai[1], Eleni Diamanti[1], Anthony Leverrier[2]; *[1]Sorbonne Univ. - LIP6, France; [2]INRIA, France.* We present a general framework for CV-QKD protocols involving only a Gaussian modulation of coherent states and heterodyne detection. We exploit their symmetry in phase-space to obtain a composable security proof against general attacks.

T5A.56

Towards hybrid entanglement distribution with an orbital angular momentum supporting fiber, Daniele Cozzolino[1], Emanuele Polino[2], Mauro Valeri[2], Gonzalo Carvacho[2], Davide Bacco[1], Nicolò Spagnolo[2], Leif Katsuo Oxenløwe[1], Fabio Sciarrino[2]; *[1]DTU Fotonik, Denmark; [2]Dipartimento di Fisica, Sapienza Università di Roma, Italy.* We present a scheme to distribute photon pairs entangled in vector vortex states in a recently developed 1.2-km long air-core fiber, which supports orbital angular momentum modes. This scheme opens new pathways to transmit quantum correlated photons.

T5A.57

Effective Single-SPAD Implementation of Quantum Key Distribution, Paolo Martelli[1], Marco Brunero[1], Annalaura Fasiello[1], Francesca Rossi[1], Mario Martinelli[1]; *[1]Politecnico di Milano, DEIB, Italy.* We propose a novel implementation of BB84 protocol for QKD, based on the use of a Faraday rotator variable over four levels and a single SPAD. The feasibility of this solution has been experimentally verified.

T5A.58

Point-ahead demonstration of a transmitting antenna for satellite quantum communication, Xuan Han[1], Hai-Lin Yong[1]; *[1]Univ of Science and Technology of China, China.* We design a novel transmitting antenna with a point-ahead function, and provide an easy-to-perform calibration method with an accuracy better than 0.2 mrad.

Subsequently, our antenna establishes an uplink to the quantum satellite, Micius, with a link loss of 41–52 dB over a distance of 500–1,400 km

T5A.59

Noisy Detector? Good! Analysis of Trusted-Receiver Scenario in Continuous-Variable Quantum Key Distribution, Fabian Laudenbach[1,2], Christoph Pacher[1]; *[1]AIT Austrian Inst. of Technology, Austria; [2]Faculty of Physics, Univ. of Vienna, Austria.* In CV-QKD the trusted-receiver assumption allows for a significant improvement in terms of key rate and achievable transmission distance. Moreover, as we demonstrate, sometimes detection noise can even be beneficial for the key rate.

T5A.60

Experimental Research on Remote Preparation of Qubit States Based on GHZ Channel, Xu Wang[1]; *[1]Guizhou Univ., China.* We obtain the results in three-qubit quantum teleportation system tested on IBM quantum computer prototypes based on GHZ channel. Then we discuss the noise impacts on remote state preparation by analyzing the fidelity of add-noise-GHZ channel.

T5A.61

Testing a Bell inequality in full field images of spontaneous parametric down-conversion., Paul-Antoine Moreau[1], Reuben S. Aspden[1], Ermes Toninelli[1], Thomas Gregory[1], Peter A. Morris[1], Miles J. Padgett[1]; *[1]Univ. of Glasgow, UK.* We use an imaging setup based on heralded imaging to test a Bell-CHSH inequality within images. Based on a single full-field image accumulated by a camera we find that the Bell inequality is violated.

T5A.62

Biased Estimate For Superresolving Quantum Imaging, Alexander Mikhalychev[1], Ilya L. Karuseichyk[1], Anton A. Sakovich[1], Peter I. Novik[1], Dmitri S. Mogilevtsev[1]; *[1]B. I. Stepanov Inst. of Physics of NASB, Belarus.* We apply Fisher information analysis to the problem of superresolving quantum imaging and investigate the effect of imposing constraints on the reconstructed object. An approach for resolution quantification for unconstrained and constrained problems is proposed.

T5A.63

Quantum Temporal Imaging with Finite Time Aperture, Giuseppe Patera[1], Dmitri Horoshko[1], Mikhail Kolobov[1]; *[1]CNRS UMR 8523 - PhLAM, France.* We consider a temporal imaging scheme based on the sum-frequency generation time lens with a finite time aperture. We obtain a unitary transformation of the field operators and identify the contribution of vacuum fluctuations.

T5A.64

Incoherence and Lens-less Imaging in Quantum Ghost Diffraction, Andres Vega[1], Sina Saravi[1], Thomas Pertsch[1], Frank Setzpfandt[1]; *[1]Friedrich Schiller Univ. Jena, Germany.* We theoretically analyze quantum ghost diffraction of a double slit, and find that for certain parameters an image of the double-slit without interference can be obtained, similar to classical incoherent lens-less imaging.

T5A.65

Contrast Enhanced Imaging Using Quantum Correlations, Thomas Gregory[1], Paul-Antoine Moreau[1], Ermes Toninelli[1], Miles J. Padgett[1]; *[1]Univ. of Glasgow, UK.* Using quantum states of light allows classical limits of imaging to be surpassed. Using entangled photon pairs we show a contrast enhancement compared to classical imaging techniques.

T5A.66

Correlation Plenoptic Microscopy, Francesco Vincenzo Pepe[2], Alessio Scagliola[1], Francesco Di Lena[1, 2], Augusto Garuccio[1, 2], Milena D'Angelo[1, 2]; *[1.]Università degli Studi di Bari, Italy; [2]Sezione di Bari, INFN, Italy.* Plenoptic imaging is a promising technique for 3D reconstruction of microscopic samples. We propose a novel method for microscopic plenoptic imaging, based on correlation measurements, that overcomes the spatial-vs-directional resolution tradeoff of classical plenoptic devices.

T5A.67
Optically Controlled Quantum Capacitor for Imaging, Pouya Dianat[1,2], Bahram Nabet[1,2]; [1]*Drexel Univ., USA;* [2]*Nanograss, USA.* Quantum capacitor devices are utilized for sensitive imaging, by manipulating chemical potential of *interacting* two-dimensional Fermions. Specifically, optically-generated carriers alter energy landscape of the device, gauged by a 40 times enlargement in its capacitance, similar to CCD pixels.

T5A.68
Measurement of temporal signal based on second-order correlation in time domain, WeiTao Liu[1], Hui-Zu Lin[1], Yao-Kun Xu[1], Ding Yang[1]; [1]*College of Science, NUDT, China.* Based on second-order correlation in time domain, we demonstrated tomography of single photon states via two-photon interference, recovery of a fast signal with a much slower detector, and enhancement of ghost imaging.

T5A.69
Magnon heralding in cavity optomagnonics, Victor A. Bittencourt[1], Verena Feulner[1], Silvia Viola-Kusminskiy[1]; [1]*Max Planck Inst. for the science of light, Germany.* We propose a magnon heralding protocol in cavity optomagnonics, in which a one magnon Fock state is created by the measurement of one photon, and we analyze its implementation requirements in YIG systems.

T5A.70
Hong-Ou-Mandel interference between two weak coherent pulses retrieved from room-temperature quantum memories, Alessia Scriminich[1], Mehdi Namazi[2], Mael Flament[2], Sonali Gera[2], Steven Sagona-Stophel[2], Giuseppe Vallone[1], Paolo Villoresi[1], Eden Figueroa[2]; [1]*Dept. of Information Engineering, Univ. of Padova, Italy;* [2]*Dept. of Physics, Stony Brook Univ., USA.* We measure Hong-Ou-Mandel interference between weak coherent pulses retrieved from room-temperature rubidium vapor quantum memories operating via Electromagnetically-Induced Transparency. The interference visibility of V=(46.8±3.4)% makes the system suitable for Quantum Repeater applications.

T5A.71
Atom-to-Photon State Mapping by Quantum Teleportation, Jan Arenskötter[1], Stephan Kucera[1], Matthias Kreis[1], Pascal Eich[1], Floriane Brunel[2], Philipp Müller[1], Jürgen Eschner[1]; [1]*Universität des Saarlandes, Germany;* [2]*Université Côte d'Azur, France.* Using a high-brightness narrowband source of $^{40}Ca^+$-ion-resonant entangled photon pairs at 854 nm, we teleport a qubit from the $D_{5/2}$ Zeeman sub-levels of the ion onto the polarization qubit of a single photon by heralded absorption.

T5A.72
Interferometric spin wave processor with reversible optical interface, Mateusz Mazelanik[1], Michal Parniak[1], Adam Leszczynski[1], Michal Lipka[1], Wojciech Wasilewski[1]; [1]*Univ. of Warsaw, Poland.* We demonstrate operation of a spatiotemporal multimode quantum memory for light with embedded processing capabilities. We perform complex operations on stored states of light and demonstrate a variety of protocols implemented at the processing stage.

T5A.74
Polarization-preserving quantum frequency conversion for entanglement distribution in trapped-atom based quantum networks, Matthias Bock[1], Stephan Kucera[1], Pascal Eich[1], Matthias Kreis[1], Andreas Lenhard[1], Jürgen Eschner[1], Christoph Becher[1]; [1]*Saarland Univ., Germany.* We present efficient and low-noise polarization-preserving quantum frequency conversion devices connecting trapped Ca^+-ions (854nm) and Rb-atoms (780nm) to the telecom bands for long-distance entanglement distribution in quantum networks.With Ca^+-ions, entanglement-preserving conversion is realized.

T5A.75
Towards a Suburban Quantum Network Link, Tim B. van Leent[1], Robert Garthoff[1], Kai Redeker[1], Paul Koschmieder[1], Wei Zhang[1], Wenjamin Rosenfeld[1,2], Harald Weinfurter[1,2]; [1]*Fakultät für Physik, Ludwig-Maximilian-*

Universität, Germany; [2]Max-Planck-Inst. für Quantuenoptik, Germany. We report on progress on achieving heralded entanglement between atoms separated by several kilometers. This work is based on recent achievement of entanglement generation over a distance of 400 meter.

T5A.76

Noise Suppression via Atomic Absorption in a Raman Quantum Memory, Thomas M. Hird[1,2], Sarah Thomas[1], Joseph Munns[1], B. Brecht[1], Dylan Saunders[1], Joshua Nunn[3], Ian A. Walmsley[1], Patrick Ledingham[1]; *[1]Univ. of Oxford, UK; [2]Univ. College London, UK; [3]Univ. of Bath, UK.* We propose and demonstrate a scheme to strongly suppress four-wave mixing noise on the output of a Raman quantum optical memory. We show that heralded single-photon states can be recalled nonclassically using our device.

T5A.77

Quantum repeaters based on two species trapped ions, Vladimir S. Malinovsky[1], Siddhartha Santra[1], Sreraman Muralidharan[1], Liang Jiang[2], Christopher R. Monroe[3]; *[1]US Army Research Laboratory, USA; [2]Applied Physics, Yale Univ., USA; [3]Physics, Univ. of Maryland, USA.* We consider two species trapped ions as building blocks of large-scale quantum repeaters across trans-continental distances. Key generation rate dependence on experimental gate error rates, operation time and coupling efficiency to a fiber is discussed.

T5A.78

Magneto-Optical Switch Based on Ultrahigh-Contrast Electromagnetically Induced Absorption in a Cesium Vapor Cell, D. V. Brazhnikov[1,2], Stepan M. Ignatovich[1], Alexey S. Novokreshchenov[1], Vladislav I. Vishnyakov[1], Mikhail N. Skvortsov[1]; *[1]Inst. of Laser Physcis SB RAS, Russian Federation; [2]Novosibirsk State Univ., Russian Federation.* A Cs vapor cell is studied under two counter-propagating light beams. The probe-wave transmission represents just a single subnatural-linewidth electromagnetically induced absorption resonance without any pedestal. The proposed scheme serves as an efficient optical switch.

T5A.79

Overcoming the Decoherence Caused by Three-Body Collision in One-dimensional Single-mode Atomic Waveguide, Wei Jiang[1]; *[1]Microsystems and Terahertz Research Center, China Academy of Engineering Physics, China.* We investigate the decoherence dynamics caused by three-body interaction in one-dimensional sinlge-mode atomic waveguide. By using proper Feshbach resonance to modulate the relative interaction strength, the coherence can be recovered.

T5A.80

Unviversal turn-on dynamics of superconducting nanowire single-photon detectorrs, Kathryn L. Nicolich[1], Clinton Cahall[2], Nurul T. Islam[1], Gregory P. Lafyatis[1], Jungsang Kim[2,3], Aaron J. Miller[4], Daniel J. Gauthier[1]; *[1]The Ohio State Univ., USA; [2]Dept. of Electrical and Computer Engineering, Duke Univ., USA; [3]IonQ Inc., USA; [4]Quantum Opus LLC., USA.* We model the turn-on dynamics of superconducting nanowire single-photon detectors (SNSPDs), predicting that the rising edge of the readout signal encodes photon number, nanowire length and detector bias current, and experimentally verify these predictions.

T5A.82

AtoMIc Gravi-GradiOmeter AMIGGO, Romain Caldani[1]; *[1]Laboratoire SYRTE, France.* We demonstrate a method for simultaneous determination of the gravity acceleration and its gradient, based on a dual lock and the precise compensation of the differential phase using a frequency jump on the interferometer lasers.

T5A.83

Electromagnetic induction imaging with atomic magnetometers, Cameron Deans[1], Luca Marmugi[1], Ferruccio Renzoni[1]; *[1]Univ. College London, UK.* We report on atomic magnetometer-based electromagnetic induction imaging. A highly-sensitive and broadly tunable radio-frequency atomic magnetometer provides the core of our system. A range of applications – from security to biomedical imaging – is discussed and demonstrated.

T5A.84

Spatial entanglement patterns and Einstein-Podolsky-Rosen steering in Bose-Einstein condensates, Matteo Fadel[1]; [1]*Univ. of Basel, Switzerland.* We demonstrate EPR steering in an atomic system. This is allowed by spin correlations between spatially separated regions that we detect by performing high-resolution imaging of BECs in a spin-squeezed state.

T5A.86

Mid-infrared Frequency-domain Optical Coherence Tomography with Undetected Photons, Aron Vanselow[1], Paul Kaufmann[1], Ivan Zorin[2], Bettina Heise[2], Helen Chrzanowski[1], Sven Ramelow[1]; [1]*Humboldt-Universität zu Berlin, Germany;* [2]*Research Center for Materials Characterization and Non-Destructive Testing GmbH, Austria.* We implement mid-infrared frequency-domain optical coherence tomography (OCT) based on a nonlinear interferometer using correlated photon-pairs, enabling high-resolution depth-scans of strongly scattering samples with high sensitivity, speed and lateral resolution.

T5A.87

Optimal estimation of Hamiltonian parameters using Bayesian approach, Claudio M. Sanavio[1]; [1]*Univ. of Malta, Malta.* We apply the Bayesian approach of quantum estimation theory to optomechanics and matter-field interaction. We find the POVM minimizing the mean square error to infer the coupling constant, showing differences and similarities.

T5A.88

Near-Perfect Measurement of Photonic Spatial Modes, Natalia A. Herrera Valencia[1,2], Frederic Bouchard[3], Florian Brandt[2], Robert Fickler[4,2], Marcus Huber[2], Mehul Malik[1,2]; [1]*Heriot Watt Univ., UK;* [2]*Inst. for Quantum Optics and Quantum Information (IQOQI), Austria;* [3]*Dept. of Physics, Univ. of Ottawa, Canada;* [4]*Tampere Univ., Finland.* We propose and experimentally demonstrate a method to measure arbitrary spatial modes with a greater than 99% accuracy. This technique will be useful for quantum communication proto- cols where high-quality measurements are necessary and losses can be tolerated.

T5A.89

Feasibility of satellite quantum key distribution with continuous variable, Daniele Dequal[1], Luis Trigo Vidarte[2,3], Victor Roman Rodriguez[2,3], Anthony Leverrier[4], Giuseppe Vallone[5,6], Paolo Villoresi[5,6], Eleni Diamanti[3]; [1]*Italian Space Agency, Italy;* [2]*Institut d'Optique Graduate School, France;* [3]*Laboratoire d'Informatique de Paris 6, Université Pierre et Marie Curie, France;* [4]*Institut National de Recherche en Informatique et en Automatique, France;* [5]*Dipartimento di Ingegneria dell'Informazione, Università degli Studi di Padova, Italy;* [6]*Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche, Italy.* We analyze the feasibility of continuous variable quantum key distribution from satellite. By modeling the signal transmission, we quantify the achievable key rate including finite size effects. Results will help in determining mission requirements.

Friday 5 April

Poster Area
17:30 – 19:00
F5A • Poster Session II

F5A.1
First experimental realization of genuine time-bin entanglement, Francesco Vedovato[1], Costantino Agnesi[1], Marco Tomasin[1], Marco Avesani[1], Jan-Ake Larsson[2], Giuseppe Vallone[1], Paolo Villoresi[1]; [1]*Universita degli Studi di Padova, Italy;* [2]*Institutionen for systemteknik, Linkoping Universitet, Sweden.* The postselection loophole rendered to date time-bin entanglement unsuitable for quantum cryptography and conclusive Bell's test. We implemented a time-bin entanglement scheme free of the postselection, opening up to its exploitation in quantum information protocols.

F5A.2
Photon Entanglement In Strongly Non-Degenerate Parametric Down Conversion And Its Applications, Roman Zakharov[1,2], Olga V. Tikhonova[1,2]; [1]*Physics Faculty, Moscow State Univ., Russian Federation;* [2]*Skobeltsyn Inst. of Nuclear Physics, Russian Federation.* Parametric down conversion with output THz and optical beams is investigated. Methods to manage spatial properties and photon correlations of emitted squeezed quantum light are developed. Ways to collect lossless the THz radiation are found.

F5A.3
Quantum Communication Protocols Based on Hybrid Entanglement of Light, Giovanni Guccione[1], Adrien Cavaillès[1], Tom Darras[1], Hanna Le Jeannic[2], Jérémy Raskop[1], Kun Huang[3], Julien Laurat[1]; [1]*Laboratoire Kastler Brossel, France;* [2]*Niels Bohr Inst., Denmark;* [3]*Shanghai Key Laboratory of Modern Optical Systems and Engineering Research Center of Optical Instruments and Systems, China.* Hybrid entanglement of light combines two quantum information paradigms, the particle-like and the wave-like encodings, together. We report on recent experiments that engage this resource for two quantum communication protocols: remote state preparation and quantum steering.

F5A.4
Generating counterpropagating path-entangled photon pairs source using simultaneous collinear spontaneous parametric down-conversion processes of nonlinear photonic crystal, Chaoxiang Xi[1], Can Yang[1], Guangqiang He[1]; [1]*Shanghai Jiao Tong Univ., China.* We propose a counterpropagating path-entangled photon pairs source using a quasi-periodic modulated lithium niobate crystal. Through the simulation of jointspectral amplitude of photons, we confirm that our scheme can produce the maximally path-entangled two-photon states.

F5A.5
How to detect qubit environment entanglement in pure dephasing evolutions, Katarzyna Roszak[1], Damian Kwiatkowski[2], Lukasz Cywinski[2]; [1]*Dept. of Teoretical Physics, Wroclaw Univ. of Science and Technology, Poland;* [2]*Inst. of Physics, Polish Academy of Sciences, Poland.* We propose a straightforward experimental test for qubit-environment entanglement generation during qubit pure dephasing. The protocol is implemented using measurements and operations on the qubit only – no measurement of the system-environment state is required.

F5A.7
Verifying Multi-Particle Entanglement with a Few Detection Events, Valeria Saggio[1], Aleksandra Dimić[2], Chiara Greganti[1], Lee Rozema[1], Philip Walther[1], Borivoje Dakić[1]; [1]*Univ. of Vienna, Austria;* [2]*Univ. of Belgrade, Serbia.* Entanglement verification becomes hard when dealing with large quantum systems. By treating this task probabilistically, we certify entanglement with high confidence in an experimental photonic six-qubit cluster state by using only a few detection events.

F5A.8
Frequency Comb single photon interferometry for optical measurement with undetected photons , Sun Kyung Lee[1], Noh Soo Han[1], Tai Hyun Yoon[3,1], Minhaeng Cho[2,1]; *[1]Inst. for Basic Science (IBS), Korea; [2]Chemistry, Korea Univ., Korea; [3]Physics, Korea Univ., Korea.* We demonstrate a frequency-comb single-photon interferometry for quantum spectroscopy and imaging with undetected photons by utilizing both of optical frequency comb technique and quantum erasing mechanism with path-entangled photon pairs.

F5A.9
Wavefront Shaping of Spatially Entangled Photons Scattered by Dynamic Random Media, Ohad Lib[1], Giora Hasson[1], Yaron Bromberg[1]; *[1]The Racah Inst. of Physics, The Hebrew Univ. of Jerusalem, Israel.* We compensate for scattering of pairs of spatially entangled photons from a dynamic diffuser, by tailoring the wavefront of the pump beam which generates the photon-pairs in a spontaneous parametric down conversion process.

F5A.10
Manipulation of Cooper pair entanglement in hybrid topological Josephson junctions, Gianmichele Blasi[1], Vittorio Giovannetti[1], Fabio Taddei[1], Alessandro Braggio[1]; *[1]Scuola Normale Superiore di Pisa, Italy.* In this paper we demonstrate that combining s-wave superconductivity with the helical properties of 2D TIs, the non-local manipulation of spin-entangled states by means of local gating can be done.

F5A.12
Hyperentangled photons for quantum communication?, Nicolo Lo Piparo[1], Michael Hanks[1], William Munro[2,1], Kae Nemoto[1]; *[1]National Inst. of Informatics, Japan; [2]NTT Basic Research Laboratories & NTT Research Center for Theoretical Quantum Physics, NTT Corporation, Japan.* Quantum communication relies on the transmission of photons across lossy channels. Here, we show how hyperentangled photons can improve the efficiency of generating high fidelity entangled pairs between two parties.

F5A.14
Super-resonant parametric generation and golden ratio entanglement in hexagonally poled nonlinear crystals, Ottavia Jedrkiewicz[1], Alessandra Gatti[1], Enrico Brambilla[2], Katia Gallo[3]; *[1]CNR Istituto Fotonica e Nanotecnologie, Italy; [2]Department of Science and High Technology, Univ. of Insubria, Italy; [3]KTH- Royal Inst. of Technology, Sweden.* We analyze the twin beam radiation generated by parametric down-conversion in a hexagonally-poled photonic crystal representing an interesting monolithic source of path-entangled photonic states. We highlight a super-resonance condition associated with a four-mode entanglement state.

F5A.15
Towards single-shot readout in double-sided coaxial circuit-QED, Martina Esposito[1], Joseph Rahamim[1], Andrew Patterson[1], James Wills[1], Giulio Campanaro[1], Takahiro Tsunoda[1], Peter Spring[1], Matthias Mergenthaler[1], Sophia Sosnina[1], Salha Jebari[1], Kitty Ratter[1], Giovanna Tancredi[1], Brian Vlastakis[1], Peter Leek[1]; *[1]Univ. of Oxford, Physics Dept., UK.* We developed and characterized a Josephson parametric amplifier based on an LC resonator and an array of superconducting quantum interference devices (SQUIDs). We performed preliminary experiments of qubit readout in a double-sided coaxial circuit-QED architecture.

F5A.16
Multiphoton Discrete Fractional Fourier Operations in Waveguide Beam Splitters, Roberto d. Leon Montiel[1], Konrad Tschernig[2], Omar Magaña-Loaiza[3], Alexander Szameit[4], Kurt Busch[2], Armando Perez-Leija[5]; *[1]National Autonomous Univ. of Mexico, Mexico; [2]Humboldt-Universitat zu Berlin, Germany; [3]NIST, USA; [4]Institut fur Physik, Universitat Rostock, Germany; [5]Max-Born-Institut, Germany.* We show that by injecting N indistinguishable photons in a waveguide beam-splitter, one can create lattice-like structures in the photon number space, which are equivalent to coupled systems that perform discrete fractional Fourier operations.

F5A.17
Teleportation Algorithm Settled in a Resonant Cavity Using Non-local Gates, Francisco J. Delgado-Cepeda[1]; *[1]Tecnologico de Monterrey, Mexico.* This work presents the implementation of teleportation algorithm inside of a

two-mode magnetic resonant cavity using non-local gates. Process can be grown easily to larger states than the single-qubit case shown here.

F5A.18

Realizing an adiabatic quantum search algorithm with shortcuts to adiabaticity in an ion-trap system, Wei Wu[1], Jie Zhang[1]; [1]*Natl Univ Defense Tech, China.* We demonstrated the application of shortcuts to adiabaticity (STA) in adiabatic quantum computing by implementing a 2-bit STA assisted Grover's algorithm.

F5A.19

Quantum Zeno Effect by Incomplete Measurements, Manchao Zhang[1], Chunwang Wu[1], Yi Xie[1], Wei Wu[1], Pingxing Chen[1]; [1]*NUDT, China.* We investigate the quantum Zeno effect caused by incomplete measurements. We show that a more efficient quantum Zeno effect than the complete measurements case can occur if parameters are properly set.

F5A.22

Visual assessment of multiphoton interference, Fulvio Flamini[1], Nicolò Spagnolo[1], Fabio Sciarrino[1]; [1]*Università di Roma La Sapienza, Italy.* Machine learning allows to extract meaningful patterns hidden within high-dimensional data. Here we combine two such algorithms to investigate and validate multiphoton quantum interference in Boson Sampling experiments.

F5A.23

Advantage of Indefinite Causal Order in Quantum Metrology, Xiaobin Zhao[1]; [1]*The Univ. of Hong Kong, Hong Kong.* We discover an advantage of indefinite causal structure in estimation of the product of two conjugate variables with randomly fluctuating phase. In this scenario, higher precision is achieved when the black boxes are no signaling.

F5A.24

Modeling two-qubit Grovers algorithm implementation in a linear optical chip, Eduard Samsonov[1], Fedor Kiselev[1]; [1]*ITMO Univ., Russian Federation.* We introduce a model of Grovers algorithm suitable for implementation in a linear photonic chip. We compared two known realizations of two-qubit CZ gates and determined tolerance boundaries for distortions of the coupler dimensions.

F5A.25

Thermodynamic properties of stochastic quantum measurements, Lorenzo Buffoni[1,2], Stefano Gherardini[2,1], Filippo Caruso[1,2]; [1]*Università degli Studi di Firenze, Italy;* [2]*LENS, Italy.* We characterize the effect of stochastic fluctuations on the distribution of the quantum-heat exchanged by a quantum system with an external observer under sequences of projective measurements performed at random times.

F5A.26

Experimental learning of quantum states, Andrea Rocchetto[2,3], Scott Aaronson[4], Simone Severini[2,5], Gonzalo Carvacho[1], Davide Poderini[1], Iris Agresti[1], Marco Bentivegna[1], Fabio Sciarrino[1]; [1]*La Sapienza Universitá di Roma, Italy;* [2]*Dept. of Computer Science, Univ. College London, UK;* [3]*Dept. of Materials, Univ. of Oxford, UK;* [4]*Dept. of Computer Science, Univ. of Texas at Austin, USA;* [5]*Inst. of Natural Sciences, Shanghai Jiao Tong Univ., China.* The exponential scaling in sample complexity which characterizes quantum tomography can be circumvented using a computational learning theory approach, reducing it to a linear one.
Here we experimentally demonstrate this linear scaling in optical systems with up to 6 qubits.

F5A.27

Communication using an indefinite causal structure, Lorenzo Procopio[1]; [1]*C2N-CNRS, France.* It has recently been shown that if two completely depolarizing channels are in a superposition of different orders, classical information can be transmitted. Here, we present a generalization to study communication with arbitrary depolarizing channels.

F5A.28

Supervised learning of time-independent Hamiltonians for gate design, Luca Innocenti[1], Mauro Paternostro[1], Alessandro Ferraro[1], Leonardo Banchi[2], Sougato Bose[3]; [1]*Queen's Univ. Belfast, UK;* [2]*Imperial College London, UK;* [3]*Univ. College London, UK.* We present a general framework to approach the problem of finding time-independent dynamics generating target unitary evolutions. We solve this problem in physically relevant instances, like finding time-independent dynamics for Toffoli and Fredkin gates.

F5A.31

Spectral Path Entanglement of Photons Using the All-Optical Stern-Gerlach Effect, Aviv Karnieli[1], Ady Arie[1]; [1]*Tel Aviv Univ. , Israel.* We show that proper engineering of a quadratic nonlinear interaction induces quantum entanglement between the spatial and spectral degrees of freedom of incident photons via the all-optical analogue of the Stern-Gerlach effect.

F5A.32

Quantum Blockchain, a Simplified Framework, Xin Sun[1,2], Mirek Sopek[3], Quanlong Wang[2], Piotr Kulicki[1]; [1]*The John Paul II Catholic Univ. of, Poland;* [2]*Univ. of Oxford, UK;* [3]*MakoLab SA, Poland.* The paper presents Quantum Logical Ledger (QLL) being a simplified framework for quantum blockchain. It is shown that the cost of quantum resources is reduced in QLL compared to the existing quantum blockchains. QLL is unconditionally secure and can be realized by the current technology.

F5A.33

Demonstration of Einstein-Podolsky-Rosen Steering via Enhanced Subchannel Discrimination, Kai Sun[1]; [1]*Univ. of Sci. & Tech. of China, China.* We designed a feasible collection of subchannels for a quantum channel and experimentally demonstrated the corresponding subchannel discrimination task where probabilities of correct discrimination are clearly enhanced by exploiting steerable states with the optical system.

F5A.34

Direct Reconstruction of the Quantum Density Matrix by Strong Measurements, Giulio Foletto[1], Luca Calderaro[1,3], Daniele Dequal[4], Paolo Villoresi[1,2], Giuseppe Vallone[1,2]; [1]*Dipartimento di Ingegneria dell'Informazione, Università degli Studi di Padova, Italy;* [2]*Istituto di Fotonica e Nanotecnologie, CNR, Italy;* [3]*Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo", Università degli Studi di Padova, Italy;* [4]*Matera Laser Ranging Observatory, Agenzia Spaziale Italiana, Italy.* We propose a quantum state reconstruction method based on ancilla-assisted strong measurements. It is simpler than standard tomography and more accurate than methods that require weak measurements. We validate it with an optical experiment.

F5A.35

Experimental nonlocality-based randomness generation with nonprojective measurements, Santiago A. Gómez[1]; [1]*Ciencias Físicas y Matemáticas, Universidad de Concepción, Chile.* We report on an optical setup generating more than one bit of randomness from one entangled bit. To attain this result we implemented a high-purity entanglement source and a nonprojective three-outcome measurement.

F5A.36

Extended wavefunctions for the Variational Quantum Eigensolver, Leonardo Guidoni[1], Francesco Benfenati[1], Guglielmo Mazzola[2], Panagiotis Barkoutsos[2], Pauline Ollitrault[2], Ivano Tavernelli[2]; [1]*Univ. of L'Aquila , Italy;* [2]*IBM-Research Zurich, Switzerland.* We extend the class of wavefunctions used within the framework of the Variational Quantum Eigensolver. Testing such extended variational space in simple cases, we achieve high quality wavefunction with reduced circuit depth.

F5A.37

"Which-way" Spin Decoherence in a Coupled Quantum Dot System, Mateusz Krzykowski[1], Michal Gawelczyk[1,2], Krzysztof Gawarecki[1], Pawel Machnikowski[1]; [1]*Dept. of Theoretical Physics, Faculty of Fundamental Problems of Technology, Wroclaw Univ. of Science and Technology, Poland;* [2]*Dept. of Experimental Physics, Faculty of Fundamental Problems of Technology, Wroclaw Univ. of Science and Technology, Poland.* We study numerically and analytically decoherence of spin doublet coupled to phonon bath environment during the spin tunnelling. We recognize it as "which-way" type of process with the phonon bath effectively measuring the spin.

F5A.38
Dense Measurements for Quantum Computations, Laszlo Gyongyosi[1,2], Sandor Imre[2]; *[1]Univ. of Southampton, UK; [2]Budapest Univ. of Technology and Economics, Hungary.* Quantum measurement is a fundamental cornerstone of experimental quantum computations. We define a novel measurement for quantum computations called dense quantum measurement. The dense measurement aims at fixing the main drawbacks of standard quantum measurements.

F5A.40
Quantum communication advantage with coherent states and one beam splitter, Federico Centrone[2,1], Niraj Kumar[1], Eleni Diamanti[1], Iordanis Kerenidis[2]; *[1]Sorbonne Université, France; [2]Université Paris Diderot, France.* We propose a quantum proof for the NP-complete verification problem using coherent states, linear optics and single photon detectors, showing an exponential gap between quantum and classical proof size even in presence of experimental imperfections.

F5A.41
Quantum algorithms on a four-qubit photonic controlled-shift gate, Joseph Ho[1,2], Raj B. Patel[1,3], Timothy C. Ralph[4], Geoff J. Pryde[1]; *[1]Centre for Quantum Computation and Communication Technology and Centre for Quantum Dynamics, Griffith Univ., Australia; [2]School of Engineering and Physical Sciences, Heriot-Watt Univ., UK; [3]Clarendon Laboratory, Oxford Univ., UK; [4]Centre for Quantum Computation and Communication Technology and School of Mathematics and Physics, The Univ. of Queensland, Australia.* We implement a four-qubit controlled-shift gate leveraging photon entanglement in extended Hilbert spaces and observe \(P_{success}=0.25\).
This enables our demonstration of a DQC1 protocol and the quantum phase estimation algorithm featuring a multi-qubit unitary.

F5A.42
Critical-point behaviour of a measurement-based quantum heat engine, Suman Chand[1], Asoka Biswas[1]; *[1]Indian Inst. of Technology, Ropar, India.* Long-range interaction among the particles can substantially enhance the efficiency of a quantum Otto engine, around quantum criticality. We demonstrate this with two trapped ions driven by variable magnetic field, using a measurement-assisted cooling protocol.

F5A.43
Improving SPDC Single-Photon Sources Via Spectral Filtering And Feed-Forward Control, Marcello Massaro[1], E. Meyer-Scott[1], Nicola Montaut[1], Harald Herrmann[1], Christine Silberhorn[1]; *[1]Univeristy of Paderborn, Germany.* Parametric downconversion sources often trade generation rate for increased purity. We present a feed-forward scheme that mitigates the adverse effects of filtering on photon generation rates while simultaneously removing uncorrelated noise from the source output.

F5A.44
New insights in phase diffusion process in a gain-switched semiconductor laser for quantum random number generation (QRNG), Brigitta Septriani[1], Oliver de Vries[1], Markus Graefe[1], Marta Gilaberte Basset[1]; *[1]Fraunhofer Inst. for Applied Optics and Precision Engineering IOF, Germany.* We present a parametric study of QRNG using phase diffusion in gain-switched DFB laser diode. We present new theoretical findings on the maximal raw data rate and explain the advantage of pulsed regime against cw.

F5A.45
Verifying genuine multipartite entanglement of the whole from its separable parts, Ladislav Mista[1], Michal Micuda[1], Robert Starek[1], Jan Provaznik[1], Olga Leskovjanova[1]; *[1]Palacky Univ., Czechia.* We experimentally prepare a quantum state with genuine multipartite entanglement which can be certified from its separable marginals. This confirms detectability of emerging global properties of composite quantum systems from their parts lacking the properties.

F5A.46

Controlling Multi-Level Quantum Systems in Cryogenic Surface-Electrode Ion Traps, Maciej Malinowski[1]; *[1]D-PHYS, Inst. for Quantum Electronics, ETH Zurich, Switzerland.* I report on progress in trapping and controlling Ca ions in cryogenic planar traps. I discuss experiments on quantum contextuality and a new modular setup for testing next-generation traps with junctions and integrated optics.

F5A.48

Engineering of Quantum States through Quantum Walk in the Angular Momentum, Taira Giordani[3], Emanuele Polino[3], Sabrina Emiliani[3], Alessia Suprano[3], Nicolò Spagnolo[3], Fabio Sciarrino[3], Luca Innocenti[2], Helena Majury[2], Mauro Paternostro[2], Alessandro Ferraro[2], Lorenzo Marrucci[1]; *[1]Dipartimento di Fisica "Ettore Pancini", Universit`a Federico II, Italy; [2]School of Mathematics and Physics, Queen's Univ. Belfast, UK; [3]Dipartimento di Fisica, Sapienza Università di Roma, Italy.* We demonstrate exprimentally a state-engineering protocol based on discrete time quantum walk in the orbital angular momentum degree of freedom. To confirm the protocol feasibility, we have engineered different qudit states in a six-dimensional space.

F5A.49

Tuning single-photon sources for telecom multi-photon experiments, Chiara Greganti[1], Peter Schiansky[1], Irati Alonso Calafell[1], Lorenzo Procopio[2], Lee Rozema[1], Philip Walther[1]; *[1]Univ. of Vienna, Austria; [2]Université Paris-Saclay, France.* Accidental photon noise and imperfect single-photon purity in spontaneous parametric down-conversion (SPDC) at telecom wavelengths are overcome by exploiting a passive temporal multiplexing scheme and optimizing the spectral properties of the down-converted photons.

F5A.50

Tunable two-photon quantum interference of structured light, Vincenzo D'Ambrosio[1], Gonzalo Carvacho[2], Iris Agresti[2], Lorenzo Marrucci[1], Fabio Sciarrino[2]; *[1]Università di Napoli Federico II, Italy; [2]Università di Roma Sapienza, Italy.* To exploit the full potential of structured photons in quantum domain, the control over two-photon quantum interference is needed. By using a q-plate we tune such interference in a compact, efficient and robust way.

F5A.52

Light-matter interaction in an optically asymmetric wedge type nanocavity, Belkis Gokbulut[1], Mehmet Naci Inci[1]; *[1]Bogazici Univ., Turkey.* Light-matter interaction is studied in an optically and geometrically asymmetric wedge type nanocavity via time-resolved fluorescence lifetime spectroscopy. Inhibition of about 50% is observed in the spontaneous emission rate.

F5A.54

Dynamics of tripartite quantum systems: Squeezing properties and entanglement collapse to nonzero constant values, Pradip Laha[1], S Lakshmibala[1], V Balakrishnan[1]; *[1]Indian Inst. of Technolodgy Madras, India.* The dynamics of tripartite systems of field-atom interactions and optomechanics is investigated through relevant tomograms. Quadrature and tomographic entropic squeezing and entanglement properties are examined. Entanglement collapses to constant nonzero values over significant time intervals.

F5A.55

Estimating entanglement indicators from multipartite optical tomograms, Sharmila Balamurugan[1], S Lakshmibala[1], V Balakrishnan[1]; *[1]Indian Inst. of Technology Madras, India.* We obtain entanglement indicators for continuous variable systems directly from tomograms avoiding detailed state reconstruction. Tomographic indicators are compared with those from inverse participation ratios and with the subsystem von Neumann entropy.

F5A.56

Peculiarities of Coherent Population Trapping During the Interaction of Three-level Atom with Non-classical Light, Daria Popolitova[1,2], Olga V. Tikhonova[1,2]; *[1]Dept. of Physics, M.V. Lomonosov Moscow State Univ., Russian Federation; [2]Skobeltsyn Inst. of Nuclear Physics, M.V. Lomonosov Moscow State Univ., Russian Federation.* Dynamics of three-level atom in non-classical fields is investigated analytically. Significant change of photon statistics and entanglement between the atom and quantum field are demonstrated. Peculiarities of coherent population trapping in quantum light are found.

F5A.57

Spinor atoms in an optical nanocavity: generation of *N*-photon pulses and spin-entangled states, Andrew Scott Parkins[2,1], Caspar Groiseau[2,1], Stuart Masson[2,1]; [1]*Dept. of Physics, Univ. of Auckland, New Zealand;* [2]*Dodd-Walls Centre for Photonic and Quantum Technologies, New Zealand.* We propose a single spin-*F* atom in a nanocavity as a source of superradiant (2*F*)-photon pulses. Using the same scheme, photon counting on the cavity output can conditionally prepare spin-entangled states of multiple spin-*F* atoms.

F5A.58

Nonreciprocity with a Nonlinear Superconducting Circuit, Andres Rosario Hamann[1], Clemens Müller[1,2], Markus Jerger[1], Maximilian Zanner[3], Joshua Combes[1], Mikhail Pletyukhov[4], Martin Weides[3,5], Thomas M. Stace[1], Arkady Fedorov[1]; [1]*ARC Centre of Excellence for Engineered Quantum Systems, The Univ. of Queensland, Australia;* [2]*Inst. for Theoretical Physics, ETH Zürich, Switzerland;* [3]*Physikalisches Institut, Karlsruhe Inst. of Technology (KIT), Germany;* [4]*Inst. for Theory of Statistical Physics, RWTH Aachen Univ., Germany;* [5]*School of Engineering, Electronics & Nanoscale Engineering Division, Univ. of Glasgow, UK.* Nonreciprocal devices are fundamental for signal routing and noise isolation, however, they are bulky and inherently lossy. Here, we experimentally realize a minimal, passive nonreciprocal device by embedding two superconducting artificial atoms in a waveguide.

F5A.59

Debye-Waller factor depend on temperature with the influence of doping ratio of the crystal structure metals in extended X-Ray absorption fine structure, Duc B. Nguyen[2,1]; [1]*Tan Trao Univ., Viet Nam;* [2]*Physics, Tan Trao Univ., Viet Nam.* Effects of the doping ratio and temperature on the Debye-Waller factor (DWF) of metals was investigated using the extended X-ray absorption fine structure spectra. The numerical results agree reasonably with experiments and other theories

F5A.61

Atom-mediated Nonlinear Photon-Pair Generation using Photonic Band-Gap Modes, Sina Saravi[1], Alexander N. Poddubny[3,2], Thomas Pertsch[1], Frank Setzpfandt[1], Andrey A. Sukhorukov[3]; [1]*Friedrich-Schiller-Universität Jena, Germany;* [2]*ITMO Univ., Russian Federation;* [3]*Nonlinear Physics Centre, Research School of Physics and Engineering, Australian National Univ., Australia.* By coupling a photonic band-gap mode to a 2-level emitter, we enable the otherwise forbidden photon-pair generation by spontaneous parametric down-conversion in the nonlinear photonic system, leading to excitation of the atom and single-photon emission.

F5A.62

High-Resolution Spectroscopy of Deterministically Generated Single Photons from a Single Atom, Matthias Kreis[1], Konstantin Klein[1], Christian Haen[1], Jurek Frey[1], Jürgen Eschner[1]; [1]*Uni des Saarlandes, Germany.* Using a high-finesse optical Fabry-Perot cavity, we measure the spectrum of single 854-nm photons generated from a trapped single $^{40}Ca^{+}$-ion by controlled Raman scattering on the $D_{5/2}$ - $P_{3/2}$ - $S_{1/2}$ transition.

F5A.63

Process steps behind extrcating quantum information out of measured data, Chandra Roychoudhuri[1]; [1]*Univ. of Connecticut, USA.* We underscore interaction process steps behind registering data for a quantum effect, leading to differentiate the measurable Superposition Effect from the un-measurable Superposition Principle. Extracting quantum information out of photoelectric data needs revisiting.

F5A.64

Proposing an experimental setup for probing coherent light-matter interaction in dense atomic clouds, Klara R. Theophilo[1], Pablo G. Dias[2], Pedro H. Magnani[2], Philippe W. Courteille[1], Raul Teixeira[2]; [1]*USP, Brazil;* [2]*UFSCAR, Brazil.* We propose an experimental setup to study the transition from diluted to dense samples in a cold ^{88}Sr cloud. Our main goal is observing light scattering in 3D samples where classical diffusion behavior is modified.

F5A.65

Study of wide-field Imaging spectrometer based on Fery prism with optical fiber array, Weiyan Li[1]; [1]*Chinese Academy of Science (CAS), China.* Researches a technique change the position of the secondary mirror through the thermal control technology to adjust the sensor. Experiment shows that the deflection angle is less than 15"

F5A.66

Two-membrane Cavity Optomechanics, Paolo Piergentili[1,2], Letizia Catalini[1], Mateusz Bawaj[1,2], Stefano Zippilli[1,2], Nicola Malossi[1,2], Riccardo Natali[1,2], David Vitali[1,2], Giovanni Di Giuseppe[1,2]; [1]*School of Science and Technology, Physics Division, Univ. of Camerino, Italy;* [2]*INFN, Sezione di Perugia, Italy.* We present an optomechanical multi-mode system where two Si_3N_4 membranes are placed inside a driven Fabry-Pérot cavity. Accordingly the coupling strength is enhanced by a factor $\sim$2.47 with respect to the single membrane case.

F5A.67

Ultra-low dissipation mechanical resonators for cavity optomechanics, Mohammad J. Bereyhi[1], Amir H. Ghadimi[1], Sergey A. Fedorov[1], Alberto Beccari[1], Ryan Schilling[1], Dalziel J. Wilson[2], Nils J. Engelsen[1], Tobias J. Kippenberg[1]; [1]*Physics, EPFL, Switzerland;* [2]*IBM Research, Switzerland.* We study the theory of dissipation dilution and realize two experimental techniques - "elastic-strain engineering" and "clamp-tapering" - for exceptional mechanical quality factor ($Q\times f>10^{15}$ Hz) of high stress Si_3N_4 nanobeams at room temperature.

F5A.68

Nonlinear Stroboscopic Quantum Optomechanics, Andrey A. Rakhubovsky[1], Radim Filip[1]; [1]*Palacky Univ., Czechia.* We present feasible experimental proposals to construct an optomechanical transducer entangling radiation modes by quadratic nonlinearities and to prepare a cubic phase state of the mechanical oscillator. We show the robustness of both protocols to thermal noise.

F5A.69

Exploring corrections to the Optomechanical Hamiltonian, Tommaso Tufarelli[1], Kamila Sala[1]; [1]*School of Mathematical Sciences, Univ. of Nottingham, UK.* We compare corrections to the “linear model” of optomechanics, derived via: (I) a number-conserving phenomenological Hamiltonian; (II) Law's microscopic Hamiltonian. While (I) improves the linear model, (II) becomes necessary beyond second order in the coupling.

F5A.70

Quantum thermometry in optomechanics, Francesco Marin[1,2]; [1]*Dipartimento di Fisica e Astronomia, Università degli Studi di Firenze, Italy;* [2]*Sezione di Firenze, INFN, Italy.* We describe a method to control the cavity detuning in optomechanics experiments. This helps accurate measurements of the asymmetry in the motional sidebands, that testify the quantum behavior of the oscillator and quantifies its occupation number.

F5A.71

On the observation of the dynamical Lamb effect with a superconducting circuit, Mirko Amico[1,2], Oleg Berman[1,2], Roman Kezerashvili[1,2]; [1]*Physics, Graduate Center, City Univ. of New York, USA;* [2]*Physics, New York City College of Technology, USA.* We suggest the possibility of the observation of the dynamical Lamb effect using a superconducting circuit which allows to switch between longitudinal and transverse coupling.

F5A.72

Entanglement generation and simultaneity with superconducting qubits, Carlos Sabín[1]; [1]*Instituto de Física Fundamental (CSIC), Spain.* We analyse DCE-entanglement between two superconducting qubits in several states of qubit motion. We show that correlated absorption and emission of photons is crucial, which can be linked to the special-relativity notion of simultaneity.

F5A.73

Experimental Realization of an Innovative Phase-Stable Bulk-Optic Scheme for Quantum Walks, Andrea Geraldi[1], Luìs D. Bonavena[1], Carlo Liorni[2], Paolo Mataloni[1], Álvaro Cuevas[1]; [1]*Physics Dept., Univ. of Rome La Sapienza, Italy;* [2]*Inst. for Theoretical Physics III, Heinrich-Heine-Univ., Germany.* We present a bulk-optics setup for discrete quantum walks, based on a novel multipass displaced Sagnac geometry. It is phase stable, reconfigurable and allows to meausure the output radiation at each step. The experimental results of both ordered and disordered one-particle evolutions are reported.

F5A.74

Directly Measuring the Winding Number in Photonic Discrete Time Quantum Walks, Xiao-Ye Xu[1], Qin-Qin Wang[1], Chuan-Feng Li[1]; *[1]Key Lab of Quantum information,USTC, China.* Topological phases determined by the system's ground state can be completely classified by topological invariants. By fully reconstructing the final wave function, we report a dynamical method for measuring the topological invariants in photonic quantum walks.

F5A.75

Refocusing in forced photonic quantum walks controlled by liquid crystal gratings, Alessio D'Errico[2], Filippo Cardano[2], Chiara Esposito[2,1], Bruno Piccirillo[2], Maria Maffei[3,2], Alexandre Dauphin[3], Maciej Lewenstein[3,4], Pietro Massignan[3,5], Lorenzo Marrucci[2,6]; *[1]Dipartimento di Fisica, Università degli studi di Roma Sapienza, Italy; [2]Dipartimento di fisica, Università degli studi di Napoli Federico II, Italy; [3]ICFO-Institut de Ciencies Fotoniques, The Barcelona Inst. of Science and Technology, Spain; [4]ICREA Instituciò Catalana de Recerca i Estudis Avancats, Spain; [5]Departament de Fìsica, Universitat Politecnica de Catalunya, Spain; [6]CNR-ISASI, Inst. of Applied Science and Intelligent Systems, Italy.* We mimic one dimensional forced quantum walks by using the photonic implementation obtained by means of a sequence of liquid-crystal devices (”g-plates”), which apply polarization-dependent transverse kicks to the photons in the beam. We observed refocusing phenomena for localized initial states.

F5A.76

Quantum Control of Quantum Solitons, Giulia Marcucci[1], Simone Montangero[2], Tommaso Calarco[3], Claudio Conti[1]; *[1]Physics, Univ. of Rome "La Sapienza", Italy; [2]Physics and Astronomy, Univ. of Padova, Italy; [3]Inst. for Complex Quantum Systems, Ulm Universität, Germany.* Controlling quantum nonlinear optical processes is a major challenge in optics. We apply novel quantum control techniques to optical solitons. By phase-space methods, we show that a proper control function alters the soliton evolution.

F5A.77

Noise-assisted transport through quantum networks using cold atoms, Plamen G. Petrov[1], Andrew White[1], Christopher Gill[1], Vincent Boyer[1]; *[1]Univ. of Birmingham, UK.* We simulate the excitation transport in a noisy quantum network with a weakly radio-frequency coupled atom-field system in the presence of a broadband classical noise. We observe noise-enhanced transport from initial optically-pumped magnetic state to target state.

F5A.78

Ignorance of the whole does not imply ignorance of the parts: Qudit Random Access Codes in spatial modes of light, Michael Kewming[1], Sally Shrapnel[1], Jacquiline Romero[1], Andrew White[1]; *[1]Univ. of Queensland, Australia.* Using spatial modes of light, we implement a high dimension random access coding scheme capable of testing the question 'does ignorance of the whole, imply ignorance of the parts?'.

F5A.79

Probing magnetic ordering and dynamics with ultracold bosonic atoms, Araceli Venegas Gomez[1], Wolfgang Ketterle[2,3], Andrew J. Daley[1]; *[1]Univ. of Strathclyde , UK; [2]Harvard-MIT Center for Ultracold Atoms, USA; [3]Dept. of Physics, Massachusetts Inst. of Technology, USA.* We explore time-dependent dynamics in magnetic models corresponding to two-component bosons in an optical lattice.

F5A.81

Witnessing entanglement with nonlocal operation, Weidong Li[1]; *[1]Shanxi Univ., China.* We suggest to identify quantum entanglement by measuring the statistical response of a quantum system to an arbitrary nonlocal parametric evolution. Our suggestion does not basing on the tomographic reconstruction of the quantum state, or the realization of witness operators.

F5A.82

Long-range distribution of multiphoton entanglement, Monika E. Mycroft[1], Adam Buraczewski[1], Stefanie Barz[2,3], Magdalena Stobinska[1]; [1]*Faculty of Physics, Univ. of Warsaw, Poland;* [2]*Inst. for Functional Matter and Quantum Technologies, Univ. of Stuttgart, Germany;* [3]*Center for Integrated Quantum Science and Technology, Univ. of Stuttgart,, Germany.* We propose a long-distance quantum communication protocol based on multiphoton bipartite entanglement and photon-number-resolved detection, which shows remarkable robustness to high transmission losses and offers near-maximally entangled states in realistic implementations.

F5A.83
A modified Hong-Ou-Mandel interferometer for two-parameter sensing, Yu Yang[1,2], Luping Xu[1], Vittorio Giovannetti[2]; [1]*Xidian Univ., China;* [2]*Scuola Normale Superiore, Italy.* A modification of the standard Hong-Ou-Mandel interferometer is proposed to recover two independent parameters via the coincidences counts. Whether in the ideal or the parameter fluctuating case, estimating the parameters with the bi-photon states performs well than with the semiclassical states.

F5A.84
A novel method of data remapping for quantum information science, Syed Adil Rab[1], Silvia Colabrese[1]; [1]*Cogisen Srl, Italy.* We propose a novel method of data remapping which scales linearly with the size of the system and captures information from multidimensional structures. Results demonstrate it is highly effective for quantum dots states' recognition.

F5A.85
Quantum Control in Ultrafast Coherent Bond Making, Zohar Amitay[1], Liat Levin[1], Daniel M. Reich[3], Ronnie Kosloff[2], Christiane P. Koch[3]; [1]*Technion - IIT, Israel;* [2]*Hebrew Univ., Israel;* [3]*Kassel Univ., Germany.* Quantum control of ultrafast coherent bond making and subsequent molecular dynamics is experimentally demonstrated by controlling branching ratio into different target molecular states. This is a significant step toward realizing a new quantum coherent photochemistry.

F5A.86
Optical Trapping of Magnesium Ions in Two-Dimensional Arrays and Spectroscopy on Magnesium Rydberg Atoms, Oliver Wipfli[1]; [1]*ETH Zürich, Switzerland.* We propose trapping two-dimensional Coulomb crystals of ions in the strong light field of an optical resonator without radio-frequency fields, with an aim to perform quantum simulation of two-dimensional many-body Hamiltonians.

F5A.87
Simulation of Integrated Photonic Gates, Andrei-Emanuel Dragomir[1], Cristian Ivan[1], Radu Ionicioiu[1]; [1]*Horia Hulubei National Institute for Physics and Nuclear Engineering IFIN-HH, Romania.* Integrated photonics is a major platform for quantum technologies. We design a novel algorithm to simulate quantum gates, including: Hadamard, NOT and Fourier. The algorithm provides a flexible tool for developing quantum devices in integrated photonics.