

07:30–16:00 Registration, Market Street Foyer, Fairmont Hotel

08:00–10:00

FThA • Nonlinear Optics in Micro-Nano Optical Structures II ▶Vladimir Ilchenko; *OEwaves Inc USA, Presider*

FThA1 • 08:00 ▶

A Quantum Theory of Four-Wave Mixing in Graphene, Zheshen Zhang^{1,2}, Paul Voss^{1,2}; ¹*Electrical and Computer Engineering, Georgia Tech Lorraine, France*; ²*Electrical and Computer Engineering, Georgia Institute of Technology, USA*. We present a dynamic quantum perturbation theory to describe four-wave-mixing intensity at optical frequencies in graphene. The theory, which uses a classical field and quantum graphene, fits recent experimental results.

FThA2 • 08:15 ▶

Nanoscale Coherent Perfect Absorber of Light, Heeso Noh¹, Yidong Chong¹, A. Douglas Stone¹, Hui Cao^{1,2}; ¹*Applied Physics, Yale Univ., USA*; ²*Physics, Yale Univ., USA*. Based on the concept of time-reversing a laser, we develop two schemes of 100% coupling of light into individual nanoparticles, either a dielectric nanoparticle buried in a scattering medium or a single metallic nanoparticle in vacuum.

FThA3 • 08:30 ▶

1- and 2-Photon Absorption With Cold Rubidium Using An Optical Nanofiber, Sile Nic Chormaic^{1,2}, Laura Russell^{1,3}, Mark Daly^{1,3}; ¹*Physics, Univ. College Cork, Ireland*; ²*Univ. of Kwazulu-Natal, South Africa*; ³*Tyndall National Institute, Ireland*. We demonstrate the use of an optical nanofiber as a spectroscopic tool for cold Rb-85. We present recent single-photon absorption results which demonstrate surface interaction effects. Future work on 2-photon absorption in Rb-85 is discussed.

08:00–10:00

FThB • Laser-Based Radiation Therapy and Enabling Sources ▶William White; *SLAC, USA, Presider*FThB1 • 08:00 **Tutorial** ▶

Prospects for Laser-Driven Ion Beam Therapy, T. Cowan; *FZ Dresden-Rossendorf, Germany*. Abstract Not Available.

08:00–9:15

FThC • Optical Design with Unconventional Polarization IQiwen Zhan; *Univ. of Dayton, USA, Presider*FThC1 • 08:00 **Invited**

Mechanical Consequences for Conservation of Light Angular Momentum, Aristide Dogariu, *Univ. of Central Florida, USA*. Abstract not available.

FThC2 • 08:30

Non-interferometric Generation of Vector Beams, Santosh Tripathi¹, Kimani C. Toussaint²; ¹*Department of Electrical and Computer Engineering, Univ. of Illinois at Urbana Champaign, USA*; ²*Department of Mechanical Science and Engineering, Univ. of Illinois at Urbana Champaign, USA*. We present a non-interferometric method for generating vector beams. Potential gain in stability obtained from using this non-interferometric approach is expected to facilitate the use of vector beams in metrology and microscopy.

08:00–10:00

FThD • Image-Based Wavefront Sensing and Adaptive Optics IBruce Dean; *NASA Goddard, USA, Presider*

FThD1 • 08:00

Fast Approximate Broadband Phase Retrieval for Segmented Systems, Alden S. Jurling¹, James Fienup¹; ¹*Institute of Optics, Univ. of Rochester, USA*. We applied an approximate technique for broadband phase retrieval to a modeled segmented-aperture system in the ultra-broadband (133% bandwidth) regime, where it yielded an over-200X improvement in runtime, but at the cost of reduced accuracy.

FThD2 • 08:15

Image-Based Adaptive Optics for High-Resolution Microscopy, Richard Simmonds¹, Anisha Thayil¹, Martin Booth¹; ¹*Engineering Science, Univ. of Oxford, United Kingdom*. Aberrations frequently affect image quality in microscopes. Many adaptive microscopes use image-based rather than direct sensing. We derive efficient adaptive schemes to correct aberrations for confocal, multiphoton and harmonic microscopes.

FThD3 • 08:30 **Invited**

Wavefront Sensing and Advanced Imaging, Rick Kendrick^{1,2}; ¹*Lockheed Martin, USA*; ²*Lockheed Martin, USA*. We are investigating photon correlation and heterodyne techniques that will enable extremely large aperture imaging systems. Triple correlations and closure phases are used to estimate and correct wavefront errors using image plane data.

08:00–10:00

FThE • Quantum Computation and Communication II ▶Mikhail Lukin; *Harvard Univ., USA, Presider*FThE1 • 08:00 **Tutorial** ▶

Quantum Optical Interface for Atoms and Electro-mechanical Systems, Eugene S. Polzik¹; ¹*Niels Bohr Institute, Copenhagen Univ., Denmark*. Light can be used as an efficient quantum bus and a coupling agent connecting disparate systems, such as atomic ensembles, mechanical oscillators and electronic circuits.



Eugene Polzik is Professor of Physics at the Niels Bohr Institute in Copenhagen. His research interests are centered around quantum interface between light and matter. He is Member of the Royal Danish Academy of Science, Fellow of the American Physical Society and Fellow of the Optical Society of America.

07:30–16:00 Registration, Market Street Foyer, Fairmont Hotel

08:00–10:00

FThF • Novel Sensors and Applications II

Maksim Skorobogatiy; Ecole Polytechnique de Montreal, Canada, *Presider*

FThF1 • 08:00 **Invited**

High Spatial and Spectral Resolution Long-Range Sensing Using Brillouin Echoes, Luc Thevenaz¹, Stella M. Foaleng¹, Sanghoon Chin¹, Nikolay Primerov¹, Kwang-Yong Song^{1,2}; ¹Institute of Electrical Engineering, Ecole Polytechnique Federale de Lausanne, Switzerland; ²Department of Physics, Chung-Ang Univ., Republic of Korea. While classical configurations have a practical spatial resolution of 1 meter, novel approaches have been demonstrated that can overcome this limit to offer spatial resolutions in the centimetre range, while preserving full measurand accuracy.

FThF2 • 08:30

System Characterization of a SOA-FWM Wavelength Converter, Eduardo C. Magalhães¹, Rafael C. Figueiredo¹, Napoleão S. Ribeiro¹, Evandro Conforti¹, Aldario Bordonalli¹; ¹FEEC/DMO, UNICAMP, Brazil. An empirical characterization of SOA-FWM wavelength conversion is presented. The converted signal BER was analyzed for OOK transmission rates up to 12.5 Gb/s and different input channel optical powers.

08:00–10:00

FThG • Progress in Digital Holography I ▶

Christian Depeursinge; EPFL, Switzerland, *Presider*

FThG1 • 08:00 **Invited** ▶

Withdrawn

FThG2 • 08:30 ▶

Sub-Diffraction Limited Patterning via Optical Saturable Transformations, Precious Cantu¹, Nicole Brimhall¹, Trisha Andrews², Rajesh Menon³; ¹Electrical and Computer Engineering, Univ. of Utah, USA; ²Chemistry, Massachusetts Institute of Technology, USA. Here, we report on a method that resolves nanoscale patterns by exploiting the transitions of organic photochromic derivatives induced by their photoisomerization at low light intensities.

08:30–10:00

LThA • Nano-scale Light Matter Interaction III

Nuh Gedik; MIT, USA, *Presider*

LThA1 • 08:30 **Invited**

Cascaded Plasmon Resonances for Enhanced Ultrafast Nonlinear Optical Switching, Pieter Kik^{1,2}; ¹CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA; ²Department of Physics, Univ. of Central Florida, USA. Surface plasmon resonances on metallic nanostructures produce strongly enhanced third order nonlinear susceptibilities, while adding linear loss. We show that the use of cascaded resonances enables improved figures of merit for nonlinear switching.

08:00–10:00

LThB • Ultrafast X-Rays II

Mariano Trigo; SLAC National Accelerator Lab, USA, *Presider*

LThB1 • 08:00 **Invited**

Ultrafast Non-thermal Dynamics of Striped Nickelate via Femtosecond Resonant Soft X-ray Diffraction Using X-ray Free Electron Laser at LCLS, Wei-Sheng Lee¹; ¹SIMES, SLAC National Accelerator Lab., USA. We compare the non-thermal dynamics of spin and charge order in the striped nickelate. Analyses of recovery behavior elucidate the coupling of spin and charge order, as well as the effect of the spin anisotropy.

LThB2 • 08:30 **Invited**

X-ray / Optical Wave Mixing, Ernie Glover¹, T. Allison², M. Cammarata³, J. Feldkamp³, D. Fritz³, J. Hastings³, S. Harris⁴, David Reis^{4,5}, S. Schwarz⁴; ¹Lawrence Berkeley National Laboratory, USA; ²National Institute of Standards and Technology, USA; ³Linac Coherent Light Source, SLAC National Accelerator Laboratory, USA; ⁴Stanford Univ., USA; ⁵PULSE Institute, SLAC National Accelerator Laboratory, USA. We report the first observation of x-ray/optical sum frequency generation. An ultrafast optical pulse drives charge oscillations to the chemical bonds in diamond. A co-propagating x-ray pulse micro-probes the accompanying chemical bond distortion.

08:00–10:00

LThC • Orbital Angular Momentum and Applications III

Monika Ritsch-Marte; Innsbruck Medical Univ., Austria, *Presider*

8:00 • LThC1 **Invited**


Entanglement of very high orbital angular momentum, Robert Fickler, Peizhe Li, Radek Lapkiewicz, Mario Krenn, Christoph Schaeff, Marcin Wiesniak, Sven Ramelow, Anton Zeilinger; University of Vienna, Austria. Orbital angular momentum (OAM) of single photons represents a new optical degree of freedom for the entanglement of photons [1,2]. One physical realization of OAM carrying light beams are the so called Laguerre-Gaussian modes of light with the required helical phase structure. One big advantage over the well-known polarization degree of freedom is the possibility of realizing entanglement between two photons with very high quantum numbers. However, the creation of photonic OAM entanglement using the widely used spontaneous parametric downconversion process is limited by the strongly reduced efficiency for higher momenta [3]. We have realized a novel method to create entanglement between two photons with a very high difference in their OAM quantum number and momentum respectively. Furthermore we have explored hybrid entanglement of photons in the OAM and polarization degree of freedom.

LThC2 • 08:30 **Invited**


Angular Momentum in Optics and Acoustics: complementary studies, Karen Volke-Sepulveda¹; ¹Instituto de Física, Universidad Nacional Autónoma de México, México. The angular momentum in wave fields is discussed and analyzed by means of examples in optics and acoustics, showing that complementary studies provide a general and enriching perspective of rotating waves and phase singularities.

FThA • Nonlinear Optics in Micro/Nano Optical Structures II—Continued
FThA4 • 08:45  

Optofluidic Lasers and Their Applications in Highly Sensitive Intra-Cavity Biomolecular Detection. Yuze Sun¹, Xudong Fan¹; ¹*Biomedical Engineering, Univ. of Michigan, USA.* We report the progress of optofluidic lasers in the field of intra-cavity biosensing. Intra-cavity DNA detection is demonstrated with high differentiation between complementary sequence and single-base-mismatched sequence.

FThA5 • 09:15 

Second Harmonic Generation in CVD Graphene Induced by DC Electric Current. Anton Y. Bykov¹, Tatiana V. Murzina¹, Oleg A. Aktsipetrov¹, Maxim G. Rybin², Elena D. Obratsova²; ¹*Physics department, M.V. Lomonosov Moscow State Univ., Russian Federation*; ²*A.M. Prokhorov General Physics Institute, Russian Federation.* We present the first observation of DC electric current-induced optical second harmonic generation (SHG) in multilayer graphene. SHG intensity from graphene was found to increase dramatically with in-plane direct current application.

FThA6 • 09:30 

Size Distribution Effects on the Optical Properties of Gold Nanoparticles Synthesized by Polyol Process. Arun Thirumurugan¹, Justin Joseyphus¹; ¹*Physics, National Institute of Technology, India.* Gold nanoparticles were prepared using various polyols and with various additives by polyol process. Size distribution effects on the optical properties of gold nanoparticles studied by UV-VIS spectroscopy, SEM and TEM.

FThB • Laser-Based Radiation Therapy and Enabling Sources—Continued
FThB2 • 08:45  

Laser Plasma Accelerators for Cancer Treatment. Victor Malka¹; ¹*LOA, ENSTA, X, CNRS, France.* Laser plasma accelerators have made considerable progresses, which make them a future good candidate for medical applications such as radiotherapy or radiobiology.

FThB3 • 09:15  

Providing Thin-Disk Technology for High Laser Pulse Energy at High Average Power. Johannes Tuemmler¹, Robert Jung¹, Thomas Nubbemeyer¹, Ingo Will¹, Wolfgang Sandner¹; ¹*Max Born Institute, Germany.* Thin disk technology has the potential for providing laser pulses with high pulse energy and high repetition rate. Large laser projects like ELI or HiPER benefit from this technology as well as stand alone systems like e.g. laser driven x-ray sources

FThC • Optical Design with Unconventional Polarization I—Continued
FThC3 • 08:45

Fiber Amplifiers of Radially or Azimuthally Polarized Light. Moti Fridman¹, Micha Nixon¹, Asher A. Friesem¹, Nir Davidson¹; ¹*Weizmann Institute of Science, Israel.* A novel configuration for amplifying radial or azimuthal polarized light with fiber amplifier is presented. We obtained 40dB amplification with more than 85% polarization purity and efficient conversion to linear polarization.

FThC4 • 09:00


Cylindrical Vector Beam-Splitters. Jiao Lin¹, P. Genevet¹, F. Capasso¹; ¹*Harvard Univ., USA.* We show that radial and azimuthal polarizations can be separated with a circular sub-wavelength grating. The proposed grating-based beam-splitter can be used to generate cylindrical vector beams from circularly polarized light.

FThD • Image-Based Wavefront Sensing and Adaptive Optics I—Continued
FThD4 • 09:00


Phase Retrieval for an Undersampled Thermal Infrared System. Matthew R. Bolcar¹, Eric Mentzell¹; ¹*NASA Goddard Space Flight Center, USA.* Phase retrieval was used on an undersampled, thermal infrared system to estimate focal plane displacement (defocus) across the field of view. We compare phase-retrieval estimated defocus values to those obtained using an independent technique.

FThD5 • 09:15 

Phase Retrieval with Broadband Light. James R. Fienup¹; ¹*Institute of Optics, Univ. of Rochester, USA.* Image-based wavefront sensing by phase retrieval can be performed with broadband light, using a few different approaches. One may also estimate the spectrum of the light while retrieving the phase.

FThE • Quantum Computation and Communication II—Continued
FThE2 • 08:45 

Non-Markovian Spontaneous Emission from a Single Quantum Dot. Kristian H. Madsen¹, Serkan Ates¹, Toke Lund-Hansen¹, Andreas Löffler², Stephan Reitzenstein¹, Alfred Forchel¹, P. Lodahl¹; ¹*DTU Fotonik, Technical Univ. of Denmark, Denmark*; ²*Technische Physik, Universität Würzburg, Germany.* We observe non-Markovian dynamics of a single quantum dot when tuned into resonance with a cavity mode. Excellent agreement between experiment and theory is observed providing the first quantitative description of such a system.

FThE3 • 09:00 

A Study of Multipartite Entanglement Using Hyperentangled Photons. Aditya N. Sharma¹, Kevin T. McCusker¹, Julio T. Barreiro², Paul Kwiat¹; ¹*Department of Physics, Univ. of Illinois at Urbana-Champaign, USA*; ²*Institut für Experimentalphysik, Universität Innsbruck, Austria.* We present an experimental study of multipartite entanglement using hyperentangled photon pairs. We first demonstrate some interesting properties of the bound-entangled "Smolin state" and then discuss further studies using this source.

FThE4 • 09:15 

Quantum Random Bit Generation Using Degenerate Optical Parametric Oscillator. Alireza Marandi¹, Nick C. Leindecker¹, Konstantin L. Vodopyanov¹, Robert L. Byer¹; ¹*E. L. Ginzton Lab, Stanford Univ., USA.* We implement a twin optical parametric oscillator as a true random bit generator, and verify the randomness statistically. The operation principle is based on two stable phase states in degenerate synchronously pumped optical parametric oscillators.

FThE5 • 09:30 

On-chip Spectrally-Bright Photon-Pair Source from SiN Ring Micro-cavity. Stephane Clemmen¹, Alessandro Farsi¹, Jacob Levy², Luke Helt³, Marco Liscidini⁴, John Sipe², Michal Lipson², Alexander L. Gaeta¹; ¹*School of Applied and Engineering Physics, Cornell University, USA*; ²*School of Electrical and Computer Engineering, Cornell Univ., USA*; ³*Department of Physics, Univ. of Toronto, Canada*; ⁴*Department of Physics, Univ. of Pavia, Italy.* We report the first demonstration of photon pair generation in SiN cavity. Photon pairs are generated over very narrow bands at a rate up to 0.7 MHz / resonance and aligned to the ITU grid.

FIO

FThF • Novel Sensors and Applications II—Continued**FThF3 • 08:45**

Sparse, Mutually Orthogonal, Fully Permutable Optical Code Sets, Adly T. Fam¹; ¹*Electrical Engineering, SUNY at Buffalo, USA*. A class of sparse mutually orthogonal optical code is introduced, based on defining the separation between nonzero elements via logarithms of powers of relatively prime numbers. They are particularly suited for soliton based optical codes.

FThF4 • 09:00

A Novel Polarization Interleaving Approach for SCFDM-PON Based on Direct Detection, Juhao Li¹, Bangjiang Lin¹, Hui Yang¹, Song Jiang¹, Lixin Zhu¹, Yongqi He¹, Zhangyuan Chen¹; ¹*Peking Univ., China*. We propose a polarization interleaving (PI) approach for SCFDM-PON, which can significantly reduce the bandwidth requirement for components while achieve much lower complexity of MIMO algorithm.

FThF5 • 09:15

See FTZZ6

FThF6 • 09:30

Optically Controlled Waveplate at a Telecom Wavelength Using a Ladder Transition in Rb Atoms for All-Optical Switching via the Quantum Zeno Effect, Selim M. Shahriar^{1,2}, Krishnamurthy Subramanian¹, Ye Wang¹, Shih Tseng¹, Yanfei Tu¹; ¹*EECS Department, Northwestern Univ., USA*; ²*Physics and Astronomy Department, Northwestern Univ., USA*. We show, theoretically and experimentally, how to realize an optically controlled waveplate at a telecommunication wavelength using a ladder transition in Rb atoms at room temperature for all-optical switching via the quantum Zeno effect

FThG • Progress in Digital Holography I—Continued**FThG3 • 08:45**

Creating 3D Lattice Patterns Using Programmable Dammann Gratings, Jeffrey A. Davis¹, Ignacio Moreno², Jose Luis Martinez², Travis J. Hernandez¹, Don M. Cottrell¹; ¹*Physics, San Diego State Univ., USA*; ²*Universidad Miguel Hernandez, Spain*. A 3D lattice of equally intense focus spots can be created using a 3D Dammann structure. We show 4 planar arrays each having 4x4 points using a single pattern.

FThG4 • 09:00

Experimental Realization of 3D Clustered Speckle Field Simulation: An Approach to Optical Trapping, Juan Pablo Staforelli¹, Alberto Lencina²; ¹*Center for Optics and Photonics (CEFOP), Chile*; ²*Centro de Investigaciones Ópticas, Argentina*. A three-dimensional approach for the clustered speckles field is presented, attaching a multiple aperture mask to a diffuser. Results enable a proper description of this field, enhancing the possibility of their use for different applications.

FThG5 • 09:15

Vortex Sensing Diffraction Gratings, Jeffrey A. Davis¹, Don M. Cottrell¹, Ignacio Moreno²; ¹*Physics, San Diego State Univ., USA*; ²*Universidad Miguel Hernandez, Spain*. Vortex sensing diffraction gratings can analyze the sign and charge value of an incident vortex beam. They allow vortex spectral analysis of fractional vortex beams as well as the output from segmented spiral phase plates.

FThG6 • 09:30

Spatial Coherence Properties of the One-Dimensional Projection of Optical Vortices, Ashok Kumar¹, Shashi Prabhakar¹, Pravin Vaity¹, Ravindra P. Singh¹; ¹*Theoretical Physics Division, Physical Research Laboratory, India*. The experimental spatial coherence function of the one dimensional projection of optical vortices is compared with that of their two dimensional counterpart and also used to derive the information entropy and the Wigner distribution function.

LS

LThA • Nano-scale Light Matter Interaction III—Continued**LThA2 • 09:00** **Invited**

The Nano-Optics of Plasmonic Optical Tweezers, SERS Substrates and Multi-Colored Silicon Nanowires, Kenneth Crozier¹; ¹*Harvard Univ., USA*. We demonstrate nanoparticle manipulation using surface plasmons. We fabricate optical antennas for SERS, with gaps down to 3 nm. We demonstrate that silicon nanowires take on a surprising variety of colors covering the visible spectrum.

LThA3 • 09:30

Mid-Infrared Transition Metal Doped II-VI Semiconductor Lasers, Sergey Mirov^{1,2}, Igor Moskalev², Vladimir Fedorov^{1,2}, Dmitri Martyshev^{1,2}, Mikhail Mirov², NoSung Myoung¹; ¹*Univ. of Alabama at Birmingham, USA*; ²*2IPG Photonics, Mid-Infrared Lasers, USA*. Advances in Cr²⁺ and Fe²⁺ doped mid-IR II-VI gain materials fabrication and lasing under optical excitation are presented. First steps towards achieving a direct electrical excitation are demonstrated.

LThB • Ultrafast X-Rays II—Continued**LThB3 • 09:00** **Invited**

The X-Ray View of Ultrafast Nanomagnetism, Hermann Durr¹; ¹*Helmholtz Zentrum Berlin, Germany*. Femtosecond x-ray pulses from synchrotrons and free electron lasers are used to probe angular momentum dynamics in magnetic materials. Such studies reveal how optical excitation can be used to control magnetic interactions on microscopic length and timescales.

LThB4 • 09:30 **Invited**

Ultrafast X-ray Diffraction using Synchrotrons and Plasma Sources, M. Bargheer¹, D. Schick², R. Shayduk¹, M. Herzog², A. Bojahr², J. Goldshteyn¹, H. Navirian¹, W. Leitenberger², P. Gaal²; ¹*Helmholtz Zentrum Berlin, Germany*; ²*Institute of Physics and Astronomy, University of Potsdam, Germany*. Ultrafast X-ray diffraction yields material-specific information on transient strain in crystals, thin films and multilayers. Here we highlight ultrafast heat-driven processes in ferroelectric and ferromagnetic oxides.

LThC • Orbital Angular Momentum and Applications III—Continued**LThC3 • 09:00**

Far-field Diffraction of Vortex Beams, Anindya Ambuj¹, Hsiao-harn Shiau¹, Mike Lucini^{1,2}, Reeta Vyas¹, Surendra Singh¹; ¹*Physics Department, Univ. of Arkansas, USA*; ²*Department of Physics, Boston College, USA*. Novel features in the far field diffraction of optical Laguerre-Gauss vortex beams are studied experimentally. These features depend on the orbital angular momentum carried by photons and are in agreement with the theoretical predictions.

LThC4 • 09:15 **Invited**

On the use of Photon Orbital Angular Momentum in Studies of Space, Bo Thidé¹; ¹*Uppsala Univ., Sweden*. Abstract not available.

10:30–12:30

FThH • Frequency Combs II: Applications ▶Alex Gaeta; Cornell, USA, *Presider*FThH1 • 10:30 **Invited** ▶

Precision THz time-domain spectroscopy with Two Offset-Linked Frequency Combs, Albrecht Bartels¹, Gregor Klatt¹, Marcel Indlekofer¹, Raphael Gebis², Axel Bruchhausen², Helena G. Barros², Thomas Dekorsy²; ¹Gigaoptics GmbH, Germany; ²Center for Applied Photonics, Univ. of Konstanz, Germany. Two offset-linked 1 GHz frequency combs enable precision THz-TDS. Enhanced resolution at the few MHz level is demonstrated through resonant subharmonic excitation. The system is capable of software-based toggling between ASOPS and ECOPS mode.

FThH2 • 11:00 ▶

A Coherent Dual-Comb Spectrometer at 3.4 μm for Accurate Line Center Measurement of Methane, Esther Baumann¹, Fabrizio R. Giorgetta¹, Ian Coddington¹, William C. Swann¹, Alex M. Zolot¹, Nathan R. Newbury¹; ¹NIST, USA. Doppler-broadened methane lines around 3.4 μm are measured with a coherent dual-comb spectrometer with an absolute-frequency axis. The obtained accuracy of the line-center frequency is 300 kHz, about 1 part per thousand of the linewidth.

10:30–12:00

FThI • Metamaterials ▶Martti Kauranen, Tampere University of Technology, Finland, *Presider*FThI1 • 10:30 **Invited** ▶

Complex Plasmonic Oligomers and Metamaterials and their Applications, Harald Giessen; Univ. Stuttgart, Germany. Abstract not available.

FThI2 • 11:00 ▶

Plasmonic Metamaterials for Optical Wavefront Control, Ann Roberts¹, Ling Lin¹, Xiao Ming Goh¹; ¹The Univ. of Melbourne, Australia. We discuss progress in the development of devices containing arrays of resonant apertures utilizing phase shifts accompanying resonance. We show that lenses producing three-dimensional focussing and planar quarter-wave plates can be created.

10:30–12:30

FThJ • Optical Design with Unconventional Polarization II ▶Andrew Forbes; National Laser Centre, South Africa, *Presider*FThJ1 • 10:30 **Invited** ▶

Radial Polarisation Beams in Nanophotonics, Min Gu¹; ¹Centre for Micro-Photonics, Swinburne Univ. of Technology, Australia. A superresolution volume of the focal spot and an axially-superresolved quasi-spherical focal spot can be produced for three-dimensional nano-photonics fabrication, when radially polarized beams are focused by a high numerical-aperture objective.

FThJ2 • 11:00 ▶

Polarization Properties of Suspended Si:Ga Nanowires, Michael J. Theisen^{1,2}, Brian L. McIntyre², Thomas G. Brown¹; ¹The Institute of Optics, Univ. of Rochester, USA; ²URnano, Univ. Of Rochester, USA. We investigate the polarimetric properties of suspended nanowires fabricated in gallium doped silicon. When measured using a polarimetric microscope, the nanowires show a high reflectivity and strong retardance on reflection.

10:30–11:45

FThK • Image-Based Wavefront Sensing and Adaptive Optics II ▶James Fienup; Univ. Rochester, USA, *Presider*FThK1 • 10:30 **Invited** ▶

Commissioning and Optical Control for JWST, Scott Acton; Ball Aerospace, USA. Abstract not available.

FThK2 • 11:00 ▶

Iterative Transform Phase Diversity: An object and wavefront recovery algorithm, Jeffrey S. Smith¹; ¹Optics Branch, NASA Goddard Space Flight Center, USA. Presented is a solution for recovering the wavefront and an extended object. It builds upon the HDA VSM architecture and deconvolution algorithms. Simulations are shown for recovering the wavefront and extended object for noisy data.

10:30–12:30

FThL • Quantum Computation and Communication IIISusan M. Clark; Univ. of Maryland, USA, *Presider*

FThL1 • 10:30

Integrated Quantum Photonics, Jeremy O'Brien¹; ¹Bristol, United Kingdom. We developed multimode devices [1], quantum walks [2] and efficient quantum circuits [3,4]. We describe the latest applications to reconfigurable quantum devices, quantum algorithms, quantum simulations, quantum metrology and quantum communication.

FThL2 • 10:45

Withdrawn

FThL3 • 11:00

Spectral and Temporal Manipulation of Single Photons from a Quantum Dot by Pulsed Frequency Upconversion, Matthew T. Rakher^{1,2}, Lijun Ma³, Marcelo Davanco^{2,4}, Oliver Slattery³, Xiao Tang³, Kartik Srinivasan²; ¹Departement Physik, Universität Basel, Switzerland; ²Center for Nanoscale Science and Technology, National Institute of Standards and Technology, USA; ³Information Technology Laboratory, National Institute of Standards and Technology, USA; ⁴Maryland NanoCenter, Univ. of Maryland, USA. Telecommunications-band single photons from a quantum dot are upconverted using <1-ns, 1550-nm pulses to create Gaussian shaped single photon pulses at 710-nm. Such a technique will be useful for integrating quantum systems via photons.

FIO

10:30–12:30

FThM • Optical Communications II

Misha Brodsky; *AT&T Labs, USA, President*

FThM1 • 10:30

Fast Physical Random Number Generation with Bandwidth Enhancement of Chaotic Semiconductor Lasers, Taiki Yamazaki¹, Yasuhiro Akizawa¹, Atsushi Uchida¹, Takahisa Harayama², Satoshi Sunada², Kazuyuki Yoshimura², Peter Davis²; ¹*Department of Information and Computer Sciences, Saitama Univ., Japan*; ²*NTT Communication Science Laboratories, NTT Corporation, Japan*. We experimentally demonstrate random bit generation using multi-bit samples of bandwidth-enhanced chaos in semiconductor lasers. The bit generation rate of 75 Gigabit per second is achieved.

FThM2 • 10:45

Post-Processing Method for Fast Random Number Generation with Chaotic Semiconductor Lasers, Yasuhiro Akizawa¹, Taiki Yamazaki¹, Atsushi Uchida¹; ¹*Information and Computer Sciences, Saitama Univ., Japan*. We propose a post-processing method for fast random number generation with chaotic semiconductor lasers. The equivalent rate of random number generation at 400 Giga bit per second is achieved by using the post-processing.

FThM3 • 11:00

Complexity Analysis in Optically-Coupled Chaotic Semiconductor Lasers with Consistency, Kazutaka Kanno¹, Atsushi Uchida¹; ¹*department of information and computer sciences, Saitama university, Japan*. The complexity of optically-coupled chaotic semiconductor lasers is quantitatively evaluated in terms of the entropy. It is found that the complexity is strongly dependent of the consistency of the two coupled lasers.

10:30–12:30

FThN • Silicon Microphotonic Devices

Peter Gunter; *Swiss Federal Institute of Technology, Switzerland*

FThN1 • 10:30 **Tutorial**

Monolithic Silicon Microphotonics: Devices, Process Integration and Circuits, Lionel C. Kimerling; *MIT, USA*. This tutorial presents the principles of sustainable scaling of information processing and transport. Specifically addressed are the silicon photonic device suite, monolithic process integration and system design freedom enabled by Ge-on-Si lasers.

10:30–12:00

LThD • Nano-scale Light Matter Interaction IV

Pieter Kik; *Univ. of Central Florida, USA, President*

LThD1 • 10:30 **Invited**

Gold Nanoparticles as Optical and Mechanical Resonators, Matthew Pelton¹; ¹*Center for Nanoscale Materials, Argonne National Laboratory, USA*. Plasmons in metal nanoparticles can strongly couple to excitons in semiconductor nanocrystals, leading to new optical phenomena. They can also serve as highly sensitive probes of the damping of mechanical vibrations within the nanoparticles.

LThD2 • 11:00

Plasmonic Snowflake Antennas with an Adjustable Broadband Spectral Response, Umut Tok¹, Kursat Sendur²; ¹*Sabanci Univ., Turkey*. Plasmonic snowflake nanoantennas are utilized to obtain a broadband spectral response. Insensitivity of dipole antennas to circular polarization provides an adjustable broadband spectral response via manipulating geometrical parameters.

LS

10:30–12:00

LThE • Ultrafast X-Rays III

David Reis; *Stanford Univ., President*

LThE1 • 10:30 **Invited**

Multi Photon Physics at the LCLS, Christoph Roedig¹, Pierre Agostini¹, Gilles Doumy², Lou DiMauro¹; ¹*Physics, The Ohio State Univ., USA*; ²*Argonne National Laboratory, USA*. Nonlinear absorption of femtosecond kilovolt x-rays in Neon is investigated. A possible two-photon ionization is observed with the presence of Ne9+ at photon energies below the Ne8+ 1s2 ionization threshold.

LThE2 • 11:00 **Invited**

Imaging Airborne Particulate Matter with X-ray Lasers, Mike Bogan¹; ¹*SLAC National Accelerator Laboratory, USA*. We report x-ray FEL experiments at FLASH and LCLS that show single-particle x-ray diffractive imaging (XDI) can recover nanoscale morphological information of individual airborne particulate matter over a large complexity range.

10:30–11:45

LThF • Orbital Angular Momentum and Applications IV


Bo Thidé; *Uppsala University, Sweden, President*

LThF1 • 10:30 **Invited**

Using Cascaded Moiré DOEs to Generate Spiral Phase Plates of Continuously Adjustable Helical Charge, Stefan Bernet¹, Monika Ritsch-Marte¹; ¹*Division for Biomedical Physics, Innsbruck Medical Univ., Austria*. A pair of diffractive optical elements (DOEs), together forming a specially designed Moiré pattern, can create an effective spiral phase plate with a helical charge that depends upon the mutual rotation angle.

LThF2 • 11:00


Characterizing the Azimuthal and radial Mode Indices of a Laguerre-Gaussian Beam using Diffraction from a Triangular Aperture, Areti Mourka¹, Michael Mazilu¹, Chris Shanor², Ewan Wright^{2,1}, Kishan Dholakia^{1,2}; ¹*Physics and Astronomy, Univ. of St. Andrews, United Kingdom*; ²*College of Optics, Univ. of Arizona, USA*. We discuss here the performance of a new method for determining both the azimuthal as well as radial indices of a Laguerre-Gaussian beam by measuring the far-field diffraction pattern from a tailored annular triangular aperture.

FThH • Frequency Combs II: Applications—Continued**FThH3 • 11:15** 


Absolute Distance Measurement Using Long-Path Heterodyne Interferometer with Optical Frequency Comb. Xiaonan Wang¹, Satoru Takahashi¹, Kiyoshi Takamasu¹, Hirokazu Matsumoto¹; ¹*Department of Precision Engineering, The Univ. of Tokyo, Japan.* A new heterodyne interference system with an acoustic-optical modulator and a piezo-electric transducer is presented to realize absolute long-distance measurement. The experimental results at 22.5m show the reproducibility of 2 μ m in an hour.

FThH4 • 11:30  


Femtosecond Operation and Self-Doubling of Cr:ZnS Laser. Evgeni Sorokin¹, Irina T. Sorokina²; ¹*Photonics Institute, Vienna Univ. of Technology, Austria;* ²*Physics Department, Norwegian Univ. of Science and Technology, Norway.* The availability of frequency comb sources in the mid-IR is set to change dramatically the way of molecular spectroscopy, suggesting novel measurement techniques but also changing how the conventional devices are being designed and used.

FThI • Metamaterials—Continued**FThI3 • 11:15** 

Parametric Maps of Extraordinary Optical Transmission Through Arrays of Metallic Nanoscale Slits. Jaewoong Yoon^{1,3}, Yiwu Ding³, Muhammad Haisam Javed¹, Seok Ho Song³, Robert Magnusson¹; ¹*Electrical Engineering, Univ. of Texas at Arlington, USA;* ²*Resonant Sensors Incorporated, USA;* ³*Physics, Hanyang Univ., Republic of Korea.* We present a method of expedient visualization that clearly maps operative mechanisms of extraordinary optical transmission (EOT) in parametric space. The parametric maps reveal the essential physics of EOT through one-dimensional slit arrays.

FThI4 • 11:30 


Fabrication of Large Periodic Arrays of Plasmonic Nanostructures Applying Inverse Templates. Hall-dor G. Svavarsson¹, Jaewoong Yoon^{2,3}, Robert Magnusson², Seok Ho Song³; ¹*School of Science and Engineering, Reykjavik Univ., Iceland;* ²*Electrical Engineering, Univ. of Texas at Arlington, USA;* ³*Physics, Hanyang Univ., Republic of Korea.* An expedient procedure to fabricate large arrays of highly ordered metal nanocups, 150-200 nm in diameter, is reported. Their ability to support localized surface-plasmon polaritons is manifested by reflectance spectroscopy.

FThI5 • 11:45 


Light Focusing by Planar Array of Antennas. Babak Memarzadeh¹, Hossein Mosallaei¹; ¹*Electrical Engineering, Northeastern Univ., USA.* Utilizing concentric loops as the scatterers of a transmitter, subwavelength light localization in a desired distance is achieved. The flexibility of the elements makes it a convenient structure to engineer a high performance system.

FThJ • Optical Design with Unconventional Polarization II—Continued**FThJ3 • 11:15**

Interaction of Polarized near-UV Light with Si Nanostructures: Raman Imaging and Stress Study. Vladimir Poborchii¹, Tetsuya Tada¹, Yukinori Morita¹, Toshihiko Kanayama¹, Pavel Geshev²; ¹*Nanoelectronics Research Institute, AIST, Japan;* ²*Institute of Thermophysics of the Russian Academy of Sciences, Russian Federation.* A record high Si structure Raman efficiency is obtained in near UV for ~10 nm wide Si nanowires. Using high-numerical-aperture lens, we observed Raman-forbidden phonons of strained-Si nanowires/islands and measured stress relaxation.

FThJ4 • 11:30 

The Pancharatnam-Berry Phase for Non-Cyclic Polarization Changes. Taco D. Visser^{1,2}, Thomas van Dijk², Wim Ubachs³, Hugo F. Schouten²; ¹*Delft Univ. of Technology, Netherlands;* ²*Physics and Astronomy, VU Univ., Netherlands.* We present a setup that allows the observation of linear, nonlinear and singular behavior of the geometric phase that accompanies non-cyclic polarization changes.

FThJ5 • 11:45 

Phase Anomaly and Phase Singularities of the Field in the Focal Region of High-Numerical Aperture Systems. Taco D. Visser^{1,2}, Xiaoyan Pang¹, Emil Wolf³; ¹*Delft Univ. of Technology, Netherlands;* ²*VU Univ., Netherlands;* ³*Univ. of Rochester, USA.* The phase behavior of the three components of the electric field in the focal region of a high-numerical aperture focusing system is studied. The Gouy phase anomaly and the occurrence of phase singularities are examined.

FThK • Image-Based Wavefront Sensing and Adaptive Optics II—Continued**FThK3 • 11:15**  

Optimization Algorithms for Phase and Pupil Amplitude Recovery. Bruce Dean¹; ¹*Optics Branch, NASA Goddard Space Flight Center, USA.* Phase retrieval and pupil amplitude recovery performance are summarized using a suite of non-linear optimization (NLO) algorithms. Test data is included from the James Webb Space Telescope (JWST) instrument test program.

FThL • Quantum Computation and Communication III—Continued**FThL4 • 11:15** 

Quantum Entanglement Between an Optical Photon and a Solid-State Spin Qubit. Emre Togan¹; ¹*Department of Physics, Harvard Univ., USA.* Quantum entanglement is among the most fascinating aspects of quantum theory. Here we realize quantum entanglement between the polarization of a single optical photon and a solid-state spin qubit associated with the nitrogen vacancy centre in diamond.

FThL5 • 11:45

Nonlinear Waveguide Source of Entangled Photon Pairs in Single Spatial Modes. Michal Karpinski¹, Czesław Radzewicz¹, Konrad Banaszek¹; ¹*Faculty of Physics, Univ. of Warsaw, Poland.* We demonstrate effective control of spatial degrees of freedom for photon pairs generated in a multimode nonlinear waveguide by dispersive properties of the structure. This is confirmed by observation of Shih-Alley polarization entanglement.



Thank you for attending
FiO/LS.
Look for your
post-conference survey
via email and let us
know your thoughts on
the program.

FIO

FThM • Optical Communications II—Continued

FThM4 • 11:15

High Efficiency, High Speed Optical Modulation at a Telecom Wavelength Using the Quantum Zeno Effect in a Ladder Transition in Rb Atoms, Selim M. Shahriar^{1,2}, Krishnamurthy Subramanian¹, Ye Wang¹, Shih Tseng¹, Yanfei Tu¹; ¹EECS Department, Northwestern Univ., USA; ²Physics and Astronomy Department, Northwestern Univ., USA. We show, theoretically and experimentally, how a high efficiency, high speed optical modulator can be realized at a telecommunication wavelength using the quantum Zeno effect in a ladder transition in Rb atoms at room temperature.

FThM5 • 11:30 **Invited**
Withdrawn

FThN • Silicon Microphotonic Devices—Continued

FThN2 • 11:15

Nonreciprocal Light Propagation in Silicon Photonics, Liang Feng¹, Maurice Ayache², Jingqing Huang¹, Ye-Long Xu³, Ming-Hui Lu³, Yan-Feng Chen³, Yeshaiahu Fainman², Axel Scherer¹; ¹Caltech, USA; ²ECE, UCSD, USA; ³Nanjing Univ, China. We have designed, fabricated and tested a metallic-silicon waveguide system to mimic microscopic non-Hermitian optical potentials for guided light, introducing on-chip nonreciprocal light propagation associated with spontaneously broken PT symmetry.

FThN3 • 11:30

Compact Silicon Diffractive Sensor Characterization, Jonathan S. Maikisch¹, Thomas K. Gaylord¹; ¹School of Electrical and Computer Engineering, Georgia Institute of Technology, USA. The compact silicon diffractive sensor platform is experimentally characterized. This configuration is independent of interaction length and attenuation and capable of measuring refractive index changes of 10^{-8} without spectral measurement.

FThN4 • 11:45

Quasi-Phase-Matching Four-Wave-Mixing via Width-Modulated Silicon Nanowire Waveguides, Jeffrey B. Driscoll¹, Richard Grote¹, Jerry I. Dadap¹, Nicolae C. Panoiu², Richard M. Osgood¹; ¹Microelectronics Sciences Laboratories, Columbia Univ., New York, NY 10027, USA, Columbia Univ., USA; ²Department of Electronic and Electrical Engineering, Univ. College London, Univ. College London, United Kingdom. We present a quasi-phase-matching technique using width-modulated Si waveguides to enhance the conversion efficiency of signals outside the device's conversion bandwidth. We find up to 40 dB conversion efficiency enhancement for modulation < 10 nm.

LS

LThD • Nano-scale Light Matter Interaction IV—Continued

LThD3 • 11:15 **Invited**

A Local View of Slow Light, Kobus Kuipers¹; ¹FOM-Institute AMOLF, Netherlands. We use a near-field microscope to investigate propagation and dynamics of light in photonic crystal structures. We investigate evanescent mode at the interface of fast to slow light, localized states and the coupling to nanocavities.

LThE • Ultrafast X-Rays III—Continued

LThE3 • 11:30 **Invited**

Dispersion Cancellation and Precise Measurement with Quantum Interferometry, Alexander Sergienko; Boston Univ., USA, Nina Rohringer; Lawrence Livermore Natl. Lab, USA. We demonstrate a technique allowing for simultaneous even and odd-order spectral dispersion cancellation in a single experiment. We discuss advantages quantum interference offers for ultra-precise measurement in telecommunication.

LThF • Orbital Angular Momentum and Applications IV—Continued


LThF3 • 11:15 **Invited**

Non-Specular Reflection and Angular Momentum of Light, J. P. Woerdman¹; ¹Huygens Laboratory, Leiden Univ., Netherlands. We discuss recent progress in diffractive corrections to geometrical optics, such as the Goos-Hänchen and Imbert-Fedorov effects, and emphasize the role of angular momentum of light therein.


LThD4 • 11:45

Exploiting the Optical Properties of Laser Generated Gold Nanoparticles to Probe Laser-Material-Ambient Interactions, Natalie Hastrup¹, Gerard M. O'Connor¹; ¹National Centre for Laser Applications, National Univ. of Ireland, Galway, Ireland. Real-time spectroscopy was used to monitor gold nanoparticles generated during laser ablation of gold films immersed in Rhodamine 6G solution. This technique overcomes some shortcomings of offline methods for characterizing nanoparticle dynamics.



FThH • Frequency Combs II: Applications—Continued**FThH5 • 12:00** 

Theory of Molecular Cooling Using Optical Frequency Combs in the Presence of Decoherence, Svetlana A. Malinovskaya¹; ¹*Physics and Engineering Physics, Stevens Institute of Technology, USA*. A semiclassical theory demonstrates that a single, phase modulated optical frequency comb may be used to control dynamics in ultracold gases aiming at creation of deeply bound ultracold molecules from Feshbach states.

FThH6 • 12:15 

Interferometric Estimation of the Offset-Frequency of Optical Frequency Comb, Hirokazu Matsumoto¹; ¹*Dept. of Precision Engineering, The Univ. of Tokyo, Japan*. The carrier-envelope offset frequency of optical frequency comb is evaluated by using a conventional interferometer with an acoustic optical-frequency shifter for establishing practical absolute distance metrology within an accuracy of 2 MHz.

FThI • Metamaterials—Continued**FThJ • Optical Design with Unconventional Polarization II—Continued****FThJ6 • 12:00**  

Plasmonic Focusing with Spatially Variant Polarization, Qiwen Zhan¹; ¹*Electro-Optics Program, Univ. of Dayton, USA*. In this talk, I will present plasmonic nanofocusing inspired by the antenna radiation theory. Optimal plasmonic focusing can be achieved through matching the plasmonic structures to the spatial polarization distributions of the illumination.

FThK • Image-Based Wavefront Sensing and Adaptive Optics II—Continued**FThL • Quantum Computation and Communication III—Continued****FThL6 • 12:00**

Efficient Measurement of Orbital Angular Momentum using Refractive Optical Elements, Martin P. Lavery¹, David J. Robertson², Johannes Courtial¹, Gregorius Berkhout^{3,4}, Gordon D. Love³, Miles Padgett¹; ¹*School of Physics and Astronomy, Univ. of Glasgow, United Kingdom*; ²*Centre of Advanced Instrumentation, Department of Physics, Durham Univ., United Kingdom*; ³*Huygens Laboratory, Leiden Univ., Netherlands*; ⁴*cosine Science & Computing BV, Netherlands*. We have produced custom refractive optical elements which transform orbital angular momentum states into transverse momentum states. This transformation allows for efficient measurement of the orbital angular momentum content of an input light beam.

FThL7 • 12:15

Demonstration of a Telecom-Band, 30-ps Window, Dual-In, Dual-Out, Entangled-Photon Switch, Neal N. Oza¹, Monika Patel¹, Matthew A. Hall¹, Joseph B. Altepeter¹, Prem Kumar¹; ¹*Center for Photonic Communication and Computing, Northwestern Univ., USA*. We present a dual-in, dual-out, optical-fiber-based entangled photon switch, capable of 30-ps operation. It improves upon a slower, three-port design and exhibits low-loss, low signal-band noise, and maintains the transmitted photons' quantum state.

12:00–13:30 Lunch Break (*On your own*)

FiO

FThM • Optical Communications II—Continued**FThM6 • 12:00**

Coherence Reduction by Nonlinear Propagation of Optical Chaos Generated from Semiconductor Laser Dynamics, Qing Liu¹, Sze-Chun Chan¹; ¹*Electronic Engineering, City Univ. of Hong Kong, China*. With an optically injected laser, chaotic signals are generated for further bandwidth broadening by fiber nonlinearities. The full width at half-maximum of fringe visibility reduces from 4.1 mm to 1.2 mm for precise chaotic ranging.

FThM7 • 12:15

Dynamical Decoupling in Optical Fibers: Preserving Polarization Qubits from Birefringent Dephasing, Bhaskar Roy Bardhan¹, Petr A. Anisimov¹, Manish K. Gupta¹, Nathan Cody Jones², Hwang Lee¹, Jonathan P. Dowling¹; ¹*Department of Physics and Astronomy, Louisiana State Univ., USA*; ²*Edward L. Ginzton Laboratory, Stanford Univ., USA*. We study preservation of polarization qubits in birefringent fibers with CPMG dynamical decoupling. Very high fidelity can be maintained by implementing such sequence with halfwave plates for given length of fiber-optical communication channel.

FThN • Silicon Microphotonic Devices—Continued**FThN5 • 12:00**

Rabi Splitting in Silicon Microdisks with Emissive Centers, Lyuba Kuznetsova^{1,2}, Gustavo E. Fernandes^{1,2}, Jimmy Xu^{1,2}; ¹*Brown Univ., USA*; ²*WCU Program at SNU, Republic of Korea*. Strong coupling between silicon emissive G-centers and nanostructured microdisk optical mode is studied. Spectra exhibit characteristic splitting (~0.92 THz) when temperature is tuned to match cavity mode (Q~2500) and emissive center frequencies.

FThN6 • 12:15

Peering into the Mirror: Slow Light in PC Waveguides, Pat Blown¹, Nadav Gutman¹, Felix J. Lawrence¹, C. Martijn de Sterke¹; ¹*The School of Physics, The Univ. of Sydney, Australia*. We present a systematic theoretical method to design PC waveguides with low or zero group velocities. Our method is based on separating the PC mirror from the waveguide, which enabled us to derive an analytical expression for the group velocity.

LS

LThD • Nano-scale Light Matter Interaction IV—Continued**LThE • Ultrafast X-Rays III—Continued****LThF • Orbital Angular Momentum and Applications IV—Continued**

Thank you for attending
FiO/LS.
Look for your
post-conference survey
via email and let us
know your thoughts on
the program.

12:00–13:30 Lunch Break (On your own)

13:30–14:45

FThO • Hybrid and III-V Integrated Optics

Mihaela Dinu, *Bell Labs, Alcatel-Lucent, USA, Presider*

FThO1 • 13:30 **Invited**

Organic and Inorganic Crystalline Wires and Thin Films for Hybrid Integrated Optics, Peter Gunter; Nonlinear Optics Laboratory, Swiss Federal Institute of Technology, Zürich, Switzerland. Organic electro-optic thin films and nanowires intended for hybrid integration with Si have been prepared. The realization of optical microresonators based on these fast responding materials and on ion-sliced LiNbO₃ thin films will be presented.

FThO2 • 14:00

Fabrication of AlN-GaN-AlN Sub-Micron Waveguide with Cleaved Facets, Vivek Krishnamurthy¹, Yijing Chen¹, Yicheng Lai¹, Seng Tiong Ho^{2,1}; ¹Nanophotonics and Electronics-photonics Integration, Data Storage Institute, Singapore; ²Electrical Engineering and Computer Science, Northwestern Univ., USA. Sub-micron waveguide fabrication in AlN-GaN-AlN is demonstrated. Improvement to sidewall verticality and reduced nanorod defects through optimized etching parameters are highlighted. Dice-and-cleave approach is adopted to achieve good end-facets.

13:30–15:15

FThP • Nonlinearities in Metamaterials ▶

Harald Giessen; *Univ. Stuttgart, Germany, Presider*

FThP1 • 13:30 ▶

Ultra-low Energy Optical Self-Amplitude and Phase Modulation in Gold Nano-Apertures, Arash Joushaghani¹, Bo Hou¹, J. Stewart Aitchison¹, Joyce Poon¹; ¹Electrical and Computer Engineering, Univ. of Toronto, Canada. We measured using X-FROG amplitude and phase modulation of picosecond pulses transmitted through subwavelength apertures in nanometer-thick gold films at per-pulse energies of 9 pJ per aperture and wavelengths set by the aperture geometry.

FThP2 • 13:45 ▶

Plasmonic Nanocomposites for Enhanced Four-Wave Mixing Generation, Ekaterina Poutrina¹, Cristian Ciraci¹, David R. Smith¹; ¹Electrical and Computer Engineering, Duke Univ., USA. Third-order nonlinear response and strong field enhancement in gold nanocomposites are utilized to analyze the enhanced effective nonlinear susceptibility and efficiency of the FWM process in the evanescent and propagating excitation regimes.

FThP3 • 14:00 **Invited** ▶

Towards Metamaterials with Engineered Nonlinear Optical Properties, Martti Kauranen¹, Goëry Genty¹, Robert Czaplicki¹, Henna Pietarinen¹, Hannu Husu¹, Mariusz Zdanowicz¹, Jouni Mäkitalo¹, Kalle O. Koskinen¹, Roope Siikonen¹, Joonas Lehtolahti², Janne Laukkanen³, Markku Kuittinen²; ¹Tampere University of Technology, Finland; ²University of Eastern Finland, Finland. Nanostructures with improved quality allow the nonlinear response of arrays of metal nanoparticles to be optimized. Minute differences in particle ordering strongly affect the second-order response of the arrays through diffractive coupling.

13:30–15:00

FThQ • Optical Design with Unconventional Polarization III ▶

Min Gu; *Swinburne Univ. of Technology, Australia, Presider*

FThQ1 • 13:30 **Invited** ▶

Imaging Spectrometers and Polarimeters, Michael W. Kudenov¹, Eustace L. Dereniak¹; ¹College of Optical Sciences, The Univ. of Arizona, USA. Imaging spectrometer and polarimeter research at the Optical Detection Lab, Univ. of Arizona, is overviewed. Topics include snapshot imaging spectroscopy, white-light channeled imaging polarimetry, and infrared hyperspectral imaging polarimetry.

FThQ2 • 14:00 ▶

Rotation Formulas in the Jones Calculus Extended to Axially Symmetrically Polarized Beam, Shigeki Matsuo¹; ¹The Univ. of Tokushima, Japan. We report the extension of the Jones calculus to an axially symmetrically polarized beam, by deducing rotation formulas for angularly variant term-added Jones vectors and matrices.

13:30–15:30

FThR • General Optical Design and Instrumentation III

R. Koshel; *Univ. of Arizona, USA, Presider*

FThR1 • 13:30

Optical Testing of the AWARE Wide Field 2-Gigapixel Multiscale Camera, Daniel L. Marks¹, Hui S. Son¹, Eric J. Tremblay², Joseph E. Ford³, Paul O. McLaughlin³, Michael Gehm⁴, Ronald A. Stack⁵, Steven D. Feller¹, Jungsang Kim¹, David Brady¹; ¹Department of Electrical and Computer Engineering, Duke Univ., USA; ²Department of Electrical and Computer Engineering, Univ. of California at San Diego, USA; ³RPC Photonics, Inc., USA; ⁴Department of Electrical and Computer Engineering, Univ. of Arizona, USA; ⁵Distant Focus Corporation, USA. Testing a 2-Gigapixel 8 arcsec IFOV, 120° FOV camera requires integration of precision mechanical automation, optical instrumentation, image diagnostics, electronics and networking hardware. We detail the ongoing AWARE Wide Field Camera efforts.

FThR2 • 13:45

Orthonormal Aberration Polynomials for Anamorphic Imaging Systems with Circular Pupils, Virendra Mahajan¹; ¹The Aerospace Corporation, USA. We extend our work on the orthonormal polynomials for anamorphic imaging systems with rectangular pupils to those with circular pupils by the Gram-Schmidt orthogonalization. Based on the results obtained, we raise a question.

FThR3 • 14:00

Emulation of Exact Ray Tracing by ABCD Matrix in a Human Eye Model, Juan F. Aguilar-Gutierrez¹, Marcelo D. Iturbe², Maximino Arroyo¹, Alberto Cordero¹, Sabino Chávez¹; ¹Universidad Autónoma de Puebla, Mexico; ²INAOEP, Mexico. By considering the simplest exact human eye model, the ray tracing technique under ABCD matrix and the exact (Q,U) method, provide very different results. To avoid this differences we introduce a new ABCD matrix for the lens.

13:30–15:30

FThS • Quantum Computation and Communication IV ▶

Alfred U'Ren; *Instituto de Ciencias Nucleares, Mexico, Presider*

FThS1 • 13:30 ▶

Anderson co-Localization of Spatially Entangled Photons, Ayman F. Abouraddy¹, Giovanni Di Giuseppe², Demetrios Christodoulides¹, Bahaa Saleh¹; ¹CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA; ²School of Science and Technology, Physics Division, Univ. of Camerino, Italy. We explore the propagation of spatially extended entangled two photons through disordered optical systems inducing Anderson localization (AL). While neither photon exhibits AL, the photon pair exhibits co-localization (reduced correlation length).

FThS2 • 13:45 ▶

Interaction-Free All-Optical Switching via Quantum Zeno Blockade, Yuping Huang¹, Abijith S. Kowligy¹, Joseph B. Altepeter¹, Prem Kumar¹; ¹EECS, Northwestern Univ., USA. Embedding a $\chi(2)$ crystal in a Fabry-Perot cavity, we propose and demonstrate an all-optical switch via quantum Zeno blockade that is implemented without any physical coupling between the signal and pump waves.

FThS3 • 14:00 ▶

An Equation of Motion for the Concurrence of 2 Qubit Pure States, Nicolas Quesada¹, Daniel F. James¹; ¹Physics, Univ. of Toronto, Canada. We derive an equation of motion for the concurrence of 2 qubits that evolve under a general time independent Hamiltonian. This equation is used to determine the type of Hamiltonians that can generate entanglement.

F i O

13:30–15:30**FThT • Novel Sensors and Applications III**Yannick Lize; *Applied Micro, USA, President***FThT1 • 13:30** **Invited**

Design and Fabrication of Photonic Crystal and Plasmonic Waveguides for Bio and Chemical Sensing; Applications from the Visible to THz Spectral Range, Maksim Skorobogatiy¹, Bora Ung² *Engineering Physics, Ecole Polytechnique de Montreal, Canada*. We will detail the latest theoretical modeling and experimental results with hollow core PCFs and plasmonic multilayer waveguides in the near-IR, as well as subwavelength and ferroelectric multilayer waveguides in the THz spectral range.

FThT2 • 14:00

Observation of Spectral Gouy Shift in Large Cross-Section Fiber Bragg Gratings, Ria G. Becker¹, Jens Thomas¹, Christian Voigtländer¹, Daniel Richter¹, Stefan Nolte¹; *Institute of Applied Physics, Friedrich-Schiller- Univ. Jena, Germany*. We observed unexpectedly broad spectral responses in large cross-section fiber Bragg gratings (LCFBG), which can be attributed to a longitudinal Gouy phase shift due to loss of guiding in the perturbed region of the LCFBG.

13:30–15:15**FThU • Progress in Digital Holography II**Jeffrey Davis; *San Diego State Univ., USA, President***FThU1 • 13:30**

Axi-Symmetric Flame Temperature Measurement Using Lensless Fourier Transform Digital Holography, Shobhna Sharma¹, Gyanendra Sheoran¹, Chandra Shakher¹; *Instrument Design Development Centre, Indian Institute of Technology, Delhi, India*. This paper demonstrates the application of lensless Fourier transform digital holographic interferometry for an axi-symmetric flames temperature measurement which utilizes fast and simple algorithm for the reconstruction process.

FThU2 • 13:45

Detuning Dependence of Losses in Bragg Gratings, Sergiy Mokhov¹, Derrek Drachenberg¹, Vadim Smirnov², George Venus¹, Boris Zeldovich¹, Leonid Glebov¹; *CREOL – the College of Optics and Photonics, Univ. of Central Florida, USA; ²OptiGrate, USA*. Optical losses vary with detuning from Bragg resonance due to variation of stored optical power inside grating. Additional modulation of absorption coefficient causes asymmetry in detuning dependence of losses. Experiments confirm analytic theory.

FThU3 • 14:00

A Static Fiber Fourier Transform Spectrometer, Kieran O'Mahoney^{1,2}, Dominic Murphy^{1,2}; *Waterford Institute of Technology, Ireland; ²Fusion Photonics Ltd., Ireland*. We report a static, no-moving parts, fiber Fourier transform spectrometer comprising a wavelength independent fiber splitter and a 3648 linear detector array can achieve wavelength resolutions of 0.6nm and wavelength measurement accuracies of 6pm.

13:30–15:30**FThV • Nonimaging Techniques for Sensing III**Gregory Gbur; *Univ. of North Carolina at Charlotte, USA, President***FThV1 • 13:30** **Invited**

Controlling Ultrashort Pulses in Scattering Media, Ori Katz¹, Eran Small¹, Yaron Bromberg¹, Yaron Silberberg¹; *Departement of Physics of Complex Systems, Weizmann Institute of Science, Israel*. We show that correction of both spatial and temporal distortions of ultrashort pulses in scattering media can be achieved by wavefront shaping. We demonstrate spatiotemporal focusing of 100-fs pulses through thick brain and bone samples.

FThV2 • 14:00

A Laser-Speckle Correlation Technique for Thickness Determination of Optically Thin Transparent Layers, Johannes Lettner¹; *Institute for Measurement Technology, Johannes Kepler Univ., Austria*. We present a method determining thicknesses of thin polar liquids on rough surfaces. Results of the reproducibility of measurements of coatings down to the μm range, which is less than the surface roughness are shown.

NOTES

FTh0 • Hybrid and III-V Integrated Optics—Continued**FTh03 • 14:15**

Photoluminescence from In_{0.5}Ga_{0.5}P/GaP Quantum Dots Coupled to Photonic Crystal Cavities, Kelley Rivoire¹, Sonia Buckley¹, Yuncheng Song², Paul Simmonds², Minjoo L. Lee², Jelena Vuckovic¹; ¹Stanford, USA; ²Yale Univ., USA. We demonstrate room temperature visible wavelength photoluminescence from In_{0.5}Ga_{0.5}As quantum dots embedded in a GaP membrane. We also observe enhanced outcoupling of quantum dot emission into photonic crystal nanocavities.

FTh04 • 14:30

Optimised GaN Directional Couplers with Mode Converters, Loyd J. McKnight¹, Yanfeng Zhang¹, Ian M. Watson¹, Erdan Gu¹, Stephane Calvez¹, Martin D. Dawson¹; ¹Institute of Photonics, United Kingdom. We propose GaN directional couplers with mode converters as a solution for integrated optical quantum circuits. This study investigates the design requirements for such directional couplers using the beam propagation method and fabricated devices.

FThP • Nonlinearities in Metamaterials—Continued**FThP4 • 14:30**

Second Harmonic Generation for UV emission from left handed material, Monika Rajput¹, Ravindra K. Sinha¹, Swati Rawal¹, Bhawana Dabas¹, Shailendra Varshney²; ¹Delhi Technological Univ., India; ²Indian Institute Technology Kharagpur, India. We present new design of left handed material structure that can emit UV light via second harmonic generation. Negative real values of permeability and permittivity with extremely low imaginary values for visible light are obtained.

FThP5 • 14:45

Polarization Properties Of SHG From Chiral G-shaped Nanostructures, Evgeniy A. Mamonov¹, Irina A. Kolmychek¹, Anton I. Maydykovskiy¹, Tatiana V. Murzina¹, Oleg A. Aktsipetrov¹, Ventsislav K. Valev², Thierry Verbiest³, Alejandro V. Silhanek³, Victor V. Moshchalkov³; ¹Physics, Moscow State Univ., Russian Federation; ²Molecular Electronics and Photonics, INPAC, Katholieke Universiteit Leuven, Belgium; ³Nanoscale Superconductivity and Magnetism, Pulsed Fields Group, INPAC, Katholieke Universiteit Leuven, Belgium. Polarization of SHG from chiral G-shaped nanostructures are studied. Different dependencies of polarization plane rotation from sample position and swapping pump beam energy into different circular polarizations are observed for enantiomeric samples

FThQ • Optical Design with Unconventional Polarization III—Continued**FThQ3 • 14:15**

Collapse and Revival of the Degree of Polarization, Amber M. Beckley¹, Thomas G. Brown¹; ¹Institute of Optics, Univ. of Rochester, USA. Using stress-engineered optical elements, we demonstrate the creation of beam cross-sections with recurring regions of high and low degrees of polarization.

FThQ4 • 14:30

Vector Beam Representation on a Higher Order Poincare Sphere and Higher Order Stokes Parameter Measurement Through Optical Angular Momentum Decomposition, Giovanni Milione¹, Robert R. Alfano²; ¹City College New York, USA. Representation of vector polarization beams by a higher order Poincare sphere and associated Stokes parameters in terms of total optical angular momentum eigenstates is presented.

FThQ5 • 14:45

Vectorial Polarimeter Using an Inhomogeneous Polarization State Generator, Fiona Kenny¹, Oscar Rodríguez¹, David Lara², Chris Dainty¹; ¹Applied Optics, School of Physics, National Univ. of Ireland, Galway, Ireland; ²The Blackett Laboratory, Imperial College London, United Kingdom. We report on the building of an experimental setup capable of generating and measuring inhomogeneous polarization states across the waist of a laser beam. A detailed description of its operation and calibration is presented.

FThR • General Optical Design and Instrumentation III—Continued**FThR4 • 14:15**

Galway Astronomical Stokes Polarimeter - A High Throughput Linear and Circular Polarimeter, Gillian Kyne¹, Brendan Sheehan¹, Patrick Collins², David Lara³, Michael Redfern¹, Andrew Shearer¹; ¹Centre for Astronomy, National Univ. of Ireland Galway, Ireland; ²Applied Optics, National Univ. of Ireland Galway, Ireland; ³The Blackett Laboratory, Imperial College London, United Kingdom. To measure the optical polarisation from rapidly changing astronomical sources we have developed a photon counting full Stokes Polarimeter using Division of Amplitude Polarimetry for large telescopes with a time resolution of < 100 microseconds.

FThR5 • 14:30

ABCD Matrix of a Medium with a Higher Refractive-Index at the Border than in the Core, Juan F. Aguilar-Gutierrez¹, Marcelo D. Iturbe², Maximino Arroyo¹, Sabino Chávez²; ¹Universidad Autonoma de Puebla, Mexico; ²INAOEP, Mexico. We solve the equation of paraxial rays for a medium with a higher refraction index at the border than in the core, obtaining a new ABCD matrix with a hyperbolic dependence.

FThR6 • 14:45

Defocus Analysis for a Coherent Plenoptic System, Sapna A. Shroff¹, Kathrin Berkner¹; ¹Digital Optics Research, Ricoh Innovations Inc., USA. We propose metrics to focus a coherent plenoptic imaging system using data captured at the sensor. These metrics can be used for lens design, system calibration, and a posteriori diagnosis and correction of defocus.

FThS • Quantum Computation and Communication IV—Continued**FThS4 • 14:15**

Two-photon Anti-correlation and Interference with Incoherent Thermal Radiations, Hui Chen¹; ¹UMBC/GEST, USA. We successfully simulate the behavior of entangled states by multi-photon interference of thermal light, theoretically and experimentally. Importantly, we have observed anti-correlation and polarization correlation with more than 71% visibility.

FThS5 • 14:30

Combined Photon Pair Generation and Quantum Walks in Quadratic Nonlinear Waveguide Arrays, Alexander Solntsev¹, Andrey Sukhorukov¹, Dragomir Neshev¹, Yuri S. Kivshar¹; ¹Nonlinear Physics Centre, Australian National Univ., Australia. We study photon pair generation through spontaneous parametric down conversion accompanied by quantum walks in arrays of quadratic nonlinear waveguides and investigate various ways to control output photon correlations.

FThS6 • 14:45

Efficient Algorithm for Optimizing Adaptive Quantum Metrology, Barry C. Sanders¹, Alexander Hentschel¹; ¹Institute for Quantum Information Science, Univ. of Calgary, Canada. We introduce an efficient self-learning swarm-intelligence algorithm for devising feedback-based quantum metrological procedures to replace what is otherwise an inefficient problem. Our algorithm can be trained with simulated or real-world trials.

FThO • Hybrid and III-V Integrated Optics—Continued
FThP • Nonlinearities in Metamaterials—Continued
FThP6 • 15:00

Metallic Annular Apertures Arrays filled by Lithium Niobate to Enhance Nonlinear Conversion: Theory and Fabrication, Elsie Barakat¹, Maria-Pilar Bernal¹, Roland Salut¹, Fadi Baida²; ¹*Département P. M. Duffieux, France*. We proposed and theoretically studied, using the finite difference time domain method, a metallo-dielectric photonic crystal based on metallic AAA associated to a nonlinear material for second harmonic generation applications. Fabrication is in progress

FThQ • Optical Design with Unconventional Polarization III—Continued
FThR • General Optical Design and Instrumentation III—Continued
FThR7 • 15:00

Towards Remote Sensing via Atmospheric Lasing, Andrew J. Traverso¹; ¹*Physics and Astronomy, Texas A&M, USA*. We depict the characterization of remote coherence brightened lasing in atmosphere. Using this backward propagating beam in conjunction with conventional laser sources, we show the feasibility of remote sensing impurities via novel Raman techniques.

FThR8 • 15:15

Development of an Ultra-Stable Iodine-based Optical Frequency Standard for Space Applications, Thilo Schuldt¹, Klaus Döringshoff², Anja Keetman¹, Matthias Reggentin², Achim Peters², Claus Braxmaier¹; ¹*Institute for Optical Systems, Univ. of Applied Sciences Konstanz (HTWG), Germany*; ²*Institut für Physik, Humboldt-Universität zu Berlin, Germany*. We present the development of a compact setup of an Iodine-standard with ultimate frequency stability for fundamental tests. Highly stable glass ceramics is used as structural material for enhanced pointing stability and a space-compatible design.

FThS • Quantum Computation and Communication IV—Continued
FThS7 • 15:00

Invited
Ion-Photon Networks for Scalable Quantum Computing, Susan M. Clark, David Hayes, David Hucul, Kenneth Lee, Shantanu Debnath, Qudsia Quraishi, Christopher Monroe, *Joint Quantum Institute, Department of Physics, University of Maryland and National Institute of Standards and Technology, USA*. Trapped ions entangled via photonic interactions are promising avenues for quantum information processing. Here, we report advances towards combining photonic gates between distant ions with Coulombic gates between nearby ions to demonstrate scalable quantum networks.

15:30–16:00 Coffee Break, Regency/Imperial Ballroom and South Tower Foyers, Fairmont Hotel



FThT • Novel Sensors and Applications III—Continued**FThT6 • 15:00**

Label-Free SERS Detection of Proteins and Bacteria Using Optical Fibers for Sensitivity Improvement, Xuan Yang¹, Claire Gu¹, Fang Qian¹, Yat Li¹, Jin Z. Zhang¹; ¹*UC Santa Cruz, USA*. Label-free detections of certain proteins and live bacterial cells in aqueous solutions are demonstrated using surface-enhanced Raman scattering and optical fiber probes, with sensitivities order(s) of magnitude higher than those previously reported.

FThT7 • 15:15

A White Light Cavity Using Chirped Gratings for Optical Data Buffering, Selim M. Shahriar^{1,2}, Honam Yum¹, Xue Liu¹, Phillip Hemmer³; ¹*EECS Department, Northwestern Univ., USA*; ²*Physics and Astronomy Department, Northwestern Univ., USA*; ³*ECE Department, Texas A&M Univ., USA*. A chirped Bragg grating reflects different wavelengths from different locations along the axis. We show how this can be used to realize a white light cavity, for high-speed data buffering with a large delay-bandwidth product

FThU • Progress in Digital Holography II—Continued**FThU7 • 15:00**

Optimization of an Aspheric Diffractive Intraocular Lens Using a Deformable Mirror, Huanqing Guo¹, Elie Delestrange¹, Alexander V. Goncharov¹; ¹*National Univ. of Ireland Galway, Ireland*. A deformable mirror is used to generate wavefront to mimic the corneal aberration of simulated pseudophakic eyes to evaluate a diffractive intraocular lens. The depth of focus shows improvement thanks to corneal spherical aberration.

FThV • Nonimaging Techniques for Sensing III—Continued**FThV6 • 15:00**

XFROG Retrieval of Extremely Complex Pulses, Justin Ratner¹, Rick Trebino¹; ¹*Physics, Georgia Institute of Technology, USA*. We test the polarization-gating cross-correlation frequency-resolved optical-gating (PG XFROG) algorithm for retrieving extremely complex pulses with time-bandwidth products of ~1000.

FThV7 • 15:15

Two Wave Mixing Analysis in Rb:BaTiO₃ using Optical Activity of Bi₁₂TiO₂₀, Chittur S. Narayanamurthy¹; ¹*Physics, Indian Institute of Space Science and Technology, India*. A new method to study the wave mixing process in photorefractive Rb:BaTiO₃ (Rb-doped Barium Titanate) using Bi₁₂TiO₂₀ (Bismuth Titanium Oxide) at a wavelength of 6328 Å is reported.

15:30–16:00 Coffee Break, Regency/Imperial Ballroom and South Tower Foyers, Fairmont Hotel

16:00–17:30

FThW • Nonlinear Optics in Micro/Nano Optical Structures III ▶Lan Yang; *Washington of Univ. at St Louis, USA, Presider*

FThW1 • 16:00 ▶

Two-photon Absorption Spectra of a Near-IR Polymethine Molecule with a Broken Ground-State Symmetry, Honghua Hu¹, Dmitry A. Fishman¹, Scott Webster¹, Olga V. Przhonska^{1,2}, Julia L. Bricks³, Alexey D. Kachkovski³, Anna Terenzi⁴, Sihui He¹, David J. Hagan¹, Eric W. Van Stryland¹; ¹CREOL: College of Optics and Photonics, Univ. of Central Florida, USA; ²Institute of Physics, National Academy of Sciences, Ukraine; ³Institute of Organic Chemistry, National Academy of Sciences, Ukraine; ⁴Dipartimento di Chimica GIAF and IN-STM UdR-Parma, Università di Parma, Italy. NIR polymethines are studied in two solvents of dissimilar polarity to investigate predictions of 2PA enhancements from ground-state symmetry-breaking (SB). However, electron-vibrational coupling appears to predominate SB.

FThW2 • 16:15 ▶

BiFeO₃ Heterostructures for Electro-Optic Modulators, Daniel Sando¹, Julie Allibe¹, Eric Jacquet¹, Stéphane Fusil¹, Bouzouhouane Karim¹, Carrétero Cécile¹, Cyrille Deranlot¹, Jerome Bourderionnet², Crété Denis¹, Jean-Claude Mage¹, Agnès Barthélémy¹, Manuel Bibes¹; ¹Unité Mixte de Physique CNRS/Thales, France; ²Thales Research & Technology, France.

The ferroelectric BiFeO₃ exhibits strong polarization and potentially large electro-optic coefficients. We present our efforts in design and fabrication of thin film EOMs based on thin film heterostructures using BiFeO₃ as the modulating medium.

FThW3 • 16:30 ▶

Diffraction Free Edge States in Optical Graphene, Mikael C. Rechtsman¹, Daohong Song², Yonatan Plotnik¹, Alexander Szameit¹, Natalia Malkova³, Mordechai Segev¹, Zhigang Chen³; ¹Solid State Institute, Technion - Israel Institute of Technology, Israel; ²Applied Physics, Nankai Univ., China; ³Physics, San Francisco State Univ., USA. Here we experimentally demonstrate diffractionless edge modes on the bearded and zigzag edges of optical graphene, the photonic analogue of conventional carbon-based graphene.

FThW4 • 16:45 ▶

Photonic Crystal Waveguide Electro-Optic Modulator for GHz Bandwidth Applications, Jianheng Li¹, Zhifu Liu¹, Bruce W. Wessels¹; ¹Northwestern Univ., USA. Electro-optic modulators were fabricated on Si₃N₄/BaTiO₃/MgO waveguides. Photonic crystals (PhCs) were introduced to minimize the phase velocity mismatch. The 3mm long PhC modulator has a $V\pi$ of 5.5V and 3dB bandwidth greater than 15GHz.

FThW5 • 17:00 Invited ▶

Optical Combs and Photonic RF Oscillators with Whispering-Gallery Mode Microresonators, Vladimir S. Ilchenko¹, Anatoliy S. Savchenkov¹, Wei Liang¹, Andrey Matsko¹, Jerry Byrd¹, Danny Eliyahu¹, David Seidel¹, Lute Maleki¹; ¹OEWaves Inc, USA. We demonstrate compact low-noise photonic oscillators with self-injection-locked semiconductor lasers and crystalline microresonators. We compare microwave feedback oscillators with electro-optic resonators, and latest optical Kerr comb generators.

16:00–18:00

FThY • Analysis and Math MethodsDamon Diehl; *Diehl Research Grant Services, USA, Presider*

FThY1 • 16:00 Invited

SVD for Imaging Systems with Discrete Rotational Symmetry, Eric Clarkson^{1,2}, Robin Palit², Matthew A. Kupinski^{2,1}; ¹Radiology, Univ. of Arizona, USA; ²College of Optical Sciences, Univ. of Arizona, USA. In the presence of discrete rotational symmetry for a tomographic imaging system we show that the dimension of the SVD computation can be reduced by a factor equal to the number of collection angles.

FThY2 • 16:30 Invited

Information-Optimal Adaptive Spectral Classification Imaging, Peter A. Jansen¹, Ivan Rodriguez¹, Michael Gehm^{1,2}; ¹Electrical and Computer Engineering Department, Univ. of Arizona, USA; ²College of Optical Sciences, Univ. of Arizona, USA. We propose a notional optical architecture for information-optimal, adaptive spectral classification at multiple spatial locations without acquisition of the spectral datacube. We will report on our simulation, design, and experimental progress.

FThY3 • 17:00

Withdrawn

16:00–17:45

FThZ • Coherence and Quantum ImagingDaniel James; *University of Toronto, Canada, Presider*

FThZ1 • 16:00 Invited

Hermann Grid's Dark Diagonals Disprove QM's "Beliefs," Reveal Stringy Electron, Nucleons, Stick Figure Constellations, Roger D. McLeod¹; ¹Physics and Applied Physics, Univ. of Massachusetts Lowell, USA. Collimated laser replicating vision's focal field shows it, QM, electrons, stringy nucleons, encode and spatially Fourier transform as field amplitudes, not "probabilities."

FThZ2 • 16:30

Engineering of Spiral Spectrum and Angular Correlations by Tuning Crystal Orientation, Mary Jacqueline Romero^{1,2}, Daniele Giovannini¹, Alison Yao², Steve Barnett³, Miles Padgett¹; ¹University of Glasgow, United Kingdom; ²University of Strathclyde, United Kingdom. We engineer the spiral and angular correlations of photons generated in parametric down-conversion by changing the orientation of the crystal. This is useful for protocols which use orbital angular momentum and angle for encoding information.

FThZ3 • 16:45

Partial Polarization of Light in a Single-photon Interference Experiment, Mayukh Lahiri¹; ¹Department of Physics and Astronomy, University of Rochester, USA. We show that light generated in a particular single-photon interference experiment is polarized when a photon behaves like wave, is unpolarized when it behaves like particle, and is partially polarized in the intermediate case.

FThZ4 • 17:00

Bayesian Analysis of Parity Based Detection Scheme, Keith R. Motes¹; ¹Physics and Astronomy, Louisiana State University, USA. Using Bayesian analysis we characterized the performance of phase estimation in the Mach-Zehnder interferometer with two-mode squeezed vacuum input. Phase uncertainty, over many trials, is examined and the dependence on photon number is found.

