

07:30–17:30 Registration, Market Street Foyer, Fairmont Hotel

08:00–10:15

**FWA • Special Symposium on 50 Years of Measuring the Eye's Aberrations I** ▶  
Howard Howland; Cornell Univ., USA, *Presider*

FWA1 • 08:00 **Tutorial** ▶

**An Historical Understanding of the Normal Eye's Monochromatic Aberrations**, Howard Howland; Cornell Univ., USA. In this paper the history of the study of monochromatic aberrations of the eye is outlined. The progress in this field has depended both on optical inventions and on the development of digital computers, the latter allowing very extensive computations on large data sets to be performed rapidly and accurately.

08:00–10:00

**FWB • Frequency Combs I: Sources** ▶  
Ian Coddington; NIST, USA, *Presider*

FWB1 • 08:00 **Tutorial** ▶

**Silicon-Chip-Based Optical Frequency Combs**, Alexander Gaeta; Cornell Univ., USA. We describe recent work on the development of chip-based frequency combs based on parametric mixing that offer the promise of highly compact, robust sources for metrology, spectroscopy, and ultrafast applications.



Alex Gaeta received his B.S degree in 1983 and his Ph.D. in 1991, both in Optics from the University of Rochester. In 1992 he joined the faculty at the School of Applied and Engineering Physics at Cornell University where he is currently a Professor and the Director for the School. His research interests include integrated nonlinear optical devices, nanophotonics, ultrafast nonlinear optics, the development and application of photonic crystal fibers, and quantum effects in nonlinear optics. He has participated in the organization of numerous meetings including serving as Chair of the 2003 OSA Annual Meeting, the 2007 QELS Conference, and the 2009 Nonlinear Optics Topical Meeting. He is a Fellow of the OSA and the APS.

08:00–10:00

**FWC • Plasmonic Waveguides and Cavities** ▶  
Hou-Tong Chen; Los Alamos National Laboratory, USA, *Presider*

FWC1 • 08:00 **Invited** ▶

**Coherent and Broadband Plasmonic Nanocavities**, Stefan A. Maier<sup>1</sup>; <sup>1</sup>Physics Department, Imperial College London, United Kingdom. We will discuss systems plasmonic nanocavities exhibiting Fano resonances or broadband light harvesting behaviour. A particular focus will lie on transformation optics as a design tool, and the coupling to nanoscale light emitters.

FWC2 • 08:30 ▶

**An Integrated Hybrid Nanophotonics Platform**, Volker J. Sorger<sup>1</sup>, Ziliang Ye<sup>1</sup>, Nitipat Pholchai<sup>1</sup>, Rupert F. Oulton<sup>2</sup>, Ren-Min Ma<sup>1</sup>, Xiaobo Yin<sup>1</sup>, Xiang Zhang<sup>1,2</sup>; <sup>1</sup>NSF Nanoscale Science and Engineering Center, UC Berkeley, USA; <sup>2</sup>Materials Sciences Division, Lawrence Berkeley National Laboratory, USA; <sup>3</sup>Experimental Solid State Physics, Imperial College, United Kingdom. Based on a hybrid-plasmon platform, we report first demonstrations of low-loss, deep-sub- $\lambda$  waveguiding, plasmon semiconductor Nanolaser and strong emitter-to-waveguide coupling towards compact photonic integrated circuits and quantum optics devices.

08:00–10:00

**FWD • Beam Shaping and Propagation, Laser Cavity Design I**  
Miguel Alonso; University of Rochester, USA, *Presider*

FWD1 • 08:00 **Invited**

**Validating Beam Propagation Algorithms**, Bryan D. Stone<sup>1</sup>; <sup>1</sup>Synopsys, Inc., USA. Modeling beam propagation is challenging and it is useful to understand the limitations of an algorithm before applying it to any given problem. The region of validity of beam propagation algorithms are described.

FWD2 • 08:30

**The Aggregate Behavior of Branch Points - Modeling Parameters**, Denis W. Oesch<sup>1</sup>, Carolyn M. Tewksbury-Christle<sup>2</sup>, Darryl J. Sanchez<sup>2</sup>, Patrick R. Kelly<sup>3</sup>; <sup>1</sup>Science Applications International Corporation, USA; <sup>2</sup>Starfire Optical Range, AFRL/RDS, USA. This paper continues a series discussing branch points. In creating a wave optical model of our experiments, we found unexpected dependencies in the branch point distributions. This paper discusses these dependencies.

08:00–09:30

**FWE • Novel Fibers and Applications III**  
Evgeny Myslivets; UCSD, USA, *Presider*

FWE1 • 08:00 **Invited**

**Novel Fibers for Telecom**, Takashi Sasaki<sup>1</sup>; <sup>1</sup>Optical Communications R&D Department, Sumitomo Electric Industries, LTD., Japan. This paper reports recent advances and perspectives of novel fibers for telecom, including low-loss and low-nonlinear fibers, multi-core fibers, and few mode fibers for telecom to cope with the increase of data traffic.

FWE2 • 08:30

**Beam Quality Factor of Gain-Guided Index-Antiguided Fiber Laser with a Finite Cladding Diameter**, Parisa Gandomkar Yarandi<sup>1</sup>, Arash Mafi<sup>1</sup>; <sup>1</sup>University of Wisconsin Milwaukee, USA. We show that the finiteness of the cladding diameter is essential in determining the physical properties, especially the beam quality factor of the gain-guided index-antiguided (GG-IAG) fibers.



07:30–17:30 Registration, Market Street Foyer, Fairmont Hotel

08:00–09:30

**FWF • Order, Disorder and Symmetry in Photonic Structures I** 

Tsampikos Kottos; Wesleyan University, USA, Presider

FWF1 • 08:00 **Tutorial** 

**Laser Emission and Coherent Control of Absorption in Complex and Random Systems**, A. Douglas Stone<sup>1</sup>, Yidong Chong<sup>1</sup>, Li Ge<sup>2</sup>, Hakan Tureci<sup>2</sup>; <sup>1</sup>Applied Physics, Yale University, USA; <sup>2</sup>Electrical Engineering, Princeton University, USA. A scattering theory of lasing and absorption in arbitrary complex and random systems is presented, leading to tractable computational methods to describe multimode lasing, as well as time-reversed lasing and coherent control of absorption.

08:00–09:45

**FWG • Optical Signal Processing Devices**

Nikola Alic; Univ. of California at San Diego, USA, Presider

FWG1 • 08:00

**A High-Speed Graphene-Based Broadband Modulator**, Ming Liu<sup>1</sup>, Xiang Zhang<sup>1</sup>; <sup>1</sup>Mechanical Engineering, UC Berkeley, USA. We experimentally demonstrate the first graphene-based waveguide-integrated broadband modulator. By tuning the Fermi level of graphene, we proved that over 1 giga-Hertz modulation speed can be realized from 1.35 to 1.6  $\mu\text{m}$  in room temperature.

FWG2 • 08:15

**2x2 Suspended Silica Splitter on Silicon**, Xiaomin Zhang<sup>1</sup>, Andrea Armani<sup>1,2</sup>; <sup>1</sup>Materials Science, University of Southern California, USA; <sup>2</sup>Electrical Engineering, University of Southern California, USA. We have successfully fabricated a novel suspended silica splitter with two input and output ports on a silicon substrate. The splitter was shown to be able to split power evenly with low crosstalk.

FWG3 • 08:30 **Invited**

**Ultrahigh-Speed Signal Processing using Temporal Imaging**, Mark Foster, Johns Hopkins Univ., USA. Parametric temporal imaging enables robust, fully guided wave optical processing systems with greater than THz bandwidths. Here we will discuss the applications of such systems for processing a variety of ultrahigh-speed signals.

08:00–10:00

**LWA • Optical Metamaterials: Theory**

George Barbasthathis; MIT, Presider

LWA1 • 08:00 **Invited**

**Slow Light Amplification and Nano-Lasing in Active Plasmonic Metamaterials**, Kosmas L. Tsakmakidis, Joachim M. Hamm, Sebastian Wuestner, and Ortwin Hess; Imperial College London, UK. We establish the theory of light amplification and lasing in optical metamaterials. We show how loss compensation in slow-light metamaterial heterostructures becomes possible, and elucidate light amplification and lasing in active nanoplasmonic double-fishnet metamaterials.

LWA2 • 08:30 **Invited**

**Metamaterials with Gain and Interpretation of Transmission in Pump-Probe Experiments**, Thomas Koschny<sup>1</sup>, C.M. Soukoulis<sup>2</sup>; Ames Lab and Iowa State University, USA. We numerically investigate loss compensation and transmission in pump-probe experiments in resonant metamaterials with gain using an FDTD algorithm coupled to semiclassical rate equations. We observe differential transmittance signals from the coupled system that are a factor of four to five larger than for the bare quantum well. We observe a more rapid temporal decay of the differential transmittance signal for the coupled system compared to the bare quantum well. The effective metamaterial gain beyond the bare quantum-well gain, leading to a significant reduction of the metamaterial's losses, but no complete compensation of the losses. We explain experimentally observed negative differential transmission by gain-dependent impedance.

08:00–10:00

**LWB • Optics and Alternative Energy Sources I**

Philippe Fauchet; Univ. of Rochester, USA, Presider

LWB1 • 08:00 **Invited**

**Light Guide Concentrating Photovoltaics System**, Duncan Moore<sup>1</sup>; <sup>1</sup>Univ. of Rochester, USA. Optical systems with microlenses, a guiding material and micro air prisms with "air bypass" prisms have been designed and fabricated. Optical efficiencies greater than 72% with 55x concentration have been tested.

LWB2 • 08:30

**Silver Nanoparticles to Enhance the Efficiency of Thin-Film Solar Cells**, Joshua D. Winans<sup>1</sup>, Jeffrey P. Clarkson<sup>1</sup>, Philippe M. Fauchet<sup>2</sup>; <sup>1</sup>Materials Science, University of Rochester, USA; <sup>2</sup>Electrical and Computer Engineering, University of Rochester, USA. Silver nanoparticles are applied to the front surface of thin-film a-Si to reduce reflection and transmission losses. We use FDTD simulations to investigate the effect of varying particle size and shape on the absorption of light.

08:00–10:00

**LWC • Attosecond and Strong Field Science II**

Michael Spanner; National Research Council of Canada, Canada, Presider

LWC1 • 08:00 **Invited**

**Femtosecond XUV Transparency in Light-coupled He Doubly Excited States**, Michal Tarana; <sup>1</sup>Univ. of Colorado, USA. Electromagnetically induced transparency-like behavior in extreme ultraviolet is studied theoretically, including the effect of laser dressing of He 2s2p(<sup>1</sup>P<sup>o</sup>) and 2p<sup>2</sup>(<sup>1</sup>S<sup>e</sup>) auto ionizing states by an intense 800 nm field. The method allows for a rigorous treatment of optical field ionization of these coupled auto ionizing states into the N=2 continuum in addition to N=1. Our calculated transient absorption spectra show reasonably encouraging agreement with experiment.

LWC2 • 08:30

**Attosecond Science at the Future ELI-ALPS Facility in Hungary**, Péter Dombi<sup>1</sup>, Peter Baum<sup>2</sup>, Dimitrios Charalambidis<sup>3</sup>, Aladár Czitrovsky<sup>1</sup>, István B. Földes<sup>4</sup>, József A. Fülöp<sup>5</sup>, János Hebling<sup>6</sup>, Ulf Kleineberg<sup>7</sup>, Ferenc Krausz<sup>8</sup>, Károly Osyay<sup>9</sup>, Gábor Szabó<sup>7</sup>, Sándor Szatmári<sup>8</sup>, George Tsakiris<sup>6</sup>, Katalin Varjú<sup>6</sup>, Laszlo Veisz<sup>6</sup>, Marc J. Vrakking<sup>10</sup>; <sup>1</sup>Research Inst. for Solid-State Physics and Optics, Hungary; <sup>2</sup>Department für Physik, Ludwig-Maximilians-Universität, Germany; <sup>3</sup>Foundation for Research and Technology - Hellas, Institute of Electronic Structure & Laser, Greece; <sup>4</sup>KFKI Research Institute for Particle and Nuclear Physics, Hungary; <sup>5</sup>Department of Experimental Physics, University of Pécs, Hungary; <sup>6</sup>Max-Planck-Institut für Quantenoptik, Germany; <sup>7</sup>Department of Optics and Quantum Electronics, University of Szeged, Hungary; <sup>8</sup>Department of Experimental Physics, University of Szeged, Hungary; <sup>9</sup>Research Group on Laser Physics, University of Szeged, Hungary; <sup>10</sup>Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie, Germany. ELI-ALPS will offer record breaking attosecond pulses optimized for time-resolved experiments in valence and core electron science, plasma physics and 4D-imaging. Additional sources spanning the THz...X-ray range will constitute a versatile facility.



**FWA • Special Symposium on 50 Years of Measuring the Eye's Aberrations I—Continued**
**FWA2 • 08:45** **Invited**

**Factors Affecting Visual Performance after Customized Wavefront Manipulation**, Geunyoung Yoon; <sup>1</sup>*Center for Visual Science, University of Rochester, USA*. The success of customized vision correction depends on the relative significance of the higher order aberration of the eye, the feasibility of implementing the correction methods and the neural system's capability to benefit fully from improved optics.

**FWA3 • 09:15** **Invited**

**Customized Clinical Correction of the Eye's Aberrations**, Ian Cox; <sup>1</sup>*Bausch and Lomb, USA*. The introduction of clinically viable wavefront sensors has opened the pathway to correction of the higher order wavefront aberration of the human eye using laser based refractive surgery, intraocular lenses and contact lenses.

**FWB • Frequency Combs I: Sources—Continued**
**FWB2 • 08:45**

**Chip-based Frequency Comb with Microwave Repetition Rate**, Jiang Li<sup>1</sup>, Hansuek Lee<sup>1</sup>, Tong Chen<sup>1</sup>, Kerry J. Vahala<sup>1</sup>; <sup>1</sup>*Department of Applied Physics, California Institute of Technology, USA*. A silicon-chip microcomb accessing the important microwave-rate FSR range is reported. 22.9 and 33.2 GHz comb spacing devices are demonstrated having 200 comb lines, 200 Hz comb heterodyne beat and threshold as low as 2.3 mW.

**FWB3 • 09:00** **Invited**

**Dual-Comb-Based Characterization of Rapidly Tuned Lasers**, Fabrizio R. Giorgetta<sup>1</sup>, Esther Baumann<sup>1</sup>, Ian Coddington<sup>1</sup>, William C. Swann<sup>1</sup>, Nathan R. Newbury<sup>1</sup>, Zeb W. Barber<sup>2</sup>, Peter A. Roos<sup>3</sup>; <sup>1</sup>*National institute of standards and technology, USA*; <sup>2</sup>*Montana state university, USA*; <sup>3</sup>*Bridger photonics inc., USA*. We demonstrate a technique to calibrate the instantaneous frequency versus time from a rapidly tuned cw laser. Our dual-comb-based spectrometer can measure optical waveforms tuned at 1500-THz/s rates over 5-THz bandwidths at high precision.

**FWC • Plasmonic Waveguides and Cavities—Continued**
**FWC3 • 08:45**

**Coupled Nanowire Array Based Long-Range Hybrid Plasmonic Waveguide for Subwavelength Mode Confinement**, Yusheng Bian<sup>1</sup>, Zheng Zheng<sup>1</sup>, Ya Liu<sup>1</sup>, Jiansheng Liu<sup>1</sup>, Jinsong Zhu<sup>2</sup>, Tao Zhou<sup>3</sup>; <sup>1</sup>*School of Electronic and Information Engineering, Beihang University, China*; <sup>2</sup>*National Center for Nanoscience and Technology of China, China*; <sup>3</sup>*Department of Physics, New Jersey Institute of Technology, USA*. A novel hybrid plasmonic waveguide that integrates semiconductor and metallic nanowires is proposed. The structure could achieve much longer propagation distance with similar degree of confinement compared to the previously reported hybrid waveguides

**FWC4 • 09:00**

**Channeled Photonic-Crystal-Surface-Plasmon-Coupled Waveguide at Terahertz Frequency**, Rajan Jha<sup>2</sup>, Triranjita Srivastava<sup>1</sup>, Ritwick Das<sup>3</sup>; <sup>1</sup>*Applied Physics, Delhi Technological University, India*; <sup>2</sup>*School of Basic Sciences, Indian Institute of Technology Bhubaneswar, India*; <sup>3</sup>*School of Physical Sciences, NISER Bhubaneswar, India*. We present a design principle of channel PCSPCW for exciting terahertz (THz) SPPs. The dispersion of supermodes due to modal interference leads to extremely large group-velocity-dispersion (~160000 ps/km- $\mu$ m) and high performance THz applications.

**FWC5 • 09:15**

**Plasmon Dynamics in Coupled Optical Microcavities**, Norberto D. Lanzillotti-Kimura<sup>1</sup>, Thomas Zentgraf<sup>1</sup>, Xiang Zhang<sup>1</sup>; <sup>1</sup>*Center for Scalable and Integrated NanoManufacturing (SINAM), University of California - Berkeley, USA*. We theoretically analyze the coupling effects and the plasmon dynamics in a structure formed by a pure optical microcavity connected to a hybrid plasmonic microcavity in a silicon optical waveguide.

**FWD • Beam Shaping and Propagation, Laser Cavity Design I—Continued**
**FWD3 • 08:45**

**Symmetry Breaking of Optical Vortices: Birth and Annihilation of Singularities in the Evanescent Field**, Paulo Brandão<sup>1</sup>, Cícero J. Julião<sup>1</sup>; <sup>1</sup>*Instituto de Física, Universidade Federal de Alagoas, Brazil*. Using total internal reflection phenomenon and superposition of four plane waves, we are able to show birth and annihilation of optical vortices in the evanescent field with curved topological features.

**FWD4 • 09:00**

**Propagation of the Cross-Polarization Component of Hermite-Gauss Laser Beams**, Jessica P. Conry<sup>1</sup>, Surendra Singh<sup>1</sup>; *University of Arkansas, USA*. Evolution of transverse intensity profiles for the dominant and cross-polarization components of linearly polarized Hermite-Gauss laser beams is studied experimentally as the beams propagate away from the waist.

**FWD5 • 09:15**

**Coherent Control on Molecular Systems by Polarization Shaped Laser Pulses**, Albrecht Lindinger<sup>1</sup>; <sup>1</sup>*Freie Universität Berlin, Institut für Experimentalphysik, Germany*. Polarization pulse shaping is presented for coherent control of multi-photon ionization of alkali dimers. Sub-pulse parameters including polarization are controlled. These pulses are guided through a photonic fiber which is valuable for endoscopy.

**FWE • Novel Fibers and Applications III—Continued**
**FWE3 • 08:45**

**Tunable High Power Er:Yb Fiber Laser**, Baldemar Ibarra-Escamilla<sup>1</sup>, Evgeny A. Kuzin<sup>1</sup>, Olivier Pottiez<sup>2</sup>, Joseph W. Haus<sup>3</sup>, Qiwen Zhan<sup>3</sup>, Peter E. Powers<sup>3,4</sup>; <sup>1</sup>*Optics, INAOE, Mexico*; <sup>2</sup>*Fiber Optics, CIO, Mexico*; <sup>3</sup>*Electro-Optics, University of Dayton, USA*; <sup>4</sup>*Physics, University of Dayton, USA*. We demonstrated a wavelength-tunable fiber laser using a double-clad Er:Yb doped fiber into the cavity. The output wavelength is tunable from 1535 to 1567 nm. We achieved a maximal output power of 850 mW.

**FWE4 • 09:00**

**Gain-induced Mode Coupling in a Fiber Amplifier**, Richard S. Quimby<sup>1</sup>, Fei Luo<sup>2</sup>, Theodore F. Morse<sup>3</sup>; <sup>1</sup>*Physics, WPI, USA*; <sup>2</sup>*FLT Inc., USA*; <sup>3</sup>*ECE/Photonics Center, Boston University, USA*. Numerical simulations are used to study the coupling of power between modes in a multimode fiber, caused by the optical gain. The mode coupling can be significant for large area fibers with radially non-uniform gain.

**FWE5 • 09:15**

**Femtosecond Pulse Compression with Large-Mode-Area Photonic Crystal Fibres**, Júlia Fekete<sup>1</sup>, Péter Rácz<sup>1</sup>, Péter Dombi<sup>1</sup>; <sup>1</sup>*Research Institute for Solid-State Physics and Optics, Hungary*. We performed nonlinear compression of transform limited 75-fs laser pulses delivered by a long-cavity Ti:sapphire oscillator to 18-fs, 75-nJ pulses using large mode area photonic crystal fibres and chirped mirrors in a simple, scalable scheme.

## FIO

## LS

**FWF • Order, Disorder and Symmetry in Photonic Structures I—Continued****FWF2 • 08:45** 


**Photonic Network Laser**, Heeso Noh<sup>1</sup>, Jin-Kyu Yang<sup>1</sup>, Seng Fatt Liew<sup>1</sup>, Michael J. Rooks<sup>1</sup>, Glenn S. Solomon<sup>2</sup>, Hui Cao<sup>1,3</sup>; <sup>1</sup>*Applied Physics, Yale University, USA*; <sup>2</sup>*Joint Quantum Institute, NIST and University of Maryland, USA*; <sup>3</sup>*Physics, Yale University, USA*. We demonstrated lasing in trivalent network structures with short-range order. Without translational or rotational symmetries, such structures have large isotropic photonic bandgap. Unlike photonic crystals, bandedge modes are strongly localized.

**FWF3 • 09:00** 


**Isotropic Structural Color of Nanostructured Metal Surfaces**, Sylvanus Y. Lee<sup>1,2</sup>, Alyssa Pasquale<sup>1</sup>, Paola Galli<sup>4</sup>, Marco Romagnoli<sup>5</sup>, Luca Dal Negro<sup>1,3</sup>; <sup>1</sup>*Department of Electrical and Computer Engineering & Photonic Center, Boston Univ, USA*; <sup>2</sup>*Department of Mechanical Engineering, Boston University, USA*; <sup>3</sup>*Division of Materials Science and Engineering, Boston University, USA*; <sup>4</sup>*Consultant, Photonic Corp, USA*; <sup>5</sup>*MIT/Photonic Corp, USA*. We design and demonstrate isotropic structural color from nanostructured metal surfaces. Plasmon-enhanced light scattering of Au nanoparticle aperiodic arrays on Au films is observed by dark-field scattering & angle-resolved reflection spectroscopy.

**FWF4 • 09:15** 


**Transmission Channels Through Random Media**, Zhou Shi<sup>1</sup>, Jing Wang<sup>1</sup>, Azriel Genack<sup>1</sup>; <sup>1</sup>*Department of physics, Queens College, City University of New York, USA*. We measure the field transmission matrix for microwave radiation propagating through random waveguides in the Anderson localization transition and observe the statistics of transmission eigenvalues.

**FWG • Optical Signal Processing Devices—Continued****FWG4 • 09:00** 

**Novel Functionalities and Devices Based on Non-linear Frequency Conversion in CMOS Compatible Integrated Waveguide Structures**, Roberto Morandotti<sup>1</sup>, Alessia Pasquazi<sup>1</sup>, Yong Park<sup>1</sup>, Marco Peccianti<sup>1,2</sup>, Brent Little<sup>3</sup>, Sai Chu<sup>3</sup>, Jose Azana<sup>1</sup>, David Moss<sup>4</sup>; <sup>1</sup>*INRS-EMT, Canada*; <sup>2</sup>*Institute for Chemical and Physical Processes, CNR, "Sapienza" University, Italy*; <sup>3</sup>*Infinera Ltd, 169 Java Drive, USA*; <sup>4</sup>*IPOS and CUDOS, School of Physics, University of Sydney, USA*. We present a series of devices for optical pulse characterization in both amplitude and phase, exploiting FWM in a low loss, CMOS compatible glass chip.

**LWA • Optical Metamaterials: Theory—Continued****LWA3 • 09:00** 


**Radiative Heat Transfer in Hyperbolic Metamaterials**, Evgenii Narimanov; *Purdue, USA*. We demonstrate that the super-singularity of the photonic density of states in hyperbolic metamaterials leads to a dramatic enhancement of radiative heat in such media, and present the theoretical description of this effect.

**LWB • Optics and Alternative Energy Sources I—Continued****LWB3 • 08:45** 

**Polymer Solar Cell as an Emerging PV Technology**, Gang Li; *Solarmer Energy Inc., USA*. In the presentation, I will present progresses in polymer solar cell in recent years. Advances in material, device structure, morphology are the focus of the talk. Progress in manufacturing technology and lifetime will be discussed.

**LWB4 • 09:15**

**Plasmonic Enhancement of Raman Scattering in P3HT/PCBM by Silver Nanoprisms**, Anne M. Kelley<sup>1</sup>, Marina Stavtyska-Barba<sup>1</sup>, Michael Salvador<sup>2</sup>, Abhishek Kulkarni<sup>2</sup>, David S. Ginger<sup>2</sup>; <sup>1</sup>*School of Natural Sciences, University of California, Merced, USA*; <sup>2</sup>*Department of Chemistry, University of Washington, USA*. Triangular silver nanoprisms enhance both resonance Raman scattering and fluorescence from the solar cell material P3HT/PCBM. The Raman spectra and enhancement profiles are qualitatively consistent with an electromagnetic enhancement mechanism.

**LWC • Attosecond and Strong Field Science II—Continued****LWC3 • 08:45** 

**Attosecond Electron Dynamics in Atoms and Solids**, Martin Schultze<sup>1</sup>; <sup>1</sup>*MPI of Quantum Optics, Germany*. This talk presents how laser-driven attosecond spectroscopy is applied to study the timing of photoemission in atoms [1] and how it serves to investigate charge dynamics in solids in real time.

**LWC4 • 09:15**

**Few-Cycle Ultrahigh-Contrast Light Pulses for Single Attosecond Pulses in the Relativistic Regime**, Julia Mikhailova<sup>1,2</sup>, Patrick Heissler<sup>1</sup>, Rainer Hoerlein<sup>1</sup>, Alexander Buck<sup>1,3</sup>, Antonin Borot<sup>4</sup>, Karl Schmid<sup>5</sup>, Chris Sears<sup>1</sup>, Lutz Waldecker<sup>1</sup>, Matthew Zepf<sup>6</sup>, Ferenc Krausz<sup>1,3</sup>, Laszlo Veisz<sup>1</sup>, George Tsakiris<sup>1</sup>; <sup>1</sup>*Max Planck Institute for Quantum Optics, Germany*; <sup>2</sup>*A.M. Prokhorov General Physics Institute, Russian Academy of Sciences, Russian Federation*; <sup>3</sup>*Department für Physik, Ludwig-Maximilians-Universität, Germany*; <sup>4</sup>*Laboratoire d'Optique Appliquée, Ecole Polytechnique, CNRS, France*; <sup>5</sup>*Department of Physics and Astronomy, Queens University Belfast, United Kingdom*. We demonstrate generation of few-cycle light pulses with a  $10^{14}$  contrast 25 ps before the pulse's peak. Irradiating solid targets with this light source, we obtained relativistic high-order harmonics that are significantly broadened and overlapped.



FiO

LS

**FWF • Order, Disorder and Symmetry in Photonic Structures I—Continued**

**FWG • Optical Signal Processing Devices—Continued**

**FWG5 • 09:30**  
Multichannel Optical Correlator Based on One Spatial Light Modulator, Xu Zeng<sup>1</sup>, Jian Bai<sup>1</sup>; <sup>1</sup>Optical Engineering Department, State Key Laboratory of Modern Optical Instrumentation, Zhejiang University, China. We present a multichannel lensless optical correlator based on one phase-only spatial light modulator. This architecture is compact and flexible in optical path adjustment by utilizing programmable Fresnel lens array.

**LWA • Optical Metamaterials: Theory—Continued**

**LWA4 • 09:30**  
A Threshold and an Above Threshold Analysis of a 2D Square and Triangular Lattice Photonic Crystal Laser, Marcin Koba<sup>1,2</sup>, Pawel Szczepanski<sup>1,2</sup>; <sup>1</sup>Warsaw University of Technology, Poland; <sup>2</sup>National Institute of Telecommunications, Poland. In this work, a threshold and an above threshold analyses based on the coupled mode theory for square and triangular lattice photonic crystal band edge laser with TE and TM polarization are presented.

**LWA5 • 09:45**  
Effect of Two-Frequency Optical Injection on Multimode Vertical-Cavity Surface-Emitting Lasers, Hong Lin<sup>1</sup>, Amod J. Basnet<sup>1</sup>, David W. Pierce<sup>1</sup>; <sup>1</sup>Physics and Astronomy, Bates College, USA. We study experimentally the dynamics of a multimode vertical-cavity surface-emitting laser subject to two-frequency orthogonal optical injection. Polarization switching, bistability, and instabilities are observed when the bias current is adjusted.

**LWB • Optics and Alternative Energy Sources I—Continued**

**LWB5 • 09:30** **Invited**  
Plasmonic and High Index Nanostructures for Efficient Solar Energy Conversion, Mark L. Brongersma<sup>1</sup>; <sup>1</sup>Stanford University, USA. I will discuss the use of nanometallic and high-index dielectric nanostructures in boosting the energy conversion efficiency of photovoltaic and photo-electrochemical cells.

**LWC • Attosecond and Strong Field Science II—Continued**

**LWC5 • 09:30** **Invited**  
Theory of Attosecond Transient Absorption in Laser-Dressed Atoms, Kenneth J. Schafer<sup>1</sup>, Shaohao Chen<sup>1</sup>, Mengxi Wu<sup>1</sup>, Mette Gaarde<sup>1</sup>; <sup>1</sup>Physics and Astronomy, Louisiana State University, USA. We present a theoretical study of transient absorption by laser dressed atoms. We solve the fully coupled Schrodinger and Maxwell equations and examine the connection between attosecond electron dynamics and the transient absorption signal.

10:00–10:30 **Coffee Break**, Imperial Ballroom, Fairmont Hotel

10:00–14:00 **Exhibit Hall Open**, Imperial Ballroom, Fairmont Hotel

NOTES

Blank lined area for notes.

10:30–12:00

**FWH • Special Symposium of 50 Years of Measuring the Eye's Aberrations II** ▶Howard Howland; Cornell Univ., USA, *Presider*FWH1 • 10:30 **Invited** ▶

Using Adaptive Optics to Create Finer Tools for Probing Visual Function, Austin Roorda; <sup>1</sup>University of California, USA. Adaptive optics compensate for blur caused by ocular aberrations and are being used in a new generation of tools that are providing insight into the role of individual cones for human vision.

FWH2 • 11:00 **Invited** ▶

Probing Cellular Function in the Living Retina with Adaptive Optics, David Williams; <sup>1</sup>University of Rochester, USA. High resolution fluorescence imaging of the living mouse, monkey, and human eye with adaptive optics can reveal functional activity in single cells throughout the retina.

10:30–12:00

**FWI • Electron Dynamics in Intense Fields** ▶Laszlo Veisz; Max-Planck-Institut, Germany, *Presider*FWI1 • 10:30 **Invited** ▶

Attosecond Control of Collective Electron Dynamics In Plasmas, Antonin Borot<sup>1</sup>, Arnaud Malvache<sup>1</sup>, Xiaowei Chen<sup>1</sup>, Patrick Audebert<sup>3</sup>, Jean-Paul Geindre<sup>3</sup>, Gérard Mourou<sup>2</sup>, Fabien Quéré<sup>2</sup>, Rodrigo Lopez Martens<sup>1</sup>; <sup>1</sup>Laboratoire d'Optique Appliquée, CNRS - ENSTA ParisTech - Ecole Polytechnique, France; <sup>2</sup>Institut de La Lumière Extrême, CNRS - ENSTA ParisTech - Ecole Polytechnique, France; <sup>3</sup>Laboratoire pour l'Utilisation des Lasers Intenses, CNRS - Ecole Polytechnique, France; <sup>4</sup>Service des Photons, Atomes et Molécules, CEA - DSM/DRECAM, France. We demonstrate for the first time attosecond time scale control of collective electron motion in overdense plasmas driven by waveform-controlled few-cycle laser pulses.

FWI2 • 11:00 **Invited** ▶

Optical Characterization of Laser-Driven Electron Acceleration, M. C. Kaluza<sup>1,2,3</sup>, H.-P. Schlenvoigt<sup>1,4</sup>, S. P. D. Mangles<sup>5</sup>, A. G. R. Thomas<sup>3,5</sup>, A. E. Dangor<sup>3</sup>, H. Schwoerer<sup>1,6</sup>, W. B. Mori<sup>7</sup>, Z. Najmudin<sup>3</sup>, K. M. Krushelnick<sup>3,5</sup>, A. Buck<sup>8,9</sup>, M. Nicolai<sup>1</sup>, K. Schmid<sup>8,9</sup>, C. M. S. Sears<sup>8</sup>, A. Sävert<sup>1</sup>, J. M. Mikhailova<sup>8</sup>, F. Krausz<sup>8,9</sup>, L. Veisz<sup>2</sup>; <sup>1</sup>Friedrich-Schiller-Universität, Germany; <sup>2</sup>Helmholtz-Institute Jena, Germany; <sup>3</sup>Imperial College, UK; <sup>4</sup>Ecole Polytechnique, France; <sup>5</sup>University of Michigan, USA; <sup>6</sup>Stellenbosch University, South Africa; <sup>7</sup>UCLA, USA; <sup>8</sup>Max-Planck-Institut für Quantenoptik, Germany; <sup>9</sup>Ludwig-Maximilians-Universität München, Germany. We present the first well-resolved experimental observation of the non-linear formation of a laser-driven plasma wave, its breaking leading to self-injection and acceleration of electrons in the wave's electric field in the regime of "Bubble-acceleration".

10:30–12:00

**FWJ • Digital Holographic Interferometry and Microscopy II**Partha P. Banerjee; University of Dayton, USA, *Presider*FWJ1 • 10:30 **Invited**

Computer-Generated Holography, Toyohiko Yatagai; *Utsumomiya University, Japan*. Abstract not available.

FWJ2 • 11:00

Development of a Table-top Time-resolved EUV laser Nano-holography Scheme, Mario C. Marconi<sup>1</sup>, Erik Malm<sup>1</sup>, Przemyslaw Wachulak<sup>1</sup>, Carmen S. Menoni<sup>1</sup>, Jorge J. Rocca<sup>1</sup>; <sup>1</sup>Electrical and Computer Engineering, Colorado State University, USA. We describe the implementation of a time-resolved high resolution Fourier holographic system. Spatial resolution below 100 nm and a temporal resolution of 1 ns is expected utilizing a compact table-top extreme ultraviolet laser.

FWJ3 • 11:15

Suppression of the Zero Order Diffracted Beam for Near Field Holographic Projection by Phase Compression, Sih-Ying Wu<sup>1</sup>, Jinyang Liang<sup>1</sup>, Michael F. Becker<sup>1</sup>; <sup>1</sup>Electrical and Computer Engineering, University of Texas at Austin, USA. Phase compression technique is demonstrated to be capable of eliminating the near field on-axis zero order diffracted (ZOD) beam. Image quality including diffraction efficiency and root mean square (RMS) error is simulated and discussed.

10:30–12:00

**FWK • Beam Shaping and Propagation, Laser Cavity Design II**Bryan Stone; Synopsys Inc., USA, *Presider*FWK1 • 10:30 **Invited**

Optical Beam Propagation through the Oceanic Turbulence, Olga Korotkova<sup>1</sup>; <sup>1</sup>University of Miami, USA. Effect of oceanic turbulence on spectrum, intensity, coherence and polarization of monochromatic and random beams is investigated on the basis of temperature-salinity power spectrum of ocean and extended Huygens-Fresnel integral.

FWK2 • 11:00

Light Scattering from Deterministic and Random Media with Semi-Soft Boundaries, Serkan Sahin<sup>1</sup>, Gregory Gbur<sup>2</sup>, Olga Korotkova<sup>1</sup>; <sup>1</sup>Physics, Miami University, USA; <sup>2</sup>University of North Carolina at Charlotte, USA. A three-dimensional multi-Gaussian function is adopted for modeling of a spherically-symmetric scatterer with semi-soft boundary, i.e. such that has continuous and adjustable drop in the index of refraction.

FWK3 • 11:15

Plasmonic Beam Shaping in the Mid-infrared, Jonathan R. Pugh<sup>1,2</sup>, Jamie Stokes<sup>1</sup>, Geoff R. Nash<sup>3,1</sup>, Craig D. Stacey<sup>2</sup>, Martin J. Cryan<sup>1</sup>; <sup>1</sup>Electrical & Electronic Engineering, University of Bristol, United Kingdom; <sup>2</sup>Photonic Systems Capability, BAE Systems, United Kingdom; <sup>3</sup>College of Engineering, Mathematics and Physical Sciences, University of Exeter, United Kingdom. Simulation results, fabrication details and measurements are presented for a one-dimensional aperture and grating array for the purpose of plasmonic beam shaping of the  $\lambda=3.99\mu\text{m}$  output of an optically pumped semiconductor laser.

10:30–12:15

**FWL • Bioplasmonics** ▶*Presider to Be Announced*FWL1 • 10:30 **Invited** ▶

Mapping the Spatial Distribution of Cell Surface Receptors with Plasmon Coupling Microscopy, Bjoern Reinhardt<sup>1</sup>, Hongyun Wang<sup>1</sup>, Jing Wang<sup>1</sup>, Guoxin Rong<sup>1</sup>; <sup>1</sup>Chemistry, Boston University, USA. A multispectral imaging modality is described for a quantitative analysis of plasmon coupling between noble metal immunolabels. The approach provides information about the spatial organization of the labels and thus of targeted receptor densities.

FWL2 • 11:00 **Invited** ▶

Plasmonics in Biological Imaging, Rohit Bhargava; *Univ. of Illinois, USA*. Rational design of nanostructured particles for surface enhanced spectroscopy, including Raman spectroscopic sensing, is modeled using Mie theory and Genetic Algorithm optimization. Fabrication and use of these nano-layered metal-dielectric particles (nanoLAMPS) presents new opportunities.

## FIO

## LS

10:30–12:00

**FWM • Order, Disorder and Symmetry in Photonic Structures II** ▶P. Lodahl; *Danmarks Tekniske Univ. Denmark, Presider*

FWM1 • 10:30 ▶

**Position-Dependent Diffusion Coefficient as Localization Criterion in Non-Conservative Random Media**, Alexey Yamilov<sup>1</sup>, Ben Payne<sup>1</sup>; <sup>1</sup>*Physics, Missouri University of Science and Technology, USA*. Position-dependent diffusion coefficient is used to distinguish different regimes in wave transport in random media with absorption or gain.

FWM2 • 10:45 ▶

**Transverse Localization of Light in Laser Inscribed Disordered Coupled Waveguide Lattices**, Somnath GHOSH<sup>1</sup>, Nicholas Psaila<sup>2</sup>, Robert R. Thomson<sup>2</sup>, Bishnu P. Pal<sup>1</sup>, Ravi K. Varshney<sup>1</sup>, Ajay Kar<sup>2</sup>; <sup>1</sup>*Physics, Indian Institute of Technology Delhi, India*; <sup>2</sup>*School of Engg and Physical Sciences, Heriot-Watt University, United Kingdom*. We report direct observation of the signature of transverse localization of light in laser-inscribed disordered array of evanescently coupled one-dimensional optical waveguides in an Er-doped Bismuthate glass.

FWM3 • 11:00 **Invited** ▶

**Unidirectional Invisibility of Photonic Periodic Structures Induced by PT-Symmetric Arrangements**, Tsampikos Kottos<sup>1</sup>, Hamidreza Ramezani<sup>1</sup>, Zin Lin<sup>1</sup>, Toni Eichelkraut<sup>2</sup>, Hui Cao<sup>3</sup>, Demetrios Christodoulides<sup>2</sup>; <sup>1</sup>*Physics, Wesleyan University, USA*; <sup>2</sup>*CREOL, University of Central Florida, USA*; <sup>3</sup>*Applied Physics, Yale, USA*. Parity-time symmetric grating structures, near the spontaneous PT-symmetry point, can act as unidirectional invisible media where the reflection and transmission from one side, is indistinguishable from those expected in the absence of a grating.

10:30–12:00

**FWN • Information Theory in Optics II: Quantum Information Theory** ▶Colin McKinstrie; *Bell Labs, USA, Presider*FWN1 • 10:30 **Tutorial** ▶

**Quantum Information Theory in Optics**, Norbert Lutkenhaus<sup>1</sup>; *Institute for Quantum Computing, Univ. of Waterloo, Canada*. Non-orthogonal signal states cannot be perfectly discriminated by any measurement. Laser pulses with different optical phase realize such signals. Using these signals pushes the limits of optical communication and accomplishes new tasks.



Norbert Lütkenhaus obtained a Diploma (general relativity) from Munich. In his PhD thesis (Strathclyde) he changed to quantum optics and quantum information. After positions in Innsbruck and Helsinki, he worked for a MagiQ Technologies. Back in academia, he started his research group in Erlangen and moved it to Waterloo and the Institute for Quantum Computing in 2006.

FWN2 • 11:15 **Tutorial** ▶

**Entanglement and Quantum Information Theory**, Steven van Enk<sup>1</sup>; *Univ. of Oregon, USA*. In this tutorial I'll review the old and modern definitions of entanglement, discuss why we think entanglement is useful, and present various methods that can be used to detect entanglement in an experiment.

Steven van Enk obtained his PhD in theoretical physics at the University of Leiden in 1992. After postdocs at the Max-Planck-Institute for Quantum Optics, the University of Innsbruck, and Caltech, he became a Member of Technical Staff at Bell Labs. Now he is a professor of physics at the University of Oregon.

10:30–12:00

**LWD • Optical Metamaterial Device Physics**Evgenii Narimanov; *Purdue University, USA, Presider*LWD1 • 10:30 **Invited**

**Control of Emission and Reflection with Hyperbolic Metamaterials**, Mikhail A. Noginov<sup>1</sup>, Thejaswi Tumkur<sup>1</sup>, Heng Li<sup>1</sup>, Yuri A. Barnakov<sup>1</sup>, Guohua Zhu<sup>1</sup>, Mohammad Mayy<sup>1</sup>, Zubin Jacob<sup>2</sup>, Evgenii Narimanov<sup>3</sup>; <sup>1</sup>*Norfolk State University, USA*; <sup>2</sup>*University of Alberta, Canada*; <sup>3</sup>*Purdue University, USA*. As metamaterials with hyperbolic dispersion strongly modify the density of photonic states, they can be used for control of spontaneous emission and reflection as well as, potentially, a variety of other optical phenomena.

LWD2 • 11:00 **Invited**

**Plasmonic Nanowire Networks: From Waveguiding to Passive and Active Nanoscale Optical Devices**, Peter Nordlander<sup>1</sup>; *Physics and Astronomy, Rice University, USA*. Plasmonic nanowires can serve as waveguides where incident light can be reemitted from remote positions. We show that by combining nanowires into networks, it is possible to realize both passive and active subwavelength optical devices.

10:30–11:45

**LWE • Optics and Alternative Energy Sources II**Susan Dexheimer; *Washington State University, USA, Presider*LWE1 • 10:30 **Invited**

**Exploration of Optimization-based Surface Textures for High Efficiency Thin-film Si Solar Cells**, Jurgen Michel; *Massachusetts Institute of Technology, USA*. We explore light-absorption behavior of thin-film silicon for normal-incidence, using surface textures to enhance absorption. Using an optimization algorithm, our optimized surface texture enhances absorption (900-1100nm) by 2.7x over the general Lambertian model.

LWE2 • 11:00

**HIPER: The European Path to Inertial Fusion Energy**, Chris Edwards<sup>1</sup>; *Central Laser Facility, STFC, United Kingdom*. HiPER is a European project which seeks to harness Laser Energy for commercial power production. This paper describes recent progress and identifies the European route to realisation of this technology on the 2035 timescale.

LWE3 • 11:15 **Invited**

**Light Trapping in Plasmonic Solar Cells**, Vivian Ferry<sup>1,2</sup>, Albert Polman<sup>2</sup>, Harry Atwater<sup>1</sup>; *1*Thomas J. Watson Laboratories of Applied Physics, California Institute of Technology, USA; *2*FOM Institute AMOLF, Netherlands. Plasmonic nanostructures enable the manipulation and molding of light in nanoscale dimensions. Light trapping nanostructures are now used for increasing photocurrent and efficiency in ultrathin film solar cells.

10:30–12:00

**LWF • Attosecond and Strong Field Science III**

Presider to Be Announced

LWF1 • 10:30 **Invited**

**Ionic State Superposition in the Strong Field Ionization of Water**, Joseph P. Farrell<sup>1</sup>, Simon Petretti<sup>2</sup>, J. Foerster<sup>2</sup>, Brian K. McFarland<sup>1</sup>, Limor S. Spector<sup>1</sup>, Y. V. Vanne<sup>2</sup>, P. Decleva<sup>3</sup>, Philip H. Bucksbaum<sup>1</sup>, Alejandro Saenz<sup>2</sup>, Markus Guehr<sup>1</sup>; *1*Stanford PULSE Institute, SLAC National Accelerator Laboratory and Stanford University, USA; *2*AG Moderne Optik, Institut fuer Physik, Humboldt-Universitaet zu Berlin, Germany; *3*Dipartimento di Scienze Chimiche, Universita di Trieste, Italy. High harmonic spectroscopy (HHS) contains rich information about atomic and molecular electronic structure and dynamics. We introduce a new method for finding multi-orbital contributions in HHS via isotope marking.

LWF2 • 11:00

**Scattering of a Strong Laser Field by an Electron Wave Packet**, Justin Peatross<sup>1</sup>, John Corson<sup>1</sup>, Eric Cunningham<sup>1</sup>, Michael Ware<sup>1</sup>, Scott Glasgow<sup>1</sup>; *Physics and Astronomy, Brigham Young University, USA*. Quantum electrodynamics indicates that an electron scatters light independent of its wave-packet size, even when larger than the stimulating wavelength. We highlight this theoretical conclusion and give a progress report on experimental validation.

LWF3 • 11:15 **Invited**

**High-Harmonic Generation: From Microscopic to Macroscopic World**, Anh-Thu Le<sup>1</sup>, Cheng Jin<sup>1</sup>, Robert Lucchese<sup>2</sup>, Chii-Dong Lin<sup>3</sup>; *1*Physics, Kansas State University, USA; *2*Chemistry, Texas A&M University, USA. Simulations, which combine accurate single molecule response with macroscopic propagation of harmonic field, compare very well with current experiments. This provides foundation for ultrafast imaging of chemical processes with few-cycle laser pulses.

### FWH • Special Symposium of 50 Years of Measuring the Eye's Aberrations II—Continued

FWH3 • 11:30 **Invited**

**Understanding the Normal and Diseased Retina Using Adaptive Optics Imaging**, Joseph Carroll; *Medical College of Wisconsin, USA*. Over the past 15 years, we have seen an explosion in the clinical applications of adaptive optics retinal imaging. Here I review some of these applications, with an emphasis on photoreceptor pathology.

### FWI • Electron Dynamics in Intense Fields—Continued

FWI3 • 11:30 **▶**

**Tunable Laser-Driven Electron Acceleration via Shock Front Injection**, Alexander Buck<sup>1,2</sup>, Johannes Wenz<sup>1,2</sup>, Karl Schmid<sup>1,2</sup>, Julia Mikhailova<sup>1</sup>, Jiancai Xu<sup>1</sup>, Konstantin Khrennikov<sup>1</sup>, Matthias Heigoldt<sup>1</sup>, Ferenc Krausz<sup>1,2</sup>, Stefan Karsch<sup>1,2</sup>, Laszlo Veisz<sup>1</sup>; <sup>1</sup>*Max Planck Institute of Quantum Optics, Germany*; <sup>2</sup>*Ludwig-Maximilians-Universität, Germany*. Stable, relativistic electron beams with up to 100 pC peak charge have been accelerated via injection into wakefields at a sharp density transition. The energy of the accelerator was tunable between 10 and 150 MeV.

FWI4 • 11:45 **▶**

**Ultrafast X-ray Absorption Spectroscopy of Isochorically Heated Copper Plasmas at Solid Density**, Byoung-ick Cho<sup>1</sup>, Kyle Engelhorn<sup>1</sup>, Alfredo A. Correa<sup>2</sup>, Tadashi Ogitsu<sup>2</sup>, Roger W. Falcone<sup>1,3</sup>, Philip A. Heimann<sup>1</sup>; <sup>1</sup>*Advanced Light Source, Lawrence Berkeley Natl Lab, USA*; <sup>2</sup>*Lawrence Livermore National Laboratory, USA*; <sup>3</sup>*Physics Department, University of California, USA*. Using ultrafast x-ray technique, we observed the changes of electronic structure of isochorically heated copper. It allows us to determine electron temperature at a few eV regimes and investigate thermo-physical properties of solid-density plasmas.

### FWJ • Digital Holographic Interferometry and Microscopy II—Continued

FWJ4 • 11:30

**Fabrication and Testing of Computer-Generated Volume Holograms in the Terahertz**, Wei-Ren Ng<sup>1</sup>, Phillip Poon<sup>1</sup>, Dathon Golish<sup>1</sup>, Hao Xin<sup>1</sup>, Michael Gehm<sup>1</sup>; <sup>1</sup>*University of Arizona, USA*. Advances in rapid prototyping technology have allowed for successful fabrication of terahertz computer-generated volume holograms. We report on our progress in the design, fabrication, and measurement of our first successful holograms.

FWJ5 • 11:45

**Measuring Complex Pulses in a Single Shot Using Crossed-Beam Spectral Interferometry and a Reference Pulse with Massive Pulse Front Tilt**, Jacob Cohen<sup>1</sup>, Pamela Bowlan<sup>1</sup>, Vikrant Chauhan<sup>1</sup>, Peter M. Vaughan<sup>1</sup>, Rick Trebino<sup>1</sup>; <sup>1</sup>*Physics, Georgia Institute of Technology, USA*. We use a reference pulse with massive pulse front tilt in crossed-beam spectral interferometry to measure extremely complex pulses, much longer than possible in traditional spectral interferometry.

### FWK • Beam Shaping and Propagation, Laser Cavity Design II—Continued

FWK4 • 11:30

**Giant Goos-Hanchen Shift Enhancement under Total Internal Reflection by One-Dimensional Photonic Crystals**, Yuhang Wan<sup>1</sup>, Zheng Zheng<sup>1</sup>, Weijing Kong<sup>1</sup>; <sup>1</sup>*School of Electronic and Information Engineering, Beihang University, China*. Giant Goos-Hanchen shifts are experimentally demonstrated from a prism-coupled one-dimensional photonic crystal beyond the critical angle. Lossless reflection with such large GH shifts could enable many interesting applications.

FWK5 • 11:45

**A Dual Wavelength Ti:Sapphire Laser Using a Ramp-Hold-Fire Seeding Technique for Resonance Ionization of Rb87**, Thomas Moore<sup>1</sup>, F. Scott Anderson<sup>1</sup>; <sup>1</sup>*Southwest Research Institute, USA*. We present a novel dual wavelength ring laser for selective ionization of Rb87 atoms. The design incorporates a Ramp-Hold-Fire technique for generating 15ns Fourier transform limited pulses immune to noise within the acoustic range.

### FWL • Bioplasmonics—Continued

FWL3 • 11:30 **▶**

**Ultrasensitive Label Free Biosensors Enables Seeing Protein Monolayers with The Naked Eye**, Ahmet A. Yanik<sup>1,2</sup>, Arif E. Cetin<sup>1,2</sup>, Min A. Huang<sup>1,2</sup>, Alp A. Artar<sup>1,2</sup>, Hossein Mousavi<sup>3</sup>, Alexander Khanikaev<sup>3</sup>, John H. Connor<sup>4</sup>, Gennady Shvets<sup>3</sup>, Hatice Altug<sup>1,2</sup>; <sup>1</sup>*Electrical and Computer Engineering, Boston Univ, USA*; <sup>2</sup>*Photonics Center, Boston University, USA*; <sup>3</sup>*Department of Physics, The University of Texas, USA*; <sup>4</sup>*Department of Microbiology, Boston University, USA*. By exploiting plasmonic sub-radiant dark modes, we demonstrate ultrasensitive biosensors with record high figure of merits (FOM=162). We also show direct detection of single monolayers of proteins with naked eye using associated Fano resonances.

FWL4 • 11:45 **▶**

**Controlled Synthesis of Gold Nanorods and Application to Brain Tumor Delineation**, Kevin Seekell<sup>1</sup>, Christy Wilson<sup>2</sup>, Hillel Price<sup>1</sup>, Gerald Grant<sup>3</sup>, Adam Wax<sup>1</sup>; <sup>1</sup>*BME, Duke University, USA*; <sup>2</sup>*Neurosurgery, Pediatric Division, Duke University, USA*. Gold nanorods are candidates for tumor delineation due to their unique optical properties and biocompatibility. The extinction characteristics of nanorods are tuned during synthesis. Anti-EGFR nanorods effectively label tumors within brain slices.

FWL5 • 12:00 **▶**

**Fluorescent Dye and OLED Based Plasmonic Dark Field Microscopy**, Feifei Wei<sup>1</sup>, Yin Wan O<sup>2</sup>, Houdong Hu<sup>1</sup>, Guixin Li<sup>2</sup>, Kok Wai Cheah<sup>2</sup>, Zhaowei Liu<sup>1</sup>; <sup>1</sup>*Department of Electrical and Computer Engineering, University of California, San Diego, USA*; <sup>2</sup>*Department of Physics, Hong Kong Baptist University, Hong Kong*. We proposed a compact, low-cost and alignment-free plasmonic dark field microscopy and demonstrated its high contrast imaging capability through utilizing chip-scale integrated plasmonic structures to substitute for conventional condenser optics.



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 Unopposed Exhibit-Only Time, Imperial Ballroom, Fairmont Hotel

**FiO**

**LS**


**FWM • Order, Disorder and Symmetry in Photonic Structures II—Continued**

**FWN • Information Theory in Optics II: Quantum Information Theory—Continued**


**LWD • Optical Metamaterial Device Physics—Continued**

**LWE • Optics and Alternative Energy Sources II—Continued**

**LWF • Attosecond and Strong Field Science III—Continued**

**FWM4 • 11:30** 

**Defect-induced Whispering-Gallery-Mode Resonances in Optical Micro-disk Resonators**, Lev I. Deych<sup>1</sup>, Yasha Yi<sup>2,3</sup>, Michel Ostrowski<sup>3,4</sup>, <sup>1</sup>Physics, Queens College of CUNY, USA; <sup>2</sup>Physics, College of Staten Island of CUNY, USA; <sup>3</sup>New York University, USA; <sup>4</sup>Massachusetts Institute of Technology, USA. We predict and confirm experimentally that, contrary to accepted models, interaction between whispering-gallery-modes of microdisks and small particles yields a double-peak response with both peaks red-shifted from initial single-disk resonance.

**FWM5 • 11:45** 

**Random Lasing in Low Molecular Weight Organic Thin Films**, Stephane Kena-Cohen<sup>1</sup>, Paul N. Stavrinou<sup>1</sup>, Donal D. C. Bradley<sup>1</sup>, Stefan A. Maier<sup>1</sup>, <sup>1</sup>Physics, Imperial College London, United Kingdom. Random lasing is observed in guest-host thermally evaporated organic thin films well within the quasi-ballistic regime. Our results and their implications for previous conventional laser demonstrations using this material system are discussed.

**LWD3 • 11:30** **Invited**

**Affine Transformational Optics**, G. Barbastathis<sup>1,2</sup>; B. Zhang<sup>3</sup>; H. Xu<sup>4</sup>; H. Gao<sup>5</sup>; Y. Luo<sup>6</sup>; H. Sun<sup>7</sup>; C. Qiu<sup>8</sup>; T. Han<sup>9</sup>; <sup>1</sup>Department of Mechanical Engineering, Massachusetts Institute of Technology, USA, <sup>2</sup>Singapore-MIT Alliance for Research and Technology (SMART) Centre, Singapore, <sup>3</sup>Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, USA, <sup>4</sup>School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore, <sup>5</sup>Department of Electrical and Computer Engineering, National University of Singapore, Singapore. We describe a class of devices whose refractive index distribution results from an affine transformation over piece-wise uniform space, including theoretical analysis and experimental realizations using anisotropic materials and surface nanopatterning.

**LWF4 • 11:45**

**Nondispersing Electron-Positron Wavepackets in the Circularly Polarized Electromagnetic and Parallel Static Electric and Magnetic Fields**, Matt Kalinski<sup>1</sup>, <sup>1</sup>Utah State University, USA. We show that the controlled Positronium trapping is possible around the charged nucleus in the twisted Langmuir configurations in the circularly polarized and the parallel electric and magnetic fields and the Helium ion field.



**12:00–13:30 Unopposed Exhibit-Only Time, Imperial Ballroom, Fairmont Hotel**

**Wednesday, 19 October**

12:00–13:30

## JWA • FIO/LS Joint Poster Session II

## JWA1

**Time Series Analysis of Ocular Wavefront Aberration**, Damber Thapa<sup>1</sup>, Abbas Ommani<sup>1</sup>, Vasudevan Lakshminarayanan<sup>1,2</sup>, <sup>1</sup>Optometry, University of Waterloo, Canada; <sup>2</sup>The Michigan Center for Theoretical Physics, University of Michigan, USA. Time series analysis of ocular wavefront aberration was performed. Autoregressive Integrative Moving Average (ARIMA) model can be fitted to the ocular wavefront aberrations; however, the model varies between individuals.

## JWA2

**Multilevel Image Enhancement for Image Processing**, Damber Thapa<sup>1</sup>, Vasudevan Lakshminarayanan<sup>1,2</sup>, <sup>1</sup>School of Optometry, University of Waterloo, Canada; <sup>2</sup>The Michigan Center for Theoretical Physics, University of Michigan, USA. A multilevel image enhancement technique is introduced that adds some image details in each level of enhancement. This technique shows very interesting results and can be used for image enhancement and features extraction.

## JWA3

**Polarization Modulated Ultrafast Pulse-Pair Control in Two-Photon Fluorescence Laser Scanning Microscopy**, Debjit Roy<sup>1</sup>, Arijit K. De<sup>1</sup>, Debabrata Goswami<sup>1</sup>, <sup>1</sup>Chemistry, Indian Institute of Technology Kanpur, India. Selective fluorescence suppression for two spectrally overlapping fluorophores that undergo simultaneous two-photon absorption from identical femtosecond pulses through precise control in relative timing and polarization of the exciting pulse-pair.

## JWA4

**Real-time Generation of Synthetic Diffractive Structures Using GPU**, Martin Nývlt<sup>1</sup>, Marek Skeren<sup>1</sup>, Pavel Fiala<sup>1</sup>, <sup>1</sup>Dept. of Physical Electronics, FNSPE, Czech Technical University in Prague, Czech Republic. Formerly, the applications of the holographic optical tweezers were limited by the speed of the algorithm used for design of the diffractive structures. Nowadays algorithm can run on the GPU, which enables new design possibilities.

## JWA5

**Cystovirus  $\phi 6$  Structure Probed by Stokes Shift Fluorescence Spectroscopy**, A. Katz<sup>1</sup>, Garrett Katz<sup>2</sup>, Alexandra Alimova<sup>3</sup>, Hui Wei<sup>3</sup>, Paul Gottlieb<sup>3</sup>, <sup>1</sup>Physics Dept., City College of New York, USA; <sup>2</sup>Mathematics, City College of New York, USA; <sup>3</sup>Sophie Davis School of Biomedical Education, City College of New York, USA. Fluorescence Stokes shift measurements of tryptophan in bacteriophage  $\phi 6$  were used to determine solvent exposure. It is determined that the envelope proteins are in a more hydrophobic environment than internal proteins of the polymerase complex.

## JWA6

**Diffraction signature of bacteria colonies and the influence of different incubation conditions**, Igor Buzalewicz<sup>1</sup>, Alina Wieliczka<sup>1</sup>, Karolina J. Bednarek<sup>2</sup>, Halina Podbielska<sup>1</sup>, <sup>1</sup>Institute of Biomedical Engineering and Instrumentation, Wrocław University of Technology, Poland; <sup>2</sup>Department of Epizootiology and Veterinary Administration with Clinic of Infectious Diseases, Wrocław University of Environmental and Life Science, Poland. The optical system with converging spherical wave illumination is proposed for bacteria colony diffraction pattern analysis to distinguish bacteria species. The influence of the bacteria growth conditions on diffraction pattern is investigated.

## JWA7

**Momentum of Light Scattered from Collections of Particles**, Zhisong Tong<sup>1</sup>, Olga Korotkova<sup>1</sup>, <sup>1</sup>Physics, University of Miami, USA. The angular dependence of the momentum flow in a polychromatic plane wave scattered from deterministic and random collections of particles is determined as a function of individual and collective properties of particles.

## JWA8

**Microscopy and Spectroscopy on a Cell Phone**, Zachary J. Smith<sup>1</sup>, Kaiqin Chu<sup>1</sup>, Sebastian Wachsmann-Hogiu<sup>1,2</sup>, Stephen Lane<sup>1</sup>, Denis Dwyre<sup>2</sup>, Dennis Matthews<sup>1</sup>, <sup>1</sup>Center for Biophotonics, UC Davis, USA; <sup>2</sup>Department of Pathology, University of California, Davis, USA. We have developed two attachments that transform a cell phone's camera into either a microscope with 1.5 micron resolution or a spectrometer with a 5 nm spectral resolution. We show applications to medically relevant problems.

## JWA9

**Silver Nanoparticles in Biomedical Application**, Valentin Smytyn<sup>1</sup>, Valentina Skobeeva<sup>1</sup>, <sup>1</sup>Experimental Physics, Odessa I.I. Mechnikov National University, Ukraine. The synthesis of silver NP with surface plasmon resonance was investigated. A quenching SPR band by adding penicillin was found. This fact can be used for sensor application.

## JWA10

**The influence of manganese on light scattering properties of Desulfuromonas acetoxidans bacteria in the process of their growth**, Oresta M. Vasylyv<sup>1</sup>, Olexandr I. Bilyy<sup>2</sup>, Svitlana O. Hnatysh<sup>1</sup>, <sup>1</sup>Microbiology, Ivan Franko National University of Lviv, Ukraine; <sup>2</sup>Physical and Biomedical Electronics, Ivan Franko National University of Lviv, Ukraine. Size distribution changes and cell relative content of Desulfuromonas acetoxidans sulfurbacteria in the chosen interval of sizes under the influence of MnCl<sub>2</sub>·4H<sub>2</sub>O during five days of cultivation have been investigated by the new method.

## JWA11

**Measurements of toxic heavy metals in liquid samples using Single Pulse and Double Pulse Laser-Induced Breakdown Spectroscopy**, Pavel Porizka<sup>1</sup>, <sup>1</sup>Brno University of Technology, Czech Republic. New apparatus for SP and DP LIBS of liquids has been constructed. LIBS measurements are focused on the detection of trace amounts of heavy metals (Pb, Cu) in liquid solutions, especially with emphasis to algae solutions measurements.

## JWA12

**Real-time Measurement of the Thickness of Soap Films with the Polarimetric Interferometer**, Shuichi Kawabata<sup>1</sup>, <sup>1</sup>Physics, Tokyo Polytechnic University, Japan. A new type of the polarimetric interferometer is introduced. It consists of the Mach-Zehnder interferometer and the polarimeter as the polarization detector. The critical thickness of soap films were measured with the polarimetric interferometer.

## JWA13

See JTU43

## JWA14

**Radiation Effects in YAG:Ce Single Crystals**, Tatyana Butaeva<sup>1</sup>, Ashot Petrosyan<sup>1</sup>, Ira Gambaryan<sup>1</sup>, Alla Vardanyan<sup>2</sup>, Mkrtych Mkrtychyan<sup>3</sup>, Christian Pedrini<sup>4</sup>, Christophe Dujardin<sup>4</sup>, <sup>1</sup>Laboratory of the Crystal Growth of Luminescence Materials, Institute for Physical Research, NAS of Armenia., Armenia; <sup>2</sup>Russian-Armenian (Slavonic) University, Armenia; <sup>3</sup>National Scientific Laboratory, Armenia; <sup>4</sup>Université de Lyon, Université Lyon 1, CNRS, UMR5620, Laboratoire de Physico-Chimie des Matériaux Luminescents., France. Characterization of spectral effects induced by  $\gamma$ -rays in YAG:Ce single crystals grown by the vertical Bridgman method is done. The influence of Ce<sup>3+</sup> ion concentration upon the radiation hardness is shown.

## JWA15

**Manipulation and observation of Ag photodoping patterns in GeS<sub>2</sub> amorphous films by a dual functional laser scanning microfabrication/microscope system**, Moriaki Wakaki<sup>1</sup>, Yoshikazu Kanai<sup>1,3</sup>, Yoshihisa Murakami<sup>1,2</sup>, Norihide Takeyama<sup>3</sup>, <sup>1</sup>Tokai University, Japan; <sup>2</sup>Tsukuba University of Technology, Japan; <sup>3</sup>Genesis Co., Japan. A dual functional laser scanning system integrating micro-machining and micro-scope systems is proposed and fabricated. As a typical photonic pattern, diffraction gratings of Ag/GeS<sub>2</sub> were fabricated and optical performances were evaluated.

## JWA16

**Coherence and polarization control by means of 90-twist nematic liquid-crystal spatial light modulators (NLC-SLM)**, Carolina Rickenstoff<sup>1</sup>, Elias Flores<sup>1</sup>, Andrey Ostrovky<sup>1</sup>, <sup>1</sup>Autonomous University of Puebla, Mexico. A technique for modulating the coherence and polarization of the electromagnetic beam is developed. Such technique uses two 90-twist nematic liquid crystal spatial light modulators arranged in an interferometric setup.

## JWA17

**Wavefront sensor for short-pulse lasers based on second-harmonic generation**, Rocio Borrego Varillas<sup>1</sup>, Carolina Romero<sup>1</sup>, Javier R. Vazquez de Aldana<sup>1</sup>, Juan M. Bueno<sup>2</sup>, Luis Roso<sup>3</sup>, <sup>1</sup>Física Aplicada, Universidad de Salamanca, Spain; <sup>2</sup>Laboratorio de Óptica, Universidad de Murcia, Spain; <sup>3</sup>Centro de Láseres Pulsados (CLPU), Spain. We report a novel technique for wavefront sensing of intense femtosecond lasers based on the angle dependence of second-harmonic generation. Results are compared with those obtained by a commercial sensor and supported by numerical simulations.

## JWA18

**Super-Hydrophobic and Wide-Angle, Anti-Reflective Infrared Films**, Kelly C. Camargo<sup>1</sup>, Alexandre F. Michels<sup>2,1</sup>, Fabiano S. Rodembusch<sup>3</sup>, Flavio Horowitz<sup>1</sup>, <sup>1</sup>Institute of Physics, UFRGS, Brazil; <sup>2</sup>Centro de Ciências Exatas, da Natureza e de Tecnologia, Universidade de Caxias do Sul, Brazil; <sup>3</sup>Instituto de Química, Universidade Federal do Rio Grande do Sul, Brazil. Simultaneous anti-reflective and superhydrophobic properties on glass are pursued by combination of multi-scale surface topology and interference coating with silica aerogel.

## JWA19

**Gas-fusion Mirrors for Atmospheric Lidar**, Shane D. Mayor<sup>1</sup>, Anna Petrova-Mayor<sup>1</sup>, Richard W. Wortley<sup>2</sup>, Daniel S. Hofstadter<sup>3</sup>, Scott M. Spuler<sup>4</sup>, Jim Ranson<sup>4</sup>, <sup>1</sup>Physics, California State University Chico, USA; <sup>2</sup>Hextek Corp., USA; <sup>3</sup>Hofstadter Analytical Services, LLC, USA; <sup>4</sup>National Center for Atmospheric Research, USA. Design analysis and test results of two 610 × 432 × 57 mm (24 × 17 × 2.25 in) light-weighted octagonal mirrors and a mounting system for a scanning 1.54-micron wavelength elastic backscatter lidar will be presented.

## JWA20

**Defected core tellurite/phosphate composite microstructured optical fiber with four zero dispersion wavelengths**, Xin Yan<sup>1</sup>, Meisong Liao<sup>1</sup>, Tong Hoang Yuan<sup>1</sup>, Takenobu Suzuki<sup>1</sup>, Yasutake Ohishi<sup>1</sup>, <sup>1</sup>Toyota technological institute, Japan. We propose a defected core tellurite/phosphate composite microstructured fiber with four zero dispersion points which creates a rich phase-matching topology. The great enhanced flexibility in the positioning has applications in four wave mixing.

## JWA21

**Production of copper nanoparticles by femtosecond laser micromachining in borosilicate glass**, Juliana M. Almeida<sup>1</sup>, Leonardo D. Boni<sup>1</sup>, Marcos R. Cardoso<sup>1</sup>, Antonio C. Hernandez<sup>1</sup>, Cleber R. Mendonça<sup>1</sup>, <sup>1</sup>Institute of Physics at São Carlos, University of São Paulo, Brazil. Femtosecond laser pulses were used to induce the precipitation of copper nanoparticles into three-dimensionally well-defined regions of borosilicate glass. Such results open new perspectives for the development of new photonic devices.

## JWA • FIO/LS Joint Poster Session II—Continued

**JWA22**

**Efficient pulse sequence generation with positive and negative chirp**, Chao-Kuei Lee<sup>1</sup>; <sup>1</sup>NSYSU, Department of Photonics, Taiwan. Efficient pulse sequence generation of not only negative but also positive chirp pulse sequences is reported using pulse shaping technique. More flexibility for coherent control applications through this changeable sign of chirp is also discussed.

**JWA23**

**Image-based wavefront sensing and calibration of a deformable mirror in remote sensing adaptive optics**, Norihide Miyamura<sup>1</sup>; <sup>1</sup>The University of Tokyo, Japan. A wavefront aberration and calibration parameters of deformable mirror (DM) are estimated simultaneously. We constructed the AOS for laboratory test, and proved that the modulated wavefront by DM almost consists with the ideal one.

**JWA24**

**Multispectral Method for Air Tract Influence Attenuation**, Andrey G. Anisimov<sup>1</sup>, Sergey N. Yarishev<sup>1</sup>, Alexander N. Timofeev<sup>1</sup>, Oleg Lashmanov<sup>1</sup>, Valery V. Korotaev<sup>1</sup>; <sup>1</sup>Optical-Electronic Devices and Systems, St. Petersburg State Univ. of Information Technologies, Mechanics and Optics, Russian Federation. Multispectral method for air tract influence attenuation on basis of color detector with Bayer filter is introduced. The difference in position of target image in different colors allows compensating the air tract refraction.

**JWA25**

**Influence of oxygen pressure variations on the optical properties of ion beam sputtered metal oxide coatings**, Peter Langston<sup>1,2</sup>; <sup>1</sup>ECE, Colorado State University, USA; <sup>2</sup>Applied Physics, Stanford University, USA. Small variations of oxygen partial pressure during the ion beam sputtering of metal oxides strongly influence the optical properties, causing an increase in the absorption loss and a decrease in laser damage fluence.

**JWA26**

**Damage Testing of Critical Optical Components for High Power Ultra Fast Lasers**, Patrick Poole<sup>1</sup>; <sup>1</sup>The Ohio State University, USA. Damage fluence of several optics is studied in air and low vacuum using a 25 fs ultra-fast laser, including broadband dielectric mirrors and pulse-compression reflection gratings with gold and silver coating with varying processing conditions.

**JWA27**

**Effect of coherence and polarization on resolution of optical imaging**, Paulo Romero Soria<sup>1</sup>, Miguel Angel Olvera<sup>1</sup>, Andrey Ostrovky<sup>1</sup>; <sup>1</sup>BUAP, Mexico. The results of the effect of coherence properties of illumination on optical imaging, well known in a scalar case, are generalized for the case of vector electromagnetic illumination.

**JWA28**

**Near-field optical imaging of plasmonic devices using heterodyne optical feedback on Er doped DFB fiber laser**, Matthieu Roblin<sup>1</sup>, Sylvain Girard<sup>1</sup>, Hervé Gilles<sup>1</sup>, Mathieu Laroche<sup>1</sup>, Julien Cardin<sup>1</sup>, Christian Dufour<sup>1</sup>, Ulrike Luders<sup>2</sup>; <sup>1</sup>CIMAP, France; <sup>2</sup>CRISMAT, France. Near field Scanning Optical Microscopy using heterodyne optical feedback on Er-doped DFB fiber laser at 1.55 $\mu$ m is investigated for optical characterizations of plasmonic waveguides. The experimental results are compared with FDTD numerical models.

**JWA29**

**Fast All Optical NAND Gate Using Coherent Control of the Linear Susceptibility of Five Level Atoms**, Steven A. Sagona-Stophe<sup>1</sup>, Christopher Search<sup>1</sup>; <sup>1</sup>Physics, Stevens Institute of Technology, USA. We present a 5-level atomic configuration functioning as an optical NAND logic gate with the linear absorption of a probe laser as the gate output. Implementation in alkali atomic vapors and optical fibers is discussed.

**JWA30**

**Experimental Observation of Broadband Extraordinary Transmission at the Plasmonic Brewster Angle in Metallic Gratings**, Mark Bloemer<sup>1</sup>, N. Akozbek<sup>2</sup>, R. Trimm<sup>3</sup>, G. D'Aguzzo<sup>3</sup>, N. Mattiucci<sup>2</sup>; <sup>1</sup>AMRDEC, USA; <sup>2</sup>AEGIS Technologies, USA; <sup>3</sup>Miltec, USA. Extraordinary transmission through thick gratings results from resonances inside the apertures and is narrowband. We report observation of extremely broadband transmission through thick gratings at angles of incidence related to a Brewster angle.

**JWA31**

**Chains of metallic nanoparticles embedded in a gain medium as ideal plasmonic waveguides**, Indika B. Udagedara<sup>1</sup>, Ivan D. Rukhlenko<sup>1</sup>, Malin Premaratne<sup>1</sup>; <sup>1</sup>Department of Electrical and Computer Systems Engineering, Monash University, Australia. Gain-assisted propagation of surface plasmon-polaritons along chains of metallic nanoparticles is studied with the coupled-dipole method, the validity of which is justified using finite-difference time-domain (FDTD) simulations.

**JWA32**

**Gold Nanosphere Coated Microtoroid Resonators**, Ce Shi<sup>1</sup>, Hong-Seok Choi<sup>1</sup>, Andrea Armani<sup>1,2</sup>; <sup>1</sup>Mork Family Department of Chemical Engineering and Materials Science, USC, USA; <sup>2</sup>Ming Hsieh Department of Electrical Engineering-Electrophysics, USC, USA. Gold nanoparticles are coated on the surface of microtoroid whispering gallery mode resonators. Quality factors greater than 5 million are demonstrated, even with strong overlap between the optical field and the nanoparticles.

**JWA33**

**Polarization-Encoded Terahertz-Optical-Asymmetric-Demultiplexer (TOAD)-Based All-Optical Multi-Valued Arithmetic Units**, Abdallah A. Cherri<sup>1</sup>; <sup>1</sup>Electrical Engineering, Kuwait University, Kuwait. Multi-valued arithmetic circuits are presented where TOADs are used as switches due to their compact size, thermal stability, and low power operation. Ternary/quaternary signed-digit numbers are represented using different polarized states of light.

**JWA34**

**Numerical analysis of Soliton Propagation in Highly Nonlinear Photonic Crystal Fiber**, Bhawana Dabas<sup>1</sup>, Monika Rajput<sup>1</sup>, Jivesh Kaushal<sup>1</sup>, Ravindra K. Sinha<sup>1</sup>; <sup>1</sup>Delhi Technological University, India. In this paper soliton pulse generation, soliton collision and Cross Phase modulation in chalcogenide As<sub>2</sub>Se<sub>3</sub> glass Photonic Crystal Fiber is numerically studied using Fourth-Order Runge-Kutta in the Interaction Picture method.

**JWA35**

**Imaging for blue light**, Monika Rajput<sup>1</sup>, Bhawana Dabas<sup>1</sup>, Swati Rawal<sup>1</sup>, Ravindra K. Sinha<sup>1</sup>; <sup>1</sup>Delhi Technological University, India. Design of left-handed plasmonic lens is presented for focusing of blue light using dispersion engineering and numerical analysis. Values of permeability and permittivity calculated by applying discrete dipole approximation.

**JWA36**

**Slow Light Nonlinear Photonic Crystal Channel Waveguide as an All-Optical Switch**, Swati Rawal<sup>1</sup>, Monika Rajput<sup>1</sup>, Ravindra K. Sinha<sup>1</sup>; <sup>1</sup>Delhi Technological University, India. The effect of slow light on nonlinear effects in photonic crystal and increased induced phase shift produced by lower group velocities is used to decrease the size and power requirements needed to operate optical switches

**JWA37**

**Analysis of subwavelength-patterned plasmonic structures with approximate models**, Jan Fiala<sup>1</sup>, Pavel Kwiecien<sup>1</sup>, Milan Sinor<sup>1</sup>, Ivan Richter<sup>1</sup>; <sup>1</sup>Physical Electronics, Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Czech Republic. Using approximate analytical models, supported with rigorous comparison, the interaction of optical waves with various classes of plasmonic sub-wavelength-patterned structures, including nanoaperture arrays and layered structures, is studied.

**JWA38**

**Compact deep-subwavelength Bragg grating based on hybrid plasmonic slot waveguide**, Xiao Jing<sup>1</sup>, Jiansheng Liu<sup>1</sup>, Zheng Zheng<sup>1</sup>, Yusheng Bian<sup>1</sup>, Guanjun Wang<sup>1</sup>, Kenk Chin<sup>2</sup>; <sup>1</sup>School of Electronic and Information Engineering, Beihang University, China; <sup>2</sup>Department of Physics, New Jersey Institute of Technology, USA. An ultra-compact and broad-band Bragg grating based on HPSW is presented which shows the capability of efficient wavelength selection near the telecom bandwidths. It will have a potential application in the broad-band telecommunications systems.

**JWA39**

**Plasmonic Nanoslit Enhanced Metal-Semiconductor-Metal Photodetectors**, Sukru Burc Eryilmaz<sup>1,2</sup>, Ali K. Okyay<sup>1,2</sup>; <sup>1</sup>Department of Electrical and Electronics Engineering, Bilkent University, Turkey; <sup>2</sup>UNAM-Institute of Materials Science and Nanotechnology, Bilkent University, Turkey. We computationally show that metallic nanoslits integrated on Germanium metal-semiconductor-metal photodetectors show absorption enhancement up to 8 $\times$  for TM-polarization in the communications C-band due to interference of horizontal surface plasmons.

**JWA40**

**Highly confined surface plasmon polariton modes guided by triangular (V-shape) metal/dielectric grooves at 1550nm**, Yusheng Bian<sup>1</sup>, Zheng Zheng<sup>1</sup>, Ya Liu<sup>1</sup>, Jiansheng Liu<sup>1</sup>, Jinsong Zhu<sup>1</sup>, Tao Zhou<sup>1</sup>; <sup>1</sup>School of Electronic and Information Engineering, Beihang University, China; <sup>2</sup>National Center for Nanoscience and Technology of China, China; <sup>3</sup>Department of Physics, New Jersey Institute of Technology, USA. Novel types of plasmonic waveguides based on hybrid metal/dielectric grooves have been proposed. It is shown that they could support highly confined plasmonic modes in a V-shape channel region with moderate propagation length.

**JWA41**

**Modeling of plasmonic nanostructures using efficient three dimensional aperiodic rigorous coupled wave analysis**, Pavel Kwiecien<sup>1</sup>, Ivan Richter<sup>1</sup>; <sup>1</sup>Physical Electronics, Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Czech Republic. Three dimensional aperiodic rigorous coupled wave analysis is applied as the efficient and robust numerical frequency domain simulation tool for modeling both modal and light propagation characteristics of 3D subwavelength plasmonic nanostructures.

**JWA42**

**Properties of 1D soliton-plasmon interactions**, Miguel A. Fuentes-Fuentes<sup>1</sup>, Gisela López-Galmiche<sup>1</sup>, Abraham Vázquez-Guardado<sup>1</sup>, Adalberto Alejo-Molina<sup>1</sup>, José J. Sánchez-Mondragón<sup>1</sup>, Albert Ferrando<sup>3,2</sup>, Carles Millán<sup>2</sup>; <sup>1</sup>Optica, INAOE, Mexico; <sup>2</sup>Interdisciplinary Modeling Group (Intertech), Universidad Politécnica de Valencia, Spain; <sup>3</sup>Departamento de Óptica, Universidad de Valencia, Spain. We present the modeling of soliton-plasmon interactions at a metal/Kerr interface, we found two kinds of stationary solutions called odd and even modes, and odd modes are more stable than even modes at strong coupling.

13:30–15:15

**FWO • Looking into the Eyes of Animal Models of Disease** ▶David Williams, Univ. of Rochester, USA, *Presider*FW01 • 13:30 **Invited** ▶

The Guinea Pig as a Model of Myopia, Sally McFadden; Univ. of Newcastle, Australia. Abstract not available.

FW02 • 14:00 ▶

A High-Stroke Ferrofluid Mirror for the Correction of Small Animal Models of Eye Disease, Melanie Campbell<sup>1,2</sup>, Denis Drouseau<sup>2</sup>, Mark Bird<sup>1</sup>, Ermanno Borra<sup>3</sup>, Anna M. Ritcey<sup>4</sup>, Simon Thibault<sup>3</sup>; <sup>1</sup>Physics and Astronomy and School of Optometry, University of Waterloo, Canada; <sup>2</sup>Guelph Waterloo Physics Institute, Canada; <sup>3</sup>Département de physique, génie physique et optique, COPL, Université Laval, Canada; <sup>4</sup>Département de chimie, CERSIM et COPL, Université Laval, Canada. We show that a novel ferrofluid mirror used as an inexpensive adaptive optics element can correct the aberrations of the eyes of animals used as disease models and normal and abnormal human eyes.

13:30–15:30

**FWP • High Fields and Plasmas** ▶T. Cowan; FZ Dresden-Rossendorf, Germany, *Presider*

FWP1 • 13:30 ▶

Application of a Multi-Terawatt 3ps CO2 Laser for Monoenergetic Proton Beam Generation, Dan Haberberger<sup>1</sup>, Sergei Tochitsky<sup>1</sup>, Chao Gong<sup>1</sup>, Chan Joshi<sup>1</sup>; <sup>1</sup>Electrical Engineering, UCLA, USA. 15TW picosecond 10 $\mu$ m laser pulses are obtained at the UCLA Neptune laboratory achieving record CO2 laser power. This laser system is applied for laser driven ion acceleration achieving 20 MeV proton beams from a H2 gas jet.

FWP2 • 13:45 ▶

Development of a 0.5 PW High Contrast Ti:Sapphire Laser System At OSU to Achieve Peak Focal Intensities Exceeding 1022 W/cm<sup>2</sup>, Patrick Poole<sup>1</sup>, Christopher Willis<sup>1</sup>, Rebecca Daskalova<sup>1</sup>, Sheng Jiang<sup>1</sup>, Douglas Wertepny<sup>1</sup>, Linn Van Woerkom<sup>1</sup>, Richard Freeman<sup>1</sup>, Enam Chowdhury<sup>1</sup>; <sup>1</sup>Physics, The Ohio State University, USA. A 0.5 PW 15 J/pulse, 30 fs, 1 shot/min, Ti:Sapphire based high pulse contrast laser system is being constructed at OSU. The laser peak intensity will be measured with a proton acceleration based technic.

FWP3 • 14:00 **Invited** ▶

Ultra- High Pulse Intensity Amplification and Compression In Plasma, Anatoli Morozov<sup>1</sup>, Shuanglei Li<sup>1</sup>, David Turnbull<sup>1</sup>, Szymon Suckewer<sup>1</sup>; <sup>1</sup>MAE, Princeton University, USA. This talk provides the summary of experimental research at Princeton on Raman Backscattering (RBS) amplification and compression in plasma [1]. The main subject of the talk is about obtaining high efficiency of such system [2,3].

13:30–15:15

**FWQ • Plasmonics**

Presider to Be Announced

FWQ1 • 13:30 **Invited**

Lensless Microscopy and Sensing on a Chip, Aydogan Ozcan<sup>1</sup>; <sup>1</sup>Electrical Engineering Department, UCLA, USA. We review our recent progress on computational lensfree on-chip microscopy and sensing approaches for high-throughput biomedical imaging and screening applications in field settings.

FWQ2 • 14:00

Design Considerations of a SPR Sensor, Saurabh M. Tripathi<sup>1,2</sup>, Arun Kumar<sup>1</sup>, Predrag Mikulic<sup>2</sup>, Wojtek Bock<sup>2</sup>; <sup>1</sup>Photonics Research Center, Université du Québec en Outaouais, Canada; <sup>2</sup>Department of Physics, Indian Institute of Technology Delhi, India. We examine the effect of longitudinal dimension on the sensitivity of SPR based sensors. It is found that for maximum sensitivity, the longitudinal dimension should be equal to the coupling length between the supermodes involved.

13:30–15:30

**FWR • Beam Shaping and Propagation, Laser Cavity Design III** ▶Olga Korotkova; University of Miami, USA, *Presider*FWR1 • 13:30 **Invited** ▶

Simple Models for Focused Fields, Miguel A. Alonso<sup>1</sup>; <sup>1</sup>The Institute of Optics, University of Rochester, USA. We discuss the use of nonparaxial orthonormal bases, which can be regarded as nonparaxial generalizations of Laguerre-Gaussian beams, to model strongly focused electromagnetic fields and their interaction with mesoscopic spherical particles.

FWR2 • 14:00 ▶

Airy Beams: the (1+1)D Non-Diffracting Bessel Beams, Héctor A. Jiménez-Romero<sup>1</sup>, Sabino Chavez-Cerda<sup>1,2</sup>; <sup>1</sup>Physics, ESEF-IPN, Mexico; <sup>2</sup>Optics, INAOE, Mexico. Propagation of Bessel and Airy beams are governed by different wave equations. However Airy functions are Bessel functions of fractional order, we show that Airy beams are better understood using the Bessel traveling wave approach.

13:30–15:30

**FWS • General Optical Design and Instrumentation I**Virendra Mahajan; Aerospace Corporation, USA, *Presider*

FWS1 • 13:30

Ultra-Low-Loss Optical Delay Line on a Silicon Chip, Tong Chen<sup>1</sup>, Hansuek Lee<sup>1</sup>, Jiang Li<sup>1</sup>, Oskar Painter<sup>1</sup>, Kerry J. Vahala<sup>1</sup>; <sup>1</sup>Applied Physics, California Institute of Technology, USA. Using a wet etch process, 7 meter long waveguides having optical loss of 0.3dB/m are demonstrated. Resonator measurements show that this loss value can be reduced to 0.03 dB/m.

FWS2 • 13:45

Ultra-High-Q Micro-Cavity on a Silicon Chip, Hansuek Lee<sup>1</sup>, Tong Chen<sup>1</sup>, Jiang Li<sup>1</sup>, Oskar Painter<sup>1</sup>, Kerry J. Vahala<sup>1</sup>; <sup>1</sup>Applied Physics, California Institute of Technology, USA. Optical resonators with quality factor as high as 750 million are demonstrated. These silicon-chip-based devices are fabricated without silica reflow, thereby expanding the range of integration opportunities and possible applications.

FWS3 • 14:00

Photonic Structures with Grating Couplers Based On Zinc Oxide, Przemyslaw P. Struk<sup>1</sup>, Tadeusz Pustelny<sup>1</sup>, Anna Piotrowska<sup>2</sup>, Michal Borysiewicz<sup>2</sup>, Marek Ekielski<sup>2</sup>, Krystyna Golaszewska<sup>2</sup>, Eliana Kaminska<sup>2</sup>; <sup>1</sup>Department of Optoelectronics, Silesian University of Technology, Poland; <sup>2</sup>Department of Micro- and Nanotechnology of Wide Bandgap Semiconductors, Institute of Electron Technology, Poland. The paper presents investigations concerning the numerical design and research of photonic structures with grating couplers based on wide band-gap oxide semiconductor - ZnO for input/output system and gas sensors structures applications.

## FIO

## LS


13:30–15:00

**FWT • Novel Sensors and Applications I** 

Curtis Menyuk; UMBC, USA, Presider

FWT1 • 13:30  

**New Class of Fiber Characterization Techniques Based on Spatial Gating of Nonlinearity**, Evgeny Myslivets; <sup>1</sup>Univ of California at San Diego, USA. We present a technique based on spatially controlled gating of the fiber nonlinearity. The proposed method is capable of characterizing spatial variations of zero dispersion wavelength (ZDW) in low-dispersive nonlinear fibers with meter-scale resolution.

FWT2 • 14:00 

**Enhanced Rotation Sensing in the Slow-light Resonator by a Tunable Add-drop Structure**, Yundong Zhang<sup>1,2</sup>; <sup>1</sup>National Key Laboratory of tunable laser Technology, Harbin Institute of Technology, China; <sup>2</sup>Institute of Opto-electronics, National Key Laboratory of Tunable Laser Technology, Harbin Institute of Technology, China. We propose an add-drop structure consisting of a dynamical tuning resonator to realize rotation sensing. The result predicts the realization of highly sensitive and compact integrated rotation sensors by using of the slow-light structures.

13:30–15:30

**FWU • Silicon Photonics**


Geert Morthier; Univ. of Gent, Belgium, Presider

FWU1 • 13:30

**Integration of Si/SiO<sub>2</sub> Multilayer GRIN Lens Optical Mode Size Converter to SOI-Based Waveguide**, TerHoe Loh<sup>1</sup>, Qian Wang<sup>1</sup>, Keh-Ting Ng<sup>1</sup>, Yi-Cheng Lai<sup>1</sup>, Seng-Tiong Ho<sup>2</sup>; <sup>1</sup>Nano-electronics-Photonics Integration, Data Storage Institute, Singapore; <sup>2</sup>Electrical Engineering and Computer Science, Northwestern University, USA. Vertical mode size conversion from 300nmthick Siwaveguide to 6to7um, coupling to singlemode fiber was demonstrated using CMOS-compatible onchip GRIN lens (length:1.5um). GRIN lens to fiber coupling loss of 2.9dB was achieved.

FWU2 • 13:45

**Guided-Mode Resonance Polarizers With 200-nm Bandwidth**, Kyu Lee<sup>1</sup>, James Curzan<sup>1</sup>, Mehrdad Shokooh-Saremi<sup>1</sup>, Robert Magnusson<sup>1</sup>; <sup>1</sup>Electrical Engineering, University of Texas at Arlington, USA. Design, fabrication and characterization of wideband guided-mode resonance polarizers with a single silicon layer are presented. The fabricated polarizer has an extinction ratio of ~670:1 at central wavelength  $\lambda_c = 1563$  nm.


FWU3 • 14:00 

**Optimizing Bandwidth Density and Power Efficiency with Silicon Photonic Interconnections**, Ashok V. Krishnamoorthy<sup>1</sup>; <sup>1</sup>Oracle Labs, Oracle, USA. We motivate the need for energy-efficient silicon-based optical interconnects to the chip and review recent progress in the development of ultra-low-power, high-density silicon photonic wavelength-division multiplexed link components.


13:30–15:30

**LWG • Nano-scale Light Matter Interaction I**

Markus Raschke; Univ. of Colorado, USA, Presider

LWG1 • 13:30 

**Plasmons in Reduced Dimensions and on Atomic Scale**, Tadaaki Nagao<sup>1</sup>; <sup>1</sup>International Center for Materials Nanoarchitectonics, National Institute for Materials Science, Japan. Plasmons can be excited, propagated, and confined in objects down to the sub-nanometer-scale. We present our experimental works on plasmons in atomic-scale metallic systems by electron spectroscopy, and the antenna resonances by optical spectroscopy.


LWG2 • 14:00 

**Controlling Plasmonic Interactions with Nanometer-scale Precision**, Matthew Hawkeye<sup>1</sup>, Kevin Savage<sup>1</sup>, Richard Taylor<sup>1</sup>, Fumin Huang<sup>1</sup>, Jeremy Baumberg<sup>1</sup>; <sup>1</sup>Physics, Cambridge University, United Kingdom. Plasmonic coupling between metallic nanostructures is critically sensitive to nanoscale geometry. We present new strategies for dynamic and precise positioning of metallic nanostructures, allowing investigation of coupled plasmonic resonances.


13:30–15:15

**LWH • Optics and Alternative Energy Sources III**

Anne Kelley; University of California, Merced, USA, Presider

LWH1 • 13:30 

**The Potential for Single-walled Carbon Nanotubes in Renewable Energy: Photovoltaics and Fuel Production**, Jeffrey Blackburn; <sup>1</sup> NREL, USA. This presentation will detail our recent studies aimed at exploring how single-walled carbon nanotubes may be incorporated into sustainable energy conversion strategies, including photovoltaics and the production of renewable fuels such as hydrogen.


LWH2 • 14:00 

**Optimization of Carrier Multiplication in Quantum Dots for More Efficient Solar Cells: Theoretical Aspects**, Christophe Delerue<sup>1</sup>, Guy Allan<sup>1</sup>; <sup>1</sup>ISEN, IEMN, France. Reviewing recent theoretical works, we propose a strategy to optimize the carrier multiplication in semiconductor quantum dots. This strategy is discussed using calculations on quantum dots of a semi-metal,  $\alpha$ -Sn.

13:30–15:15

**LWI • Orbital Angular Momentum and Applications I**

Ben McMorran; NIST, USA, Presider

LWI1 • 13:30 

**Optical Angular Momentum in Optical Tweezers - Quantitative Measurement and Applications**, Halina Rubinsztein-Dunlop<sup>1</sup>; <sup>1</sup>School of Mathematics and Physics, The University of Queensland, Australia. Using optical tweezers it is possible to exert torques to twist or rotate micro-objects. It is due to a light being able to carry angular momentum and being able to transfer spin and orbital angular momentum.

LWI2 • 14:00


**Spin-Orbit Interaction In Rotationally Symmetric Nanofiber**, Nikolai I. Petrov<sup>1</sup>; <sup>1</sup>Russia R&D Lab, I.G Electronics, Russian Federation. Effects of spin-orbit coupling of photons in optical fiber are analyzed by solving the full Maxwell's equations using the degenerate perturbation theory. Operator method for calculation of averaged parameters describing 3D polarization is developed.

**FWO • Looking into the Eyes of Animal Models of Disease—Continued**
**FWO3 • 14:15**  

**High Resolution Imaging of the Living Mouse Eye: A Model for Retinal Diseases**, Ying Geng; *Center for Visual Science<sup>1</sup>, The Institute of Optics<sup>2</sup>, University of Rochester, USA*. A Shack-Hartmann wavefront sensor with an adjustable focus beacon is incorporated into a fluorescence adaptive optics scanning laser ophthalmoscope. The instrument delivers high resolution images of multiple cell mosaics in the living mouse eye.

**FWP • High Fields and Plasmas—Continued**
**FWP4 • 14:30**  

**Manipulation of the Laser Properties through Guiding in Plasma Channels**, J. van Tilborg<sup>1</sup>, Anthony Gonsalves<sup>1</sup>, Carl Schroeder<sup>1</sup>, Carlo Benedetti<sup>1</sup>, Eric Esarey<sup>1</sup>, Wim Leemans<sup>1</sup>; *Lawrence Berkeley National Laboratory, USA*. Plasma channels allow for guiding of intense laser pulses over many Rayleigh lengths, enhancing laser-plasma interaction. Theory and experimental results are presented on laser properties during guiding such as mode, dispersion, and group velocity.

**FWO4 • 14:45** 

**Wavefront Tomography of the Human Eye Assisted with Corneal Topography and Optical Path Measurements**, Alexander V. Goncharov<sup>1</sup>, Matthew T. Sheehan<sup>1</sup>, Maciej Nowakowski<sup>1</sup>; *School of Physics, National University of Ireland Galway, Ireland*. We present a new method of reconstructing the optical system of the eye based on combined data from an aberrometer, corneal topographer and a partial coherence interferometer (IOL Master), which is used for customized eye model optimization.

**FWQ • Plasmonics—Continued**
**FWQ3 • 14:15**


**Plasmonic Color Nano-Imaging of Strain Distribution in Nanomaterials**, Satoshi Kawata<sup>1,2</sup>, Takaaki Yano<sup>1</sup>, Taro Ichimura<sup>1</sup>, Shota Kuwahara<sup>1</sup>, Fekhra H'Dhili<sup>1</sup>, Prabhakar Verma<sup>1</sup>; *Applied Physics, Osaka University, Japan; <sup>2</sup>RIKEN, Japan*. We demonstrate plasmonic nano-imaging of color-coded strain distribution in nanomaterials. Tip-enhanced Raman scattering microscopy is utilized to image and characterize locally-distributed strain at a spatial resolution of ~20 nm.

**FWQ4 • 14:30**


**Deterministic Optical Waveform Control on the Nanoscale**, Samuel Berweger<sup>1</sup>, Joanna M. Atkin<sup>1</sup>, Xiaoji Xu<sup>1</sup>, Robert L. Olmon<sup>1</sup>, Markus B. Raschke<sup>1</sup>; *Department of Physics, and JILA, University of Colorado, USA*. We demonstrate the simultaneous and independent nanometer-femtosecond spatiotemporal control of optical fields through the intrinsic adiabatic surface plasmon polariton nanofocusing ability of tapered Au tips combined with femtosecond pulse shaping.

**FWQ5 • 14:45**


**Plasmonic Modification of Temporal Coherence**, Gregory Gbur<sup>1</sup>; *UNC Charlotte, USA*. Through simulations and a simple model, it is demonstrated that the temporal coherence of a wavefield can be modified by surface plasmons. The effect is analogous to correlation-induced spectral changes.

**FWR • Beam Shaping and Propagation, Laser Cavity Design III—Continued**
**FWR3 • 14:15** 

**Sub-Wavelength Focal Dark Channel Generated in Tight Focusing of Azimuthally Polarized Beams**, Jixiong Pu<sup>1</sup>, Bo Tian<sup>2</sup>; *College of Information Science & Engineering, Huaqiao Univ, China; <sup>2</sup>College of Information Science & Engineering, Huaqiao Univ, China*. We study the focusing properties of a double-ring-shaped azimuthally polarized beam through an annular high numerical aperture objective lens. A sub-wavelength focal hole with a quite long depth of focus (called dark channel) is achieved.

**FWR4 • 14:30** 

**Generation of Vortex Beams by Twisted Nonlinear Photonic Crystals**, Noa V. Bloch<sup>1</sup>; *Tel Aviv University, Israel*. We fabricated quadratic nonlinear photonic crystals with singular structures. These structures convert Gaussian beams into vortex beams in the second harmonic. The topological charge of the generated beam is controlled by the structure.

**FWR5 • 14:45** 

**All-Optical Shaping of Nonlinear Vortex Beams**, Keren Simhony<sup>1</sup>; *Physical Electronics, Tel Aviv University, Israel*. We demonstrate methods for controlling the properties of optical vortex beams, generated within a twisted nonlinear photonic crystal. The latter enables us to all-optically shape polarization, radius, and angular momentum of optical vortex beams.

**FWS • General Optical Design and Instrumentation I—Continued**
**FWS4 • 14:15**

**Planar Collimated Illumination System Using Nano-Hybrid Low Index Materials**, Yoichi Taira<sup>1</sup>, Hidetoshi Numata<sup>1</sup>, Geraud Dubois<sup>2</sup>, Willi Volksen<sup>2</sup>; *IBM Research - Tokyo, Japan; <sup>2</sup>IBM Research - Almaden, USA*. A nano hybrid organo silicate material system is successfully used to realize a planar area illumination system with a highly collimated light output.

**FWS5 • 14:30**


**Optimized GaAs High Contrast Grating Design and Fabrication for Mid-infrared Application at 2.3 μm**, Christyves Chevallier<sup>1,2</sup>, Nicolas Fressengeas<sup>1</sup>, Frederic Genty<sup>1,2</sup>, Joel Jacquet<sup>1,2</sup>, Youness Laaroussi<sup>3</sup>, Guilhem Almuneau<sup>3</sup>, Dorian Sanchez<sup>4</sup>, Laurent Cerutti<sup>4</sup>, Thierry Taliercio<sup>4</sup>; *SUPELEC, France; <sup>2</sup>LMOPS, France; <sup>3</sup>CNRS; LAAS, France; <sup>4</sup>CNRS; IES, France*. A tolerant GaAs HCG design has been optimized for a mid-IR VCSEL application through the use of an optimization algorithm. Reflection spectra of an experimental grating are in a correct agreement with the simulations.

**FWS6 • 14:45**

**Three-Dimensional Simulation of Photopolymerization Dynamics Under Broadband Excitation**, Giovanni A. Tapang<sup>1</sup>, Paul Leonard Atchong Hilario<sup>1</sup>; *National Institute of Physics, University of the Philippines Diliman, Philippines*. We simulate the growth of a voxel in a photopolymerization reaction where the degree of polymerization is determined by the decrease in the photoinitiator concentration. Simulation was done for both single-photon and two-photon photopolymerization.

## FiO

## LS

**FWT • Novel Sensors and Applications I—Continued****FWT3 • 14:15** 

**Infiltration-free Photonic Bandgap Fiber Sensor**, Derrick Yong<sup>1,2</sup>, Mandy Yu<sup>1</sup>; <sup>1</sup>*SIMTech, Singapore*; <sup>2</sup>*Nanyang Technological University, Singapore*. A novel fiber sensor by photonic bandgap shift is demonstrated with high repeatability and 10<sup>-5</sup> refractive index unit detection limit. The fabricated all solid fiber eliminates air-hole infiltration processes in most photonic crystal fiber sensors.

**FWT4 • 14:30**  

**New Developments in Fiber-Laser Frequency Combs**, Ingmar Hartl<sup>1</sup>, J. Jiang<sup>1</sup>, A. Ruehl<sup>1</sup>, C. Mohr<sup>1</sup>, J. Bethge<sup>1</sup>, M. Ferrmann<sup>1</sup>; <sup>1</sup>*IMRA America, USA*. New developments on fiber-laser-frequency combs, demonstrating improved coherence properties, power scaling to the 80W level and extended spectral coverage from the XUV to the mid-IR will be discussed.

**FWU • Silicon Photonics—Continued****FWU4 • 14:30**


**Thermally Tuned Resonant Optical Filters Fabricated in Amorphous Silicon**, Mohammad Jalal Uddin<sup>1</sup>, Robert Magnusson<sup>1</sup>; <sup>1</sup>*Electrical Engineering, University of Texas at Arlington, USA*. A thermo-optic tunable shallow-grating guided-mode resonance filter is designed and fabricated. The experimental filter has a spectral width of 7 nm and a tuning range of 13 nm with a tuning efficiency of 0.13 nm/°C.

**FWU5 • 14:45**

**A Cage for Photons**, Jingjing Li<sup>1</sup>, David Fattal<sup>1</sup>, Marco Fiorentino<sup>1</sup>, Raymond G. Beausoleil<sup>1</sup>; <sup>1</sup>*HP Research Labs, USA*. We present a design of a “cage for photons”, i.e. an integrated optical cavity that can confine an optical mode in free space with the optical field accessible to particles such as atoms, molecules, etc.

**LWG • Nano-scale Light Matter Interaction I—Continued****LWG3 • 14:30**


**Spectral Characterization of Near-Field Thermal Radiation Using a Nano-Scale Local Thermal Light Source**, Andrew C. Jones<sup>1</sup>, Markus B. Raschke<sup>1,2</sup>; <sup>1</sup>*Physics, University of Colorado, USA*; <sup>2</sup>*Chemistry, University of Colorado, USA*. We characterize the enhancement of thermal near-fields associated with surface/bulk resonances. Our results are distinct from far-field thermal emission and verify predictions of near-field enhancement of the electromagnetic local density of states.

**LWG4 • 14:45** 


**Impedance of a Nanoantenna and a Quantum Emitter**, Jean-Jaques Greffet<sup>1</sup>, Francois Marquier<sup>1</sup>; <sup>1</sup>*LCFIO, Institut d'Optique, France*. An important figure of merit of a radiowave antenna is its impedance. The purpose of this paper is to introduce a definition of the impedance for a nanoantenna and for a quantum emitter.

**LWH • Optics and Alternative Energy Sources III—Continued****LWH3 • 14:30**

**Ultrafast Dispersive Transport in a-SiGe:H**, J. J. Felver<sup>1</sup>, J. G. Mance<sup>1</sup>, Susan L. Dexheimer<sup>1</sup>; <sup>1</sup>*Washington State University, USA*. Carrier dynamics in a-SiGe:H are studied using femtosecond optical techniques. The response reveals dispersive transport with a time-dependent mobility that varies systematically with temperature and with the degree of disorder in the material.

**LWH4 • 14:45** 

**Wave Theory for Light Trapping Design in Solar Cells**, Shanhui Fan<sup>1</sup>, Zongfu Yu<sup>1</sup>, Aaswath Raman<sup>1</sup>; <sup>1</sup>*Stanford Univ., USA*. We present a wave theory for light trapping design in solar cells. The theory illustrates many of the optical design considerations in nanophotonic solar cell structures. In particular, we show how one can understand the  $4n^2$  limit from a mode counting perspective, and we develop ways to significantly overcome such a limit. We also show that there is an angular sum rule, which relates the angular integration of the light trapping enhancement factor, to the density of states of the system.

**LWI • Orbital Angular Momentum and Applications I—Continued****LWI3 • 14:15** 

**X-ray Orbital Angular Momentum**, Ian McNulty; <sup>1</sup>*Argonne Natl. Lab, USA*. Abstract not available.

**LWI4 • 14:45**

**Photonic Spin-Orbit Interaction in Few-Mode Optical Fiber**, Dashiell L. Vitullo<sup>1</sup>, M. G. Raymer<sup>1</sup>, Cody C. Leary<sup>2</sup>, Siddharth Ramachandran<sup>3</sup>; <sup>1</sup>*Physics, University of Oregon, USA*; <sup>2</sup>*Institute of Experimental Physics, University of Warsaw, Poland*; <sup>3</sup>*Electrical and Computer Engineering, Boston University, USA*. We demonstrate interaction between spin and orbital angular momentum of light in a straight few-mode fiber, evidenced by rotation of output intensity patterns controlled by input spin handedness.



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**FWT • Novel Sensors and Applications I—Continued**

**FWU • Silicon Photonics—Continued**

**FWU6 • 15:00**  
**Optimal Design of Aperiodic, Vertical Silicon Nanowire Structures for Photovoltaics**, Chenxi Lin<sup>1</sup>, Michelle Povinelli<sup>1</sup>; <sup>1</sup>Ming Hsieh Department of Electrical Engineering, University of Southern California, USA. We use the transfer matrix method and the random walk algorithm to design an aperiodic, vertically-aligned silicon nanowire array that maximizes solar absorption. We achieved a 2.35 times enhancement in ultimate efficiency.

**FWU7 • 15:15**  
**Angular Dependence of Absorption in Silicon Nanowire Arrays**, Björn C. P. Sturmberg<sup>1</sup>, Kokou B. Dossou<sup>2</sup>, Lindsay C. Botten<sup>2</sup>, Ara A. Asatryan<sup>2</sup>, Christopher G. Poulton<sup>2</sup>, C. Martijn de Sterke<sup>1</sup>, Ross C. McPhedran<sup>1</sup>; <sup>1</sup>IPOS and CUDOS, School of Physics, University of Sydney, Australia; <sup>2</sup>CUDOS and School of Mathematical Science, University of Technology Sydney, Australia. We study the absorption of silicon nanowire arrays at non-normal angles of incidence via a novel semi-analytic method. The absorption is found to be dominated by few modes and to remain high up to 35°.

**LWG • Nano-scale Light Matter Interaction I—Continued**

**LWH • Optics and Alternative Energy Sources III—Continued**

**LWI • Orbital Angular Momentum and Applications I—Continued**

**LWG5 • 15:15**  
**Accessible Field Enhancements with Plasmonic Nanoparticles on Nanopedestals for Nanospectroscopy**, Dordaneh Etezadi<sup>1</sup>, Ronen Adato<sup>1</sup>, Hatice Altug<sup>1</sup>; <sup>1</sup>Electrical & Computer Engineering, Boston University, USA. We show that plasmonic nanoparticle arrays on dielectric nanopedestals support easily accessible hot spots for target molecules, which is crucial for increasing signals in biosensors and vibrational nanospectroscopy.

**LWI5 • 15:00**  
**Mechanically Induced Image Rotation: Analogy of the Faraday Effect for Orbital Angular Momentum**, Miles Padgett<sup>1</sup>; <sup>1</sup>University of Glasgow, United Kingdom. A spinning medium is predicted to induce a slight rotation in a transmitted image. We amplify this effect by use of ruby as a slow light medium, giving image rotations of several degrees. In the orbital angular momentum basis set such rotations are analogous to the Faraday effect.

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

**NOTES**

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Wednesday, 19 October

16:00–17:30

**FWV • Optical Design of Animal Eyes** ▶*Melanie Campbell; University of Waterloo Canada, Presider*FWV1 • 16:00 **Invited** ▶

**Multifocal Optics of the Fish Lens for Clear Color Vision**, Ronald H. Kroger<sup>1</sup>; <sup>1</sup>*Department of Biology, Lund University, Sweden*. In fishes the chromatic aberration of the eye's optical system is compensated for by multifocal lenses focusing several spectral ranges on the retina. Most other vertebrates (animals having backbones), but not humans, have similar lenses.

16:00–17:30

**FWW • Novel Photonic and Plasmonic Nanostructures** ▶*Ron Reano, Ohio State Univ., USA, Presider*FWW1 • 16:00 **Invited** ▶

**Bio-Inspired Photonic Nanostructures and Lasers**, Hui Cao<sup>1,2</sup>; <sup>1</sup>*Applied Physics, Yale University, USA*; <sup>2</sup>*Physics, Yale University, USA*. We mimic nature to fabricate photonic nanostructures with only short-range order. Despite lack of long range order, light is effectively confined in such structures, leading to efficient lasing. Lasing frequency is tuned via structural parameter.

FWW2 • 16:30 ▶

**Design Methodology for Compact Photonic Crystal Wavelength Division Multiplexers**, Victor Liu<sup>1</sup>, Yang Jiao<sup>1,2</sup>, David Miller<sup>1</sup>, Shanhui Fan<sup>1</sup>; <sup>1</sup>*Electrical Engineering, Stanford University, USA*; <sup>2</sup>*The D. E. Shaw Group, USA*. We present an extremely compact wavelength division multiplexer design, as well as a general framework for designing and optimizing frequency selective devices embedded in photonic crystals satisfying arbitrary design constraints.

16:00–17:45

**FWX • Coherence, Propagation and Imaging***Presider to be Announced*FWX1 • 16:00 **Invited**

**Phase-Space Imaging of Partially Coherent Beams in Linear and Nonlinear Media**, Laura Waller<sup>1</sup>, Guohai Situ<sup>1</sup>, Jason Fleischer<sup>1</sup>; <sup>1</sup>*Electrical Engineering, Princeton Univ., USA*. We demonstrate a phase-space imaging system that scans and Fourier transforms an aperture created by a spatial light modulator (SLM), and use it to investigate partially coherent beams as they propagate through linear and nonlinear media.

FWX2 • 16:30

**Use of Nonconventional Incoherent Beam Arrays for Reduction of Turbulence-induced Scintillation**, Yalong Gu<sup>1</sup>, Gregory Gbur<sup>1</sup>; <sup>1</sup>*Department of Physics and Optical Science, Univ. of North Carolina at Charlotte, USA*. General guidelines for use of non-conventional incoherent beam arrays in scintillation reduction are explored; with these a new beam class is considered and the scintillation of the corresponding incoherent beam array is significantly reduced.

16:00–17:30

**FWY • Quantum Computation and Communication I** ▶*Eugene S. Polzik; Niels Bohr Institute Denmark, Presider*FWY1 • 16:00 **Invited**

**A Functional Interpretation of Continuous Variable Quantum Discord**, Thomas Symul<sup>1</sup>, H.M. Chrzanowski<sup>1</sup>, S. Assad<sup>1</sup>, P.K. Lam<sup>1</sup>, T.C. Ralph<sup>2</sup>, M. Gu<sup>3</sup>, V. Vedral<sup>3</sup>; <sup>1</sup>*ARC Centre of Excellence for Quantum Computation and Communication Technology, Dept. of Quantum Science, The Australian National University, ACT 0200, Australia*; <sup>2</sup>*ARC Centre of Excellence for Quantum Computation and Communication Technology, School of Mathematics and Physics, University of Queensland, QLD 4072, Australia*; <sup>3</sup>*Centre for Quantum Technologies, National University of Singapore, Singapore*. We show that quantum discord can quantify the information advantage of a quantum processing over an optimal classical processing. We experimentally extract a lower bound on the quantum discord of a non-entangled continuous-variable quantum system.

FWY2 • 16:30 ▶

**Parity Detection for Heisenberg-limited Metrology with Coherent and Squeezed Vacuum Light**, Kaushik P. Seshadreesan<sup>1</sup>, Petr A. Anisimov<sup>1</sup>, Hwang Lee<sup>1</sup>, Jonathan P. Dowling<sup>1</sup>; <sup>1</sup>*Physics & Astronomy, Louisiana State University, USA*. The interference between coherent and squeezed vacuum light can produce path entangled states with very high fidelities. We show that Heisenberg-limited phase estimation with the above interferometric scheme can be achieved using parity detection.

16:00–17:30

**FWZ • General Optical Design and Instrumentation II***Presider to Be Announced*

FWZ1 • 16:00

**Vector Near-Field Imaging and Impedance Matching with Optical and Infrared Antennas**, Robert L. Olmon<sup>1</sup>, Peter M. Krenz<sup>2</sup>, Brian A. Lail<sup>3</sup>, Glenn D. Boreman<sup>2</sup>, Markus B. Raschke<sup>1</sup>; <sup>1</sup>*Department of Physics, and JILA, University of Colorado, USA*; <sup>2</sup>*CREOL, College of Optics and Photonics, The University of Central Florida, USA*; <sup>3</sup>*Department of Electrical and Computer Engineering, Florida Institute of Technology, USA*. We discuss optical and infrared antenna characterization using a nano-optical vector network analyzer and coplanar stripline analysis as a way to achieve impedance matching between optical antennas and nanoscale loads.

FWZ2 • 16:15

**Interference Projection Exposure System**, Guy M. Burrow<sup>1</sup>, Thomas K. Gaylord<sup>1</sup>; <sup>1</sup>*Georgia Institute of Technology, USA*. An interference projection exposure system is presented for single-exposure fabrication of low-spatial-frequency functional elements in a high-spatial-frequency, all-surrounding periodic pattern. Photonic crystal devices are demonstrated.

FWZ3 • 16:30

**Planar Solar Concentrators using Subwavelength Gratings**, Bala Pesala<sup>1</sup>; <sup>1</sup>*Central Electronics Engineering Research Institute (CEERI), CSIR, India*. New planar design to concentrate sunlight using unique diffraction properties of subwavelength gratings is presented. Concentration ratio >10X is achieved suitable for medium-concentration solar systems.

## FIO

16:00–17:30

**FWAA • Order, Disorder and Symmetry in Photonic Structures III**A. Douglas Stone; Yale University United States, *Presider*

FWAA1 • 16:00

Observation of Localized Modes in Optically Induced Disordered Lattices, Peigen Ni<sup>1</sup>, Peng Zhang<sup>1</sup>, Weining Man<sup>1</sup>, Jianke Yang<sup>2</sup>, Zhigang Chen<sup>1,2</sup>; <sup>1</sup>Department of Physics and Astronomy, San Francisco State University, USA; <sup>2</sup>Department of Mathematics and Statistics, University of Vermont, USA; <sup>3</sup>TEDA Applied Physics School, Nankai University, China. We optically induce random photonic lattices with disordered modulations in both lattice spacing and amplitude in a bulk nonlinear crystal. Both linear Anderson-like localized modes and defect modes are experimentally observed.

FWAA2 • 16:15

**Geometric Frustration in Large Arrays of Coupled Lasers**, Micha Nixon<sup>1</sup>, Eitan Ronen<sup>1</sup>, Asher A. Friese<sup>1</sup>, Nir Davidson<sup>1</sup>; <sup>1</sup>Weizmann Institute of Science, Israel. Experimental realization for phase locking several thousands of lasers arranged in a variety of 2D geometries is presented. Coupling ranges and sign are easily controlled giving rise to a variety of intriguing phase structures.

FWAA3 • 16:30

**Measurement of the Probability Distribution of Conductance on the Mobility Edge**, Zhou Shi<sup>1</sup>, Azriel Genack<sup>1</sup>; <sup>1</sup>Department of physics, Queens College, City University of New York, USA. We measure the probability distribution of conductance  $g$  of microwave radiation propagating in random waveguides on the Anderson localization transition. We found the  $P(-\ln(g))$  is asymmetric on the mobility edge.

16:00–17:30

**FWBB • Hybrid-Organic Integrated Photonics**Ashok V. Krishnamoorthy; Oracle Labs, Oracle, USA, *Presider*FWBB1 • 16:00 **Invited**

**Integration of New Organic Electro-Optic Materials into Silicon and Silicon Nitride Photonics and into Metamaterial and Plasmonic Device Structures**, Larry R. Dalton<sup>1</sup>, Stephanie Benight<sup>1</sup>, Delwin Elder<sup>1</sup>, Jinsheng Song<sup>1</sup>; <sup>1</sup>University of Washington, USA. OEO materials are designed for self-assembly that enhances EO activity. Materials are also designed for controlled index of refraction, dielectric permittivity, optical transparency, thermal stability, photochemical stability, and processability.

FWBB2 • 16:30

**Photophysics of a Near IR Nonlinear Absorber for Waveguide Applications**, San-Hui Chi<sup>1</sup>, Armand Rosenberg<sup>1</sup>, Animesh Nayak<sup>2,3</sup>, Timothy V. Duncan<sup>2</sup>, Michael J. Therien<sup>3</sup>, James J. Butler<sup>4</sup>, Steve R. Montgomery<sup>5</sup>, Guy Beadie<sup>1</sup>, Steve R. Flom<sup>1</sup>, James S. Shirk<sup>1</sup>; <sup>1</sup>United States Naval Research Laboratory, USA; <sup>2</sup>Chemistry, University of Pennsylvania, USA; <sup>3</sup>Chemistry, Duke University, USA; <sup>4</sup>Physics, Pacific University, USA; <sup>5</sup>Physics, United State Naval Academy, USA. Photophysics of a zinc porphyrin-based NIR nonlinear absorber are reported. Well-overlapped two-photon absorption and broad triplet excited state absorption result in a strong nonlinear optical response especially useful in waveguide applications.

## LS

16:00–17:30

**LWJ • Nano-scale Light Matter Interaction II**Matthew Pelton; Argonne National Laboratory, USA, *Presider*LWJ1 • 16:00 **Invited**

**Control and Tracing of Attosecond Electron Dynamics in Nanosystems**, Matthias Kling<sup>1,2</sup>; <sup>1</sup>Max Planck Institute of Quantum Optics, Germany; <sup>2</sup>Department of Physics, Kansas State University, USA. We experimentally studied the attosecond control of electron dynamics in dielectric nanoparticles. The potential attosecond probing of collective electron dynamics in nanoparticles has been studied theoretically via attosecond streaking spectroscopy.

LWJ2 • 16:30

**Ultrafast Dephasing of Surface Plasmons in Silver Nanoparticles: The Role of Capping Agents**, Euclides Almeida<sup>1,2</sup>, Augusto C. Moreira<sup>1</sup>, Antonio M. Brito-Silva<sup>2</sup>, Leonardo S. Menezes<sup>1</sup>, André Galembeck<sup>3</sup>, Cid B. de Araújo<sup>1</sup>; <sup>1</sup>Departamento de Física, Universidade Federal de Pernambuco, Brazil; <sup>2</sup>Centro de Tecnologias Estratégicas do Nordeste, Brazil; <sup>3</sup>Departamento de Química, Universidade Federal de Pernambuco, Brazil. The dephasing times of localized surface plasmons in silver colloidal nanoparticles stabilized with different capping agents are measured. The short T<sub>2</sub> measured are strongly dependent on the stabilizer. The results are supported by DFT calculations.

16:00–17:45

**LWK • Ultrafast X-Rays I**Markus Guehr; SLAC National Accelerator Lab, USA, *Presider*LWK1 • 16:00 **Invited**

**Nonequilibrium Phonon Dynamics**, Mariano Trigo<sup>1</sup>, David Reis<sup>1</sup>; <sup>1</sup>SLAC National Accelerator Lab, USA. We present x-ray diffuse scattering images of nonequilibrium phonons in InP and InSb throughout the Brillouin zone which remain out of equilibrium up to nanoseconds.

LWK2 • 16:30 **Invited**

**Femtosecond Spin State Changes: Implications for Photocatalysis**, Christian Bressler<sup>1</sup>; <sup>1</sup>European XFEL Facility, Hamburg, Germany. We present our new results exploiting simultaneously picosecond and femtosecond x-ray emission spectra in concert with x-ray diffuse scattering patterns, which provide complementary information to x-ray absorption studies. Key systems presented include a photocatalytic compound.

16:00–17:15

**LWL • Orbital Angular Momentum and Applications II**Miles Padgett, Univ. of Glasgow, UK, *Presider*LWL1 • 16:00 **Invited**


**Electron Beams Carrying Quantized Orbital Angular Momentum**, Ben McMorrán<sup>1,2</sup>, Amit Agrawal<sup>1</sup>, Ian Anderson<sup>3</sup>, Andrew Herzing<sup>3</sup>, Henri Lezec<sup>1</sup>, Jabez McClelland<sup>1</sup>, John Unguris<sup>1</sup>; <sup>1</sup>Center for Nanoscale Science and Technology, NIST, USA; <sup>2</sup>Department of Physics, University of Oregon, USA; <sup>3</sup>Surface and Microanalysis Science Division, NIST, USA. We use nanofabricated diffraction holograms to demonstrate electron vortex beams carrying quantized orbital angular momentum. These beams are analogous to optical vortices but are composed of charged particle wavefunctions possessing mass.

LWL2 • 16:30

**Exploitation of Orbital Angular Momentum for Electromagnetic Scattering**, Aaron Rury<sup>1,2</sup>, Roseanne Sension<sup>1,2</sup>, Richard Freeling<sup>3</sup>; <sup>1</sup>Applied Physics Program, University of Michigan, USA; <sup>2</sup>SRI International, USA. Access to higher order material multipole moments via interactions with Laguerre-Gauss beams is discussed in the context of scattering from metal nanoparticles. Exciting these responses in nanoparticle can have import in chemical applications.

**FWW • Optical Design of Animal Eyes—Continued****FWW2 • 16:45** **Invited**


**The Optics of Linear and Circular Polarization Vision: Recent Discoveries in Fish and Stomatopods**, Nicholas Roberts; *Univ. of Bristol, UK*. Many animals use the polarization of light to gather visual information. We have recently discovered new mechanisms by which photoreceptors of diverse species act as linear and circular polarization detectors.

**FWW • Novel Photonic and Plasmonic Nanostructures—Continued****FWW3 • 16:45** 

**Hybridization of Photonic Crystal Cavities and Surface Plasmons**, Xiaodong Yang<sup>1,2</sup>, Atsushi Ishikawa<sup>1</sup>, Xiaobo Yin<sup>1,2</sup>, Xiang Zhang<sup>1,2</sup>; <sup>1</sup>*University of California, Berkeley, USA*; <sup>2</sup>*Lawrence Berkeley National Laboratory, USA*. We propose optical nanocavities based on the hybridization of photonic crystal cavities modes and surface plasmons across nanoscale air gaps. Deep subwavelength mode volume and high quality factor are demonstrated at 1.55  $\mu\text{m}$ .

**FWW4 • 17:00** 

**Enhancement of Light Absorption in Subwavelength Plasmonic Slits by Optical Microcavities**, Changjun Min<sup>1</sup>, Liu Yang<sup>1</sup>, Georgios Veronis<sup>1</sup>; *Louisiana State University, USA*. We show that a compact structure consisting of multiple optical microcavities on both the entrance and exit side of a subwavelength plasmonic slit can greatly enhance the absorption cross section of the slit.

**FWW5 • 17:15** 

**Electrically-Injected Nano-Spin VCSELs : Design Principles and Applications**, Alan Shore<sup>1</sup>; <sup>1</sup>*Electronic Engineering, Bangor University, United Kingdom*. Design principles and procedures for optimizing the dynamical and wave-guiding properties of electrically-injected metal-clad nano-spin VCSELs are discussed. The procedures target laser bandwidth maximization and threshold current minimization.

**FWX • Coherence, Propagation and Imaging—Continued****FWX3 • 16:45**

**Correlations of Polarization in Random Electromagnetic Fields**, John Broky<sup>1</sup>, Aristide Dogariu<sup>1</sup>; <sup>1</sup>*CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA*. Statistical properties of spatially resolved polarization data discriminate between the spatial coherence properties of interfering random fields. The procedure is used to identify different scattering regimes of waves interacting with random media.

**FWX4 • 17:00**


**Synchronized Cluster Formation in Coupled Laser Networks**, Micha Nixon<sup>1</sup>, Moti Fridman<sup>1</sup>, Eitan Ronen<sup>1</sup>, Asher A. Friesem<sup>1</sup>, Nir Davidson<sup>1</sup>, Ido Kanter<sup>2</sup>; <sup>1</sup>*Physics of Complex Systems, Weizmann Institute of Science, Israel*; <sup>2</sup>*Physics, Bar-Ilan Univ., Israel*. Experimental results on the interplay between the topology of time-delayed coupled laser networks and their phase synchronization are presented. These establish the fundamental rules that govern the synchronization state of the entire network.

**FWX5 • 17:15**

**A Quantum Mask Game: Using Squeezed Light to Perform Spatially Resolving Object Detection**, Jeremy B. Clark<sup>1</sup>, Zhifan Zhou<sup>1</sup>, Quentin Glorieux<sup>1</sup>, Neil Corzo-Trejo<sup>1</sup>, Alberto Marino<sup>1</sup>, Paul Lett<sup>1</sup>; <sup>1</sup>*NIST, NIST, USA*. We experimentally investigate a scheme that exploits the multi-spatial quantum correlations between twin squeezed vacuum beams to resolve the shape of a mask partially obstructing one of the beams.

**FWX6 • 17:30**

**Partial Coherence and the Transport of Intensity and Spectrum**, Adam M. Zysk<sup>1</sup>, Robert W. Schoonover<sup>2</sup>, Paul S. Carney<sup>3</sup>, Mark A. Anastasio<sup>2</sup>; <sup>1</sup>*Electrical and Computer Engineering, Illinois Institute of Technology, USA*; <sup>2</sup>*Biomedical Engineering, Washington Univ. in St. Louis, USA*; <sup>3</sup>*Electrical and Computer Engineering, Univ. of Illinois at Urbana-Champaign, USA*. Transport of intensity and transport of spectrum equations are derived for fields having an arbitrary state of coherence. The results may improve the estimation of phase-contrast images and facilitate new phase-retrieval techniques.

**FWY • Quantum Computation and Communication I—Continued****FWY3 • 16:45** 

**From the Parametric Down-Conversion to the Raman Scattering: Nonlinear and Quantum Phenomena in Lossy Media**, Radoslaw Chrapkiewicz<sup>1</sup>, Wojciech Wasilewski<sup>1</sup>; <sup>1</sup>*Faculty of Physics, University of Warsaw, Poland*. We found the full information of the output multimode state in the Spontaneous Parametric Down-Conversion, in the lossy 1D waveguide, still manifesting quantum behavior. We refer the results to the Raman scattering in atomic media.

**FWY4 • 17:00** 

**Perfect Quantum Communication with Very Noisy Gaussian Optical Fiber Channels**, Laszlo Gyongyosi<sup>1</sup>, Sandor Imre<sup>1</sup>; <sup>1</sup>*Department of Telecommunications, Budapest University of Technology and Economics, Hungary*. We demonstrate that very noisy Gaussian optical fiber quantum channels with zero zero-error capacities can be used to transmit information perfectly. We derive how the supremum of the superactivated capacity depends on the input states.

**FWY5 • 17:15**

Withdrawn

**FWZ • General Optical Design and Instrumentation II—Continued****FWZ4 • 16:45**

Withdrawn

**FWZ5 • 17:00**

**Two Beam Spatial Phasing with a CW Laser**, Paul J. Phillips<sup>1</sup>, Cristina Hernandez-Gomez<sup>1</sup>, Ian Musgrave<sup>1</sup>, John Collier<sup>1</sup>; <sup>1</sup>*Rutherford Appleton Laboratory, CLF, Science and Technical Facility Council, United Kingdom*. We have developed a closed loop program using a wavefront sensor that is used to measure the tip / tilt and piston between the two beams for coherent combination with the laser in CW mode.

**FWZ6 • 17:15**

**An Inhomogeneously Broadened Superluminal Ring Laser for Rotation Sensing and Accelerometry**, J. Yablon1, S. Tseng<sup>1</sup>, M. Salit<sup>2</sup>, K. Salit<sup>2</sup> and M.S. Shahriar<sup>1</sup>; <sup>1</sup>*Department of Electrical Engineering and Computer Science*; <sup>2</sup>*Department of Physics and Astronomy, Northwestern University, USA*. We show how a superluminal ring laser can be realized using an inhomogeneously broadened gain medium with the addition of a dip in the gain profile, for application to enhanced precision rotation sensing and accelerometry.

17:00–20:00 **Science Educator's Day**, Ballroom, Sainte Claire Hotel18:30–20:00 **FiO Postdeadline Paper Sessions**, See the Postdeadline Papers Book in your registration bag for exact times and locations


## FiO

**FWAA • Order, Disorder and Symmetry in Photonic Structures III—Continued**

**FWAA5 • 17:15**

**Single Shot Time and Frequency Resolved Four Wave Mixing Spectroscopy**, Andrey Shalit<sup>1</sup>, Yuri Pas-kover<sup>1,2</sup>, Yehiam Prior<sup>1</sup>; <sup>1</sup>Chemical Physics Department, Weizmann Institute of Science, Israel; <sup>2</sup>Chemistry Department, Princeton University, USA. A new method is demonstrated whereby strict phase matching conditions in forward propagating four wave mixing experiments allow both spectral and temporal resolution within a single ultrashort laser pulse.

**FWBB • Hybrid-Organic Integrated Photonics—Continued**

**FWBB3 • 16:45** 


**Hybrid Multilayered Heterostructures for High-Performance Near-Infrared LEDs**, Xin Ma<sup>1</sup>, Fan Xu<sup>1</sup>, Jaime Benavides<sup>1</sup>, Sylvain G. Cloutier<sup>1</sup>; <sup>1</sup>University of Delaware, USA. We report a solution-based method producing hybrid heterostructures for light-emission in the near-IR. This low-cost and versatile approach is most useful for flexible or reconfigurable optoelectronics, energy harvesting and biosensing platforms.

**FWBB4 • 17:00**  

**Progress in Heterogeneously Integrated Silicon-InP Laser Diodes for On-Chip All-Optical Networks and Signal Processing**, Geert Morthier<sup>1</sup>, Pauline Mechet<sup>1</sup>, Rajesh Kumar<sup>1</sup>, Gunther Roelkens<sup>1,2</sup>, Thijs Spuesens<sup>1</sup>, Dries Van Thourhout<sup>1</sup>, Roel Baets<sup>1</sup>, Philippe Regreny<sup>3</sup>, Tsjibbe De Vries<sup>2</sup>, Erik-Jan Geluk<sup>2</sup>; <sup>1</sup>Information Technology, Ghent University - imec, Belgium; <sup>2</sup>COBRA Research Institute, Technical University of Eindhoven, Netherlands; <sup>3</sup>Institut de nanotechnologies de Lyon, University of Lyon, France. We describe progress in the design and fabrication of laser diodes based on InP-membranes heterogeneously integrated onto silicon-on-insulator wire waveguides. Applications in optical interconnect and all-optical logic are discussed.

## LS

**LWJ • Nano-scale Light Matter Interaction II—Continued**


**LWJ3 • 16:45** 

**Ultrafast Optical Probing of Topological Insulators**, Nuh Gedik<sup>1</sup>, David Hsieh<sup>1</sup>, James McIver<sup>1,2</sup>, Yihua Wang<sup>1,2</sup>, Young Lee<sup>1</sup>, Dillion Gardner<sup>1</sup>, Liang Fu<sup>2</sup>; <sup>1</sup>Physics, MIT, USA; <sup>2</sup>Physics, Harvard University, USA. Topological insulators are novel materials which are insulating in their bulk yet possess exotic conducting surface states. Here, we present various techniques to probe these topological states with ultrafast optical pulses.

**LWJ4 • 17:15**

**Slow-Light Enhanced Integrated Spectrometers on Chip**, Zhimin Shi<sup>1</sup>, Andreas C. Liapis<sup>1</sup>, Boshen Gao<sup>1</sup>, Robert W. Boyd<sup>2,1</sup>; <sup>1</sup>The Institute of Optics, University of Rochester, USA; <sup>2</sup>Department of Physics, University of Ottawa, Canada. We propose using slow light to enhance the spectral performance of on-chip spectrometers. We use an optimized calzone photonic crystal waveguide to analyze the potential of integrated slow-light spectrometers under practical considerations.

**LWK • Ultrafast X-Rays I—Continued**

**LWK3 • 17:00** 

**Ultrafast Imaging of Nanoclusters with Intense X-ray Laser Pulses**, Christoph Bostedt<sup>1</sup>; <sup>1</sup>Linac Coherent Light Source, SLAC National Accelerator Laboratory, USA. Free electron lasers open the door for novel applications ranging from single-shot imaging to ultrafast x-ray spectroscopy. First experiments at LCLS show how scattering patterns of single nanoclusters carry geometric and electronic information.

**LWK4 • 17:30**

**Ultrafast Nanoscale Imaging of Magnetization Dynamics**, Hamed Merdji<sup>1,2</sup>; <sup>1</sup>SPAM, CEA, France; <sup>2</sup>PULSE, SLAC, USA. We present femtosecond coherent imaging of magnetic nano-domains using our table-top soft X-ray source. We show first results obtained in single shot (20 femtoseconds snapshot) of the Co/Pd scattering resolved spectrally around the cobalt M-edge.

**LWL • Orbital Angular Momentum and Applications II—Continued**

**LWL3 • 16:45**

**Are Orbital Angular Momentum (OAM/Vortex) States of Light Long-Lived in Fibers?** Nenad Bozinovic<sup>1</sup>, Poul Kristensen<sup>2</sup>, Siddharth Ramachandran<sup>1</sup>; <sup>1</sup>ECE, Boston University, USA; <sup>2</sup>OFS-Fitel, Denmark. We study the evolution of OAM states in fibers, showing that they can be maintained over km-lengths with purity levels exceeding 94%. This suggests a novel means for encoding information in fiber-based quantum encryption links.

**LWL4 • 17:00**

**Quantum Dot Dressing Observed via Off-resonant Cavity**, Arka Majumdar<sup>1</sup>, Alexander Papageorge<sup>1</sup>, Erik D. Kim<sup>1</sup>, Michal Bajcsy<sup>1</sup>, Jelena Vuckovic<sup>1</sup>; <sup>1</sup>Stanford University, USA. Signatures of dressing of a single quantum dot by a strong resonant laser are observed by monitoring the off-resonant cavity emission.

17:00–20:00 **Science Educator's Day**, Ballroom, Sainte Claire Hotel

18:30–20:00 **FiO Postdeadline Paper Sessions**, See the Postdeadline Papers Book in your registration bag for exact times and locations