

Empire

Crystal

Gold

Valley

California

F i O

07:00–18:00 **Registration**, Market Street Foyer, Fairmont Hotel08:00–12:00 **2011 Joint FIO/LS Awards Ceremony and Plenary Session**, Regency Ballroom, Fairmont Hotel10:00–10:30 **Coffee Break**, Regency Foyer, Fairmont Hotel12:00–14:30 **LMA • LS Undergraduate Poster Session**, South Tower Foyer, Fairmont Hotel

13:30–15:30

FMA • Special Symposium on Integrated Optofluidics for the Life Sciences I ▶*Carlos Lopez-Mariscal; US Naval Research Lab, USA, Presider*

13:30–15:30

FMB • Silicon Nanophotonics*David R. Smith; Duke Univ., USA, Presider*

13:30–15:30

FMC • Special Symposium on Novel X-ray and EUV Light Sources and Sciences: Accelerator-based X-ray Free-Electron Lasers and Science ▶*Carmen Menoni, Colorado State Univ., USA, Presider*

13:30–15:30

FMD • Optomechanics I ▶*Ivan Favero; Université Paris-Diderot, France, Presider*

13:30–15:30

FME • Phase ▶*Scott Carney; Beckmann Inst., UIUC, USA, Presider***FMA1 • 13:30** **Invited** ▶

Optofluidic Manipulation of Particles for Separation, Purification, and Analysis, Sean Hart; *US Naval Research Laboratory, USA*. An optofluidic system and applications are described where biological samples are characterized and separated in a microfluidic device based upon their intrinsic properties. As an example, optical force differences have been measured between various human blood cells including lymphocytes, monocytes, granulocytes, and erythrocytes indicating the potential to harness optical force differences to separate blood cells.

FMB1 • 13:30 **Invited**

CMOS Integrated Silicon Nanophotonics for Exascale Computing, William M. Green¹, Solomon Assefa¹, Alexander Rylyakov¹, Clint Schow¹, Folkert Horst², Yuri Vlasov³; ¹*IBM Thomas J. Watson Research Center, USA*; ²*IBM Zurich GMBH, Switzerland*. CMOS integrated silicon nanophotonics allows ultra-dense monolithic single-chip integration of optical and electrical functions. This technology can enable future Exa-scale supercomputers by connecting racks, modules, and chips together with ultra-low power massively parallel optical interconnects.

FMC1 • 13:30 **Invited**

Ultrafast Dynamics in Surface Chemical Reactions Probed with Free-Electron Lasers, Wilfried Wurth; *University of Hamburg, Germany*. The talk will review recent time resolved x-ray spectroscopy experiments performed at the Linac Coherent Light Source LCLS in Stanford with the goal to follow surface chemical reactions in real time on femtosecond timescales.

FMD1 • 13:30 ▶

Near Threshold Optomechanical Backaction Amplifier, Warwick P. Bowen¹, Terry G. McRae¹; ¹*Centre for Engineered Quantum Systems, University of Queensland, Australia*. We demonstrate a near threshold optomechanical backaction amplifier, where optical amplification is achieved via dynamical radiation pressure effects. Amplification as large as 22 dB is observed with an input power of only 12 μ W.

FME1 • 13:30 **Invited** ▶

Methods and Applications of X-ray Phase Nanotomography, Manuel Guizar-Sicairos¹, Ana Diaz¹, Andreas Menzel¹, Oliver Bunk¹; ¹*Swiss Light Source, Paul Scherrer Inst., Switzerland*. A methodology for using the phase of x-ray coherent diffractive images to obtain quantitative nanoscale phase tomograms is presented. We show the application of this technique.

FMD2 • 13:45 ▶

Mechanical Squeezing via Parametric Amplification and Weak Measurement, Alex Szorkovszky¹, Andrew C. Doherty², Glen I. Harris¹, Warwick P. Bowen¹; ¹*Centre for Engineered Quantum Systems, University of Queensland, Australia*; ²*Centre for Engineered Quantum Systems, University of Sydney, Australia*. The combination of parametric driving and quantum measurement allows mechanical squeezing far surpassing that achieved by either technique alone. Strong squeezing can be achieved even for measurements much too weak to resolve the zero-point motion.

07:00–18:00 **Registration**, Market Street Foyer, Fairmont Hotel

08:00–12:00 **2011 Joint FIO/LS Awards Ceremony and Plenary Session**, Regency Ballroom, Fairmont Hotel

10:00–10:30 **Coffee Break**, Regency Foyer, Fairmont Hotel

12:00–14:30 **LMA • LS Undergraduate Poster Session**, South Tower Foyer, Fairmont Hotel

13:30–15:30

FMF • Entanglement

Presider to Be Announced

13:30–15:30

FMG • Novel Fibers and Applications I

Tanya Monro; Univ. of Adelaide, Australia, Presider

13:30–15:30

LMC • Novel Applications of Multi-Photon Contrast—Broida Award Symposium

Roseanne Sension, Univ. of Michigan, USA, Presider

13:30–15:30

LMB • Coherence and Control in Energy Transfer I

Tom Weinacht; SUNY Stony Brook, USA, Presider

13:30–16:00

LMD • Laser Science Symposium on Undergraduate Research I

FMF1 • 13:30 **Invited**

Entanglement and Propagation: Is there an equivalent of the Van Cittert-Zernike theorem for Quantum Correlations? Daniel F. James¹; ¹*Physics, University of Toronto, Canada*. It has been known for more than a century that spatial coherence of light changes on propagation, a fact quantified by the van Cittert-Zernike theorem. Here we investigate how quantum correlations change on propagation.

FMG1 • 13:30 **Invited**

Keeping Matter in Focus in Photonic Crystal Fibers, Philip Russell; *NASA Ames Research Center, USA*. Hollow or solid core silica-air PCF, incorporating metals or gases, offers many opportunities for precise studies of linear and nonlinear light-matter interactions. Recent results on gas-based nonlinear optics and particle manipulation will be reviewed.

LMC1 • 13:30 * Broida Award Winner*

Breasts and Brains, Similarities and Differences: the Role of Nonlinear Microscopy in Molecular Imaging, Warren Warren¹; ¹*Chemistry Department, Duke University, USA*. I will discuss the opportunities for nonlinear optical molecular imaging, focusing on measurement of intrinsic nonlinear optical signatures of cancer or of brain activation, and put this work in context with other modalities.

LMB1 • 13:30 **Invited**

Towards Molecular Modeling of the Dynamics and Structure Molecular Aggregates in Liquid Solution and Its Spectroscopic Signature, Eitan Geva¹; ¹*Univ Michigan, USA*; ². In this talk, I will present three examples of our ongoing attempts towards developing a theoretical and computational framework for modeling the dynamics and structure molecular aggregates in liquid solution and its spectroscopic signature.

FMA • Special Symposium on Integrated Optofluidics for the Life Sciences—Continued**FMA2 • 14:00** **Invited** ▶

Single-Molecule Biophysics with Optofluidic Trapping. David Erickson¹; ¹*Cornell University, USA.* I will present our recent work on the optical trapping and manipulation of single molecules and nanomaterials using the near-field of integrated photonic devices.

FMA3 • 14:30 **Invited** ▶

Integration Methods for Raman Spectroscopy and Passive Sorting in Optofluidics. Praveen C. Ashok¹, Kishan Dholakia²; ¹*School of Physics & Astronomy, University of St Andrews, United Kingdom.* Applications of Waveguide Confined Raman Spectroscopy (WCERS) which realizes an alignment-free microfluidic chip for Raman spectroscopic detection of analytes is described. Separately passive optical sorting techniques in optofluidics are discussed.

FMB • Silicon Nanophotonics—Continued**FMB2 • 14:00**

Silicon Waveguide Fabry-Perot Cavity Formed by a Silicon Dioxide Cladding Grating. Richard Grote¹, Jeffrey B. Driscoll¹, Cladiu G. Biris², Nicolae C. Panou³, Richard M. Osgood¹; ¹*Electrical Engineering, Columbia University, USA;* ²*Electrical and Electronic Engineering, University College London, United Kingdom.* An integrated silicon waveguide Fabry-Perot cavity is fabricated by etching distributed Bragg reflectors with a quarter wave defect cavity into the silicon dioxide cladding. The measured transmission spectrum of the cavity agrees with theory.

FMB3 • 14:15

Omnidirectional Reflector Using Guided-Mode Resonance in a Subwavelength Silicon Grating under TE Polarization. Wenhua Wu¹, Robert Magnusson¹; ¹*Electrical Engineering, University of Texas at Arlington, USA.* A very simple omnidirectional reflector based on guided-mode resonance is reported. This one-dimensional subwavelength silicon grating has an angle-averaged omnidirectional reflectivity of >95% across a ~50 nm band under TE polarization.

FMB4 • 14:30 **Invited**

Integrated Silicon Photonics Bridging Photonics and Computing. Mario Paniccia; *Intel Capital, USA.* This presentation will provide an overview of silicon photonics research at Intel Corporation, describe some of the recent advances including the recently announced demonstration of an integrated silicon photonics optical link operating at 50Gbps and the scalability of this technology to >1Tbps. In addition the presentation will provide an overview and discuss the potential applications and future opportunities for enabling “photonics” in and around the PC and server platform.

FMC • Special Symposium on Novel X-ray and EUV Light Sources and Sciences; Accelerator-based X-ray Free-Electron Lasers and Science—Continued**FMC2 • 14:00** **Invited** ▶

A Next Generation X-ray Laser Array at the Berkeley Lab: Science Drivers and Facility Overview. Robert Schoenlein; *Lawrence Berkeley National Laboratory, USA.* The Next Generation Light Source is a high-repetition-rate seeded soft X-ray FEL array proposed for the Berkeley Lab. An overview of the energy science drivers and projected technical capabilities of this facility is presented.

FMC3 • 14:30 **Invited** ▶

X-ray Lasers for Molecular-Resolution Time-Resolved Nanocrystallography in Biology. John Spence; *Arizona State Univ., USA.* Abstract not available.

FMD • Optomechanics I—Continued**FMD3 • 14:00** ▶

Observation of Backaction of Ultracold Atoms onto a Mechanical Oscillator. Maria Korppi^{1,2}, Stephan Camerer^{2,3}, Andreas Jöckel^{1,2}, Matthew T. Rakher¹, David Hunger^{2,3}, Theodor W. Hänsch^{2,3}, Philipp Treutlein^{1,2}; ¹*Departement Physik, Universität Basel, Switzerland;* ²*Fakultät für Physik, Ludwig-Maximilians-Universität, Germany;* ³*Max-Planck-Institut für Quantenoptik, Germany.* An optical lattice formed by reflection from a SiN_x membrane creates a bidirectional coupling of atomic and membrane motion. Experimental demonstrations of both direct-action and backaction in this system are reported.

FMD4 • 14:15 **Invited** ▶

Opto-Mechanics and Quantum Dot-Nanocavity QED. Jelena Vuckovic¹, Arka Majumdar¹, Alexander Papageorge¹, Armand Rundquist¹, Yiyang Gong¹, Erik D. Kim¹, Michal Bajcsy¹; ¹*Stanford University, USA.* Phonon assisted interaction between a quantum dot and an off-resonant nanocavity has been studied and employed for coherent quantum dot spectroscopy.

FME • Phase—Continued**FME2 • 14:00** **Invited** ▶

Task-Based Assessment of Phase-Contrast Mammography. Adam M. Zysk¹, Mark A. Anastasio²; ¹*Illinois Institute of Technology, USA;* ²*Washington University in St. Louis, USA.* Theoretical and computational techniques are used to assess imaging system parameters and investigate the contributions of phase and absorption contrast to object detectability measures in propagation-based X-ray phase-contrast mammography.

FME3 • 14:30 **Invited** ▶

Extracting Absolute Phase and Amplitude from DIC Imagery. Donald Duncan¹, David Fischer², Amanda Dayton², Scott Prah¹; ¹*Electrical & Computer Engineering, Portland State University, USA;* ²*Oregon Medical Laser Center, USA;* ³*NASA/Glenn Research Center, USA.* We discuss the use of a DIC microscope for characterization of the scatter and absorption properties of thin tissue samples. We demonstrate the calibration process, illustrate phase-stepping approaches, and show representative results.

FIO

FMF • Entanglement—Continued

FMF2 • 14:00

Measurement-Induced Disturbance for a Variety of Projector Operators, Asma Al-Qasimi¹, ¹University of Toronto, Canada. Like Discord, Measurement-Induced Disturbance (MID) is defined based on the fact that measurements disturb quantum systems. However, MID is symmetric and involves no maximizations. I investigate various MID projectors selected for realistic systems.

FMF3 • 14:15

Withdrawn

FMF4 • 14:30

Multi-Photon Quantum Interferences with Independent Thermal Light Sources, Steffen H. Oppel^{1,2}, Thomas Büttner¹, Joachim von Zanthier^{1,2}, ¹Department of Physics, University of Erlangen-Nuremberg, Germany; ²Erlangen Graduate School in Advanced Optical Technologies (SAOT), University of Erlangen-Nuremberg, Germany. We report multi-photon interferences up to fifth order between photons emitted by independent thermal sources and compare the corresponding multi-photon signals to those generated by single photon emitters.

FMG • Novel Fibers and Applications I—Continued

FMG2 • 14:00

Ultrafast All-Optical Modulation in Silicon Optical Fibers, Priyanth Mehta¹, Noel Healy¹, Justin Sparks², Todd Day², Pier Sazio¹, John Badding², Anna Peacock¹, ¹Optoelectronics Research Centre, Univ Southampton, United Kingdom; ²Pennsylvania State University, USA. Degenerate and non-degenerate two-photon absorption based modulation is demonstrated in a hydrogenated amorphous silicon core optical fiber. We show modulation using femtosecond pulses and compare this with theory.

FMG3 • 14:15

Strongly Twisted Solid-Core PCF: A One-Dimensional Chiral Metamaterial, Gordon Wong¹, Myeongsoo Kang¹, Howard Lee¹, Sven Burger^{2,3}, Lin Zschiedrich³, Fabio Biancalana¹, Philip Russell^{1,4}, ¹Max Planck Institute for the Science of Light, Germany; ²Zuse Institute Berlin (ZIB), Germany; ³JCMwave GmbH, Germany; ⁴Department of Physics, University of Erlangen-Nuremberg, Germany. A continuously twisted PCF can be viewed as a one-dimensional metamaterial in which both ϵ and μ tensors develop off-diagonal elements. Finite-element calculations confirm the appearance of unique loss peaks in the experimental transmission spectrum.

FMG4 • 14:30

3-D Characterization of the Refractive-Index and Residual-Stress Distributions in Optical Fibers, Michael R. Hutsel¹, Thomas K. Gaylord¹, ¹School of ECE, Georgia Institute of Technology, USA. Refractive-index and residual-stress distributions of optical fibers exposed to a focused carbon-dioxide laser beam are characterized. Azimuthal and longitudinal variations are measured. Changes of 10^{-4} in index and 0.2 MPa in stress are resolvable.

LS

LMC • Novel Applications of Multi-Photon Contrast-Broida Award Symposium—Continued

LMC2 • 14:00

Imaging the Distribution of Melanin in Human Skin Lesions with Pump-Probe Microscopy, Mary Jane Simpson¹, Jesse W. Wilson¹, Thomas E. Matthews¹, Marco Duarte², Robert Calderbank², Warren S. Warren¹, ¹Chemistry, Duke University, USA; ²Computer Science and Electrical Engineering, Duke University, USA. We report on a number of extensions of our previously published pump-probe technique that resolves the two kinds of melanin in human skin including new flexibility, three-dimensional sectioning capabilities, and improved image processing results. Sacramento (Fairmont Hotel)

LMC3 • 14:15 **Invited**

Surface-mediated Four-wave Mixing Microscopy, Eric Potma¹, Yong Wang¹, Xuejun Liu¹, ¹Chemistry, University of California, Irvine, USA. We demonstrate that four-wave mixing signals from nanostructures can be generated by traveling surface plasmon polaritons. We have chosen a counterpropagating excitation scheme in which the nanostructure is exposed only to surface excitation fields.

LMB • Coherence and Control in Energy Transfer I—Continued

LMB2 • 14:00 **Invited**

Chemical Dynamics with Emphasis on Coherence and Control, Greg Engel; *Univ. of Chicago, USA*. We have developed a new spectroscopic method image excited state dynamics and capture excitonic structure in real time. Through this method and other ultrafast multidimensional spectroscopies, we have captured coherent dynamics within photosynthetic antenna complexes.

LMB3 • 14:30 **Invited**

Investigating Energy Transfer in the Bacterial Reaction Center with 2D Electronic Spectroscopy, Gabriela S. Schlau-Cohen^{1,2}, Eleonora De Re^{1,2}, Graham R. Fleming^{1,2}, ¹Chemistry, University of California, Berkeley, USA; ²Physical Biosciences Division, Lawrence Berkeley National Lab, USA. Two-dimensional electronic spectroscopy was employed on the reaction center from purple bacteria in order to resolve previously inseparable transitions and investigate timescales and mechanisms of energy transfer between the newly revealed states.

LMD • Laser Science Symposium on Undergraduate Research I—Continued

FMA • Special Symposium on Integrated Optofluidics for the Life Sciences—Continued

FMA4 • 15:00 ▶

Optofluidic Tomography, Serhan Isikman¹, Waheb Bishara¹, Hongying Zhu¹, Aydogan Ozcan^{1,2}; ¹*UCLA, USA*; ²*California Nanosystems Inst., UCLA, USA*. We demonstrate an optofluidic tomographic microscope on a chip. Lensfree holograms of objects flowing through a microfluidic-channel are recorded at multiple illumination angles to compute sub-pixel resolved tomograms for 3D imaging on a chip.

FMA5 • 15:15 ▶

Compact and Cost-effective Lensfree Reflection and Transmission Microscopy on Chip, Myungjun Lee¹, Oguzhan Yaglidere¹, Aydogan Ozcan¹; ¹*Electrical Engineering, UCLA, USA*. We present a field-portable lensfree dual-mode (i.e., reflection and transmission on-chip microscope that can digitally image e.g., blood cells and dense histopathology slides, providing a lateral resolution of $\sim 2\mu\text{m}$ over a wide field-of-view.

FMB • Silicon Nanophotonics—Continued

FMB5 • 15:00

T-shape Slot Waveguides for Efficient Control of Birefringence and Polarization Independent Directional Coupling, Yusheng Bian¹, Zheng Zheng¹, Ya Liu¹, Jiansheng Liu¹, Jinsong Zhu², Tao Zhou³; ¹*School of Electronic and Information Engineering, Beihang University, China*; ²*National Center for Nanoscience and Technology of China, China*; ³*Department of Physics, New Jersey Institute of Technology, USA*. A novel dielectric slot waveguide supporting highly confined optical waves in a T-shape slot region for both polarizations is proposed. Polarization insensitive directional couplers based on such waveguides are also presented.

FMB6 • 15:15

High Speed Concentric Circular CMOS Photodiodes Using Stair Step Circles for Direct Detection of Spatially Multiplexed Optical Channels, Syed Murshid¹, Jamil Iqbal¹; ¹*Electrical and Computer Engineering, Florida Institute of Technology, USA*. A novel concentric circular photodiode array within the confines of standard CMOS technology with built-in inductive effect is presented for high speed operations and direct detection of concentric circular output of spatially multiplexed channels

FMC • Special Symposium on Novel X-ray and EUV Light Sources and Sciences; Accelerator-based X-ray Free-Electron Lasers and Science—Continued

FMC4 • 15:00 **Invited** ▶

Applications of the LCLS X-ray Free Electron Laser for High-Energy Density Science, Richard Lee; *LLNL, USA*. Abstract not available.

FMD • Optomechanics I—Continued

FMD5 • 14:45 ▶

Feedback Enhanced Sensitivity in Cavity Optomechanics: Surpassing the Parametric Instability Barrier, Glen I. Harris¹, Ulrik L. Andersen², Joachim Knittel¹, Warwick P. Bowen¹; ¹*University of Queensland, Australia*; ²*Department of Physics, Technical University of Denmark, Denmark*. Parametric instability places an upper limit on the useful optical power in optomechanical sensors. We surpass this limit by using feedback stabilization, enabling motion transduction sensitivity at the level of 5×10^{-19} m/rtHz.

FMD6 • 15:00 ▶

Optomechanical Coupling in a Two Dimensional Photonic Crystal Cavity, Emanuel Gavartin², Remy Braive^{1,4}, Isabelle Sagnes¹, Olivier Arcizet³, Alexios Beveratos¹, Tobias Kippenberg^{2,5}, Isabelle Robert¹; ¹*LPN-CNRS, France*; ²*EPFL, Switzerland*; ³*Néel-CNRS, France*; ⁴*Université Paris 7, France*; ⁵*MPQ, Germany*. Abstract (35 Word Limit): We investigate the mechanical behavior exhibited by a 2D photonic crystal cavity in a suspended InP membrane. We observe two different mode families: flexural and localized modes. For the latest, strong optomechanical coupling is observed.

FMD7 • 15:15 ▶

Analysis of Harmonic Generation and RF Frequency Mixing in Optomechanical Oscillators, Fenei Liu¹, Mani Hossein-Zadeh¹; ¹*Center for High Technology Materials (CHTM), University of New Mexico, USA*. We have studied the generation of harmonics and the resulting RF frequency mixing properties in optomechanical oscillators (OMOs). Preliminary results and theoretical analysis show at small detuning regime OMO functions as square-law frequency mixer

FME • Phase—Continued

FME4 • 15:00 ▶

Phase Resolved Imaging of Nonlinear Focal Fields using Heterodyne Four-wave mixing microscopy, Varun Raghunathan¹, Alex Nikolaenko¹, Eric O. Potma¹; ¹*Chemistry Department and Beckmann Laser Institute, University of California Irvine, USA*. Heterodyne four-wave mixing microscopy of nanoparticles is used to image complex nonlinear focal excitation fields of a high-NA objective lens. The capability of this technique to phase resolve shaped beams is also demonstrated.

FME5 • 15:15 ▶

Phase Retrieval through Nonlinear Media, Chien-Hung Lu¹, Christopher Barsi¹, Jason Fleischer¹; ¹*Electrical Engineering, Princeton University, USA*. We extend the Gerchberg-Saxton algorithm to the phase retrieval through nonlinear media. We experimentally verify the technique by reconstructing a phase distribution from intensity measurements in two image planes with different positions.

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

FIO

LS

FMF • Entanglement—Continued

FMF5 • 14:45

Superradiance From Entangled Atoms, Ralph O. Wiegner¹, Joachim von Zanthier¹, Girish S. Agarwal²; ¹*Institute for Optics, Information and Photonics, University of Erlangen-Nuremberg, Germany*; ²*Department of Physics, Oklahoma State University, USA*. We present detailed results on how the optical properties of entangled atomic sources differ from sources in a separable state. We explain superradiance and sub-radiance of entangled sources in terms of quantum-interference among different paths.

FMF6 • 15:00

Experimental 11-dimensional two-photon entanglement, Adetunmise Dada¹, Jonathan Leach², Gerald Buller¹, Miles Padgett², Erika Andersson¹; ¹*SUPA, Heriot-Watt University, United Kingdom*; ²*Department of Physics and Astronomy, University of Glasgow, United Kingdom*. We have measured previously untested correlations between two entangled photons and obtain violations of generalized Bell-type inequalities strong enough to indicate genuine 11-dimensional entanglement.

FMF7 • 15:15

Withdrawn

FMG • Novel Fibers and Applications I—Continued

FMG5 • 14:45

Optical Nanofibres: Tools for Particle Propulsion and Manipulation, Mary Frawley^{1,2}, Alex Petcu-Colan^{1,2}, Galvin Khara^{1,2}, Sile Nic Chormaic^{2,3}; ¹*Physics, University College Cork, Ireland*; ²*Tyndall National Institute, Ireland*; ³*Okinawa Institute of Science and Technology, Japan*. We study the optimisation of optical nanofiber parameters for particle propulsion, and investigate the null taper coupler as a method of selectively generating higher modes in the nanofiber waist for trapping purposes

FMG6 • 15:00

Tapered As₂S₃ Chalcogenide Photonic Crystal Fiber for Broadband Mid-Infrared Supercontinuum Generation, Amine Ben Salem¹, Rim Cherif¹, Mourad Zghal¹; ¹*SupCom, Tunisia*. We design an As₂S₃ tapered photonic crystal fiber for mid-infrared supercontinuum generation. More than three octave spanning spectrum is generated in 8 mm-long taper with low input pulse energy of 100 pJ at 4.7 μm.

FMG7 • 15:15

Blueprint of A Defect Tolerant Waveguide Isolator based on Unidirectional Surface Waves, Anshuman Kumar¹, Matt Klug¹, Jin-hong Choi¹, Jin Wang¹, Nicholas X. Fang²; ¹*Massachusetts Institute of Technology, USA*. We propose a scheme for defect tolerant broadband waveguide isolator in microwave & optical frequencies. By restricting bulk mode in the system, we obtain high values of isolation ratio, verified by finite element simulations in the microwave range.

LMC • Novel Applications of Multi-Photon Contrast-Broida Award Symposium—Continued

LMC4 • 14:45 **Invited**

Title to Be Announced, Peter So; *MIT, USA*. Abstract not available.

LMC5 • 15:15

Femtosecond Pulse Shaping Enables Nonlinear Imaging in Highly Scattering Materials, Kevin E. Claytor¹, Baolei Li¹, Prathyush Samineni², Warren Warren², Martin C. Fischer²; ¹*Physics, Duke University, USA*; ²*Chemistry, Duke University, USA*. Spectral reshaping of pulses from a mode-locked femtosecond laser allows detection of two photon absorption and self phase modulation in highly scattering materials, which permits nonlinear tissue imaging with this intrinsic contrast.

LMB • Coherence and Control in Energy Transfer I—Continued

LMB4 • 15:00

Probing Vibrational Energy Transfer in DNA Nucleobases with Mid-UV Four-Wave Mixing Spectroscopies, Brantley A. West², Jordan M. Womick¹, Andrew M. Moran¹; ¹*Chemistry, University of North Carolina, USA*; ²*Physics and Astronomy, University of North Carolina, USA*. Heterodyne-detected four-wave mixing spectroscopies are used to investigate vibrational energy transfer in various DNA nucleobases. Unique insights into the solute-solvent couplings associated with vibrational energy transfer are obtained.

LMB5 • 15:15

Reduced decoherence in Non-Markovian systems lacking decoherence free subspaces, Curtis J. Broadbent¹, Jun Jing², Ting Yu², Joseph H. Eberly¹; ¹*Rochester Theory Center, and Department of Physics and Astronomy, University of Rochester, USA*; ²*Center for Controlled Quantum Systems, and the Department of Physics and Engineering Physics, Stevens Institute of Technology, USA*. By numerically simulating the exact master equation for the degenerate vee-type three-level system, we demonstrate the existence of states with drastically reduced decoherence in an open quantum system which does not admit decoherence free subspaces.

LMD • Laser Science Symposium on Undergraduate Research I—Continued

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

Empire

16:00–18:00
FMH • Special Symposium on Integrated Optofluidics for the Life Sciences II ▶
 David McGloin; *University of Dundee United Kingdom, Presider*

FMH1 • 16:00 **Invited** ▶
Chip Integrated Optical Manipulation of Single Airborne Particles, Marcel Horstmann¹, Karl Probst¹, Carsten Fallnich¹; *Institute of Applied Physics, Westfälische Wilhelms-Universität, Germany*. An integrated system for the optical manipulation and characterization of single airborne microparticles is presented. Optical fibers are used to deliver the trapping laser light as well as to collect scattered light for Raman spectroscopy.

FMH2 • 16:30 **Invited** ▶
Holographic Control and High-Speed Imaging for Studies of Hydrodynamic Coupling on a Micron Scale, Miles Padgett, Richard Bowman, Arran Curran, Roberto Di Leonardo*, Maria Dienerowitz, Graham Gibson and Michael Lee; *University of Glasgow, Scotland UK*; **Sapienza Università di Roma, Italy*. New interfaces make holographic optical tweezers an attractive tool within many branches of science. Here we use optical tweezers in the study of hydrodynamic interactions, specifically the hydrodynamic synchronization of thermally driven bi-stable systems.

Crystal

16:00–18:00
FMI • Novel Metamaterials and Plasmonic Structures ▶
 Mario Paniccia; *Intel Capital, USA, Presider*

FMI1 • 16:00 **Invited** ▶
Advances in Metamaterials and Transformation Optics, David R. Smith; *Duke Univ., USA*. Transformation optics (TO) is a recent addition to the tool set of optical design. Made relevant by advances in artificially structured media, TO provides new opportunities for improving existing optical devices and creating new devices.

FMI2 • 16:30 ▶
Carpet Cloak Device for Visible Light, Christopher Gladden¹, Majid Gharghi¹, Thomas Zentgraf¹, Yongmin Liu¹, Xiaobo Yin¹, Jason Valentine¹, Xiang Zhang¹; *University of California Berkeley, USA*. We report a cloak device that makes objects undetectable by visible light. It is designed using conformal mapping and is fabricated in silicon nitride waveguide on nano-porous silicon oxide substrate with very low refractive index.

Gold

16:00–18:30
FMJ • Special Symposium on Novel X-ray and EUV Light Sources and Sciences: Extreme Ultraviolet and Soft X-Ray Small-Scale Sources: Science and Applications ▶
 Carmen Menoni; *Colorado State Univ., USA, Presider*

FMJ1 • 16:00 **Invited** ▶
Laser-based Gamma-rays and the Emergence of Nuclear Photonics, Christopher Barty; *Lawrence Livermore Natl. Lab, USA*. The optimized interaction of laser light with relativistic electrons can produce mono-energetic gamma-rays (MEGa-rays) of unprecedented peak brightness. MEGa-ray sources enable a wide range of nuclear applications with photons, i.e. nuclear photonics.

FMJ2 • 16:30 **Invited** ▶
Strong Field Physics with Long Wavelength Lasers, Anthony DiChiara¹, Lou DiMauro; *The Ohio State University, USA*. High harmonic generation and strong-field ionization provides the methods to generate attosecond extreme ultraviolet pulses. Our research has explored, in particular, how high harmonic generation and strong-field ionization scales with the wavelength of the driving laser. In general, with increasing wavelength, higher frequency harmonic combs can be generated with more favorable intrinsic spectral phase profiles.

Valley

16:00–18:00
FMK • Three-Dimensional Structure Design, Fabrication, and Nanopatterning I
 Kevin Vora; *Harvard University, USA, Presider*

FMK1 • 16:00 **Invited**
Printing and Molding Approaches for 3D Metamaterials and Plasmonic Crystals, John Rogers, Debashis Chanda; *University of Illinois at Urbana-Champaign, USA*. The optimized interaction of laser light with relativistic electrons can produce mono-energetic gamma-rays (MEGa-rays) of unprecedented peak brightness. MEGa-ray sources enable a wide range of nuclear applications with photons, i.e. nuclear photonics.

FMK2 • 16:30
Dual Adaptive Optics System for 3D Laser Fabrication in High Refractive Index Media, Richard Simmonds¹, Patrick S. Salter¹, Martin Booth¹; *Engineering Science, University of Oxford, United Kingdom*. Laser fabrication depth is limited by refractive index induced focussing aberrations. We correct these using dual adaptive optical elements that considerably extend fabrication depth in materials including diamond, fused silica and lithium niobate.

California

16:00–18:30
FML • Fluorescence and Other Imaging Techniques ▶
 Andrew Berger; *Univ. of Rochester, USA, Presider*

FML1 • 16:00 **Tutorial** ▶
In vivo Imaging Of Tumors Using Multiphoton Fluorescence and Second Harmonic Generation, Xiaoxing Han¹, Javier Lapeira¹, Ryan Burke¹, Seth Perry¹, Kelly Madden¹, Ed Brown¹; *Univ. of Rochester, USA*. In this tutorial we will discuss how epifluorescence microscopy, confocal laser-scanning microscopy, and multiphoton laser-scanning microscopy are used to provide a detailed understanding of the pathophysiology of living tumors.



Edward Brown is an Associate Professor in Biomedical Engineering at the University of Rochester Medical Center. His research focus is tumor metastasis and novel applications of the multiphoton laser-scanning microscope. He is a Pew Scholar, a DoD BCRP Era of Hope Scholar, and an NIH Director's New Innovator Awardee.

FiO

16:00–17:30

FMM • Compressed Sensing
Daniel Marks; Duke University
United States, Presider

FMM1 • 16:00 **Tutorial**

Compressed Sensing for Practical Optical Imaging Systems, Rebecca M. Willett¹, Duke University¹, Roummel F. Marcia¹, Jonathan Nichols; ¹University of California at Merced; ²Naval Research Laboratory. This tutorial discusses compressed sensing in the context of optical imaging devices, emphasizing the practical hurdles related to building such devices and offering suggestions for overcoming these hurdles. Examples and analysis specifically related to infrared imaging highlight the challenges associated with large format focal plane arrays and how these challenges can be mitigated using compressed sensing ideas.



Rebecca Willett is an assistant professor in the Electrical and Computer Engineering Department at Duke University. She completed her PhD in Electrical and Computer Engineering at Rice University in 2005. Prof. Willett received the National Science Foundation CAREER Award in 2007, is a member of the DARPA Computer Science Study Group, and received an Air Force Office of Scientific Research Young Investigator Program award in 2010. Prof. Willett has also held visiting researcher positions at the Institute for Pure and Applied Mathematics at UCLA in 2004, the University of Wisconsin-Madison 2003-2005, the French National Institute for Research in Computer Science and Control (INRIA) in 2003, and the Applied Science Research and Development Laboratory at GE Healthcare in 2002. Her research interests include network and imaging science with applications in medical imaging, wireless sensor networks, astronomy, and social networks. Additional information, including publications and software, are available online at <http://www.ee.duke.edu/~willett/>.

16:00–17:45

FMN • Novel Fibers and Applications II
Philip Russell; Max Planck Erlangen
Germany, Presider

FMM1 • 16:00

Trapping Forces by Radially Polarised Mode from High Index Nano Fibers, Yinlan Ruan¹, Shahraam Afshar¹, Tanya Monro¹; ¹Institute for Photonics and Advancing Sensing, University of Adelaide, Australia. We predict that strong longitudinal field of the radially polarised mode from 450nm silicon fibers enables stable trapping of 30nm glass particle in air.

FMN2 • 16:15

Higher Order Mode Generation in Optical Nanofibers for the Purpose of Cold Atom Trapping, Mary Frawley^{1,2}, Alex Petcu-Colan^{1,2}, Sile Nic Chormaic^{2,3}; ¹Physics Department, University College Cork, Ireland; ²Tyndall National Institute, Ireland; ³Okinawa Institute of Science and Technology, Japan. We present an investigation into the behavior of higher order modes in optical nanofibers. We excite and analyze different modes in few-mode fibers and subsequently examine their behavior during the nanofiber fabrication process.

FMN3 • 16:30 **Invited**

Towards Nanostructured Optical Fibres: New Properties and Applications, Tanya Monro; University of Adelaide, Australia. Abstract not available.

LS

16:00–18:00

LMF • Towards Clinical Applications of Nonlinear Microscopy
Martin Fischer; Duke University,
USA, Presider

LMF1 • 16:00 **Invited**

Multiphoton Microscopy of Tissues for Medical Diagnostics, Ina Pavlova, Watt Webb; Cornell Univ., USA. Multiphoton Microscopy for spectral imaging of tissue fluorescence at 500nm lateral resolution can provide early medical diagnostics for lung cancers, inflammation and infection with the potential to reduce the ubiquitous mortality associated with lung cancer.

LMF2 • 16:30 **Invited**

Non-Linear Optical Microscopy with Coherent Raman Contrast for Brain Tumor Diagnosis and Resection Guidance, Geoffrey Young; ¹Brigham and Women's Hospital and Harvard Medical School, USA. Coherent Raman Microscopy (SRS and CARS) combined with TPA can provide histopathological image content needed for real-time live and fresh tissue optical diagnosis during minimally invasive MRI guided needle biopsy and intraoperative open biopsy.

16:00–17:30

LME • Coherence and Control in Energy Transfer II
Greg Engel; Univ. of Chicago, USA,
Presider

LME1 • 16:00 **Invited**

Electronic Coherence and Structure of Biological Aggregates Probed by Coherent Multidimensional Spectroscopy, Shaul Mukamel¹, Dmitri Voronine², Darius Abramavicius³, Jun Jiang¹; ¹Chemistry, University of California, Irvine, USA; ²Institute for Quantum Science and Engineering, Texas A&M Univ., USA; ³State Key Laboratory of Supramolecular and Material, Jilin Univ., China. Using multidimensional spectroscopy, we explored the energy-transfer and charge-separation pathways in photo-systems, quantum entanglement effects in nature, and aggregation mechanism of amyloid fibrils related to neurodegenerative diseases.

LME2 • 16:30 **Invited**


Following Energy Transfer from Carotenoid to Retinal in Xanthorhodopsin, Sanford Ruhman¹, Itay Gdor¹, Boris Loevsky¹, Elena Smolensky², Noga Friedman², Mordechai Sheves², Jing yi Zhu¹; ¹Inst. of Chemistry, Hebrew University, Israel; ²Organic Chemistry, Weizmann Institute, Israel. Xanthorhodopsin is a retinal protein, including carotenoid light harvesting antenna. femtosecond VIS to NIR study demonstrating efficient ultrafast light harvesting from carotenoid to retina is described. Dynamics and intermediates are discussed.

16:30–18:00

LMG • Laser Science Symposium on Undergraduate Research II

Empire

FMH • Special Symposium on Integrated Optofluidics for the Life Sciences II—Continued

FMH3 • 17:00 


Label-free Cytometry via Wavefront Sensing, James Jacob^{1,3}, William Sullivan^{2,1}, John A. Hoffnagle^{1,4}, ¹CytoRay, USA; ²University of California Santa Cruz, USA; ³Actinix, USA; ⁴Picarro, USA. We describe a new label-free technique to analyze cells. A wavefront sensor measures the aberrations imparted onto a laser beam by single cells. The calculated Zernike coefficients of the deformed wavefronts comprise unique cellular signatures.

FMH4 • 17:15


Full-Spectrum Hyperspectral Fluorescence Microscopy with the Image Mapping Spectrometer (IMS), Liang Gao², Nathan Hagen¹, Robert Kester¹, Tomasz Tkaczyk^{1,3}, ¹Bioengineering, Rice University, USA; ²Rice Quantum Institute, Rice University, USA; ³Electrical and Computer Engineering, Rice University, USA. We present a full-spectrum fluorescence microscope using Image Mapping Spectrometer. The microscope combines three filtering mechanisms - polarization, spatial coherence and datacube filtering by spectral unmixing - to replace traditional filters.

Crystal


FMI • Novel Metamaterials and Plasmonic Structures—Continued

FMI3 • 16:45 

Demonstration of Temporal Cloaking, Moti Fridman¹, Alessandro Farsi¹, Yoshitomo Okawachi¹, Alexander L. Gaeta¹; ¹EAP, Cornell University, USA. We present the first experimental demonstration of cloaking an event in the time domain. Our temporal cloaking scheme is based on the time-space duality and novel split time-lenses.

FMI4 • 17:00 

Conversion of Polarization State to Visible Color by Anisotropic Plasmonic Cross Antenna Arrays, Tal Ellenbogen¹, Kwanyong Seo¹, Kenneth B. Crozier¹; ¹School of Engineering and Applied Sciences, Harvard University, USA. We demonstrate a plasmonic device that maps the polarization state of light to visible color. Simulations and experiments confirm that varying the illuminating polarization results in marked differences in the chromaticity of the transmitted light.

FMI5 • 17:15 

Plasmonic Nano-Bubble Cavity Probed by Cathodoluminescence, Jun Xu^{1,2}, Hyungjin Ma³, Nicholas X. Fang^{1,2}; ¹Mechanical Engineering, MIT, USA; ²Mechanical Science and Engineering, UIUC, USA; ³Physics, UIUC, USA. We present cathodoluminescence (CL) imaging of nanoscale air bubble trapped in between thin amorphous silicon layer and silver. Interestingly, multiple fringes due to enhanced luminescence with strong dependence on the air gap are observed.

Gold

F i O

FMJ • Special Symposium on Novel X-ray and EUV Light Sources and Sciences; Extreme Ultraviolet and Soft X-Ray Small-Scale Sources: Science and Applications—Continued

FMJ3 • 17:00  **Invited**

Table-top Short Pulse Driver for sub-10 nm soft X-ray Lasers, Bradley Luther, David Alessi^{1,2}, Yong Wang^{1,2}, Liang Yin^{1,2}, Dale Martz^{1,2}, Mark Woolston^{1,2}, Jorge Rocca^{1,2}; ¹NSF Engineering Research Center for Extreme Ultraviolet Science and Technology, USA; ²Colorado State Univ., USA. We demonstrate a Ti:Sa driver for pumping sub-10 nm table-top soft X-ray lasers. Output energies of 13.5 J have been obtained pre-compression, allowing gain-saturated lasing in sub-10 laser lines at 1 Hz repetition rate.

Valley

FMK • Three-Dimensional Structure Design, Fabrication, and Nanopatterning I—Continued

FMK3 • 16:45

Impact of Different Dithiol Treatments on the Optoelectronic Properties of Self-Assembled Pbs Nanocrystalline Films, Xin Ma¹, Fan Xu¹, Sylvain G. Cloutier^{1,2}; ¹Electrical and Computer Engineering, University of Delaware, USA; ²Delaware Biotechnology Institute, USA. By comparing ethanedithiol and benzenedithiol treatments, we demonstrate that the optical and electronic properties of self-assembled PbS nanocrystalline films heavily depend on the dithiol molecule used for the ligand-exchange process.

FMK4 • 17:00


Fabrication of Functionalized Optical Microstructures by Exploiting Nanofluidic Instabilities, Sara Coppola¹, Veronica Vespini¹, Andrea Finizio¹, Simonetta Grilli¹, Francesco Merola¹, Pietro Ferraro¹; ¹Istituto Nazionale di Ottica, Italy. A novel approach is presented for fabricating single or arrays of complex high-aspect ratio unique 3D microstructures. The applicability of specific structures as optical tweezers and as excitable quantum dot-embedded microresonators is presented.

FMK5 • 17:15


Low-energy Plasmons in Ultrathin Silver Structures: a Combination of Electron Energy Loss and Infrared Spectroscopy, Chung Vu Hoang¹, Tadaaki Nagao¹; ¹International Center for Materials Nanoarchitectonics, National Institute for Materials Science, Japan. A combination of two approaches: infrared (by use of photon) and electron energy loss (electron) spectroscopy is presented to show the difference of Ritchie (slab) plasmon and two-dimensional (sheet) plasmon in the silver nanostructure.

California

FML • Fluorescence and Other Imaging Techniques—Continued

FML2 • 16:45 

Second-Harmonic Microscopy for Cornea Collagen Fibril Imaging: Theoretical and Experimental Optimization, Brian Vohnsen¹, Jia Jun Li¹, Atikur Jewel¹; ¹School of Physics, University College Dublin, Ireland. Second-harmonic microscopy for collagen fibril imaging in the post-mortem porcine cornea has been analyzed experimentally and theoretically in order to optimize 3-D imaging while reducing light toxicity towards *in vivo* applications.

FML3 • 17:00 

Imaging Spectroscopy without a Spectrometer, Thomas Kohlgraf-Owens¹, Aristide Dogariu¹; ¹CREOL, College of Optics and Photonics, University of Central Florida, USA. Imaging spectroscopy implies a trade-off between spectral, spatial, and temporal resolution. We present a technique that allows for dynamic adjustment of the spectral-spatial trade-off with snapshot measurements.

FML4 • 17:15  **Invited**

***In vivo* Particle Bombardment and Viral Methods for Specific Cellular and Subcellular Labeling**, Ken Greenberg; ¹Spiral Genomics LLC, USA. We demonstrate bright coherent X-ray supercontinua generated through fully phase-matched upconversion of mid-IR laser light into the keV spectral region. The ultrabroad bandwidths can support pulse durations of few attoseconds, scalable to zeptosecond time scales.

FIO

FMM • Compressed Sensing—Continued**FMM2 • 16:45**

Image Coding for Compressive Focal Tomography, Kenneth P. MacCabe^{1,2}, David S. Kittle¹, Daniel L. Marks¹, David J. Brady¹; ¹*Electrical and Computer Engineering, Duke University, USA*; ²*Physics and Astronomy, University of North Carolina, USA*. We consider image coding to alias high spatial frequencies in a focused image into low-frequency components which survive low-pass defocusing. Coding before defocusing is shown to structure measurements appropriately for decompressive inference.

FMM3 • 17:00

Compressive Phase Space Tomography, Lei Tian¹, Justin Lee¹, Se Baek Oh¹, George Barbastathis^{1,2}; ¹*MIT, USA*; ²*Singapore-MIT Alliance for Research and Technology (SMART) Centre, Singapore*. We apply compressive sensing to retrieve mutual intensity using phase space tomography. Both simulation and experimental results show significant improvement in the recovery result.

FMM4 • 17:15

Sparse Aperture Holographic Synthesis with Multiple Speckle Realizations, Sehoon Lim¹, Daniel L. Marks¹, David Brady¹; ¹*ECE, Duke University, USA*. Sparse aperture holographic synthesis enables large scale high resolution imaging with sources in variable states of coherence. Using incoherent sources increases bandpass coverage and reduces speckle effects.

FMN • Novel Fibers and Applications II—Continued**FMN4 • 17:00**

Multi-Wavelength Dissipative Soliton, Single-Wall Carbon Nanotube Mode-Locked Fiber Laser, Ya Liu¹, Xin Zhao¹, Zheng Zheng¹, Jiansheng Liu¹, Lei Liu¹, Xin Yang², Jinsong Zhu²; ¹*School of Electronic and Information Engineering, Beihang University, China*; ²*National Center for Nanoscience and Technology of China, China*. We demonstrate a multi-wavelength, single-wall carbon nanotube passively mode-locked erbium-doped fiber laser. The laser can generate orthogonally polarized, dual-wavelength dissipative solitons at 1600 nm in a net normal dispersion cavity.

FMN5 • 17:15

Fluorescence Depolarization in Erbium-Doped Fibers Excited in 1490-1570nm Spectral Range, Liliana O. Martínez-Martínez¹, Eliseo Hernández-Hernández¹, Serguei Stepanov¹; ¹*Optica, Centro de Investigación Científica y de Educación Superior de Ensenada, Mexico*. Depolarization of the fluorescence excited at 1492, 1526, and 1568nm in EDF with concentrations 600-5600ppm proved to be in good qualitative agreement with earlier reported reduction in population gratings recorded via saturation of absorption.

LS

LMF • Towards Clinical Applications of Nonlinear Microscopy—Continued**LMF3 • 17:00 Invited**

Ultrashort-Pulse Lasers for Nonlinear Microscopies, Frank Wise¹; ¹*Cornell University, USA*. The development of short-pulse lasers for use in nonlinear microscopy will be reviewed. After a brief historical overview of lasers used in nonlinear microscopy, recent developments in fiber lasers will be described.

LME • Coherence and Control in Energy Transfer II—Continued**LME3 • 17:00 Invited**

The Role of Nuclear Modes in Coupled Electronic Systems: Quantum Coating, Vibronic Modulation, or Quantum-Dissipative Energy Flow? Niklas Christensson¹, Oliver Bixner¹, Franz Milota¹, Juergen Hauer¹, Harald F. Kauffmann¹; ¹*Faculty of Physics, University at Vienna, Austria*. The modulation of electronic dynamics by nuclear modes in a phthalocyanine dimer has been investigated by 2D-ES. Quantum-dissipative relaxation between the two excited states on 20 fs timescale is mediated by a 700 cm⁻¹ mode.

LMG • Laser Science Symposium on Undergraduate Research II—Continued

FMH • Special Symposium on Integrated Optofluidics for the Life Sciences II—Continued**FMH5 • 17:30** ▶

Adaptive Nanodispenser Microrobot for lab-on-a-chip in microfluidic platform, Sara Coppola¹, Veronica Vespini¹, Melania Paturzo¹, Simonetta Grilli¹, Pietro Ferraro¹; ¹Istituto Nazionale di Ottica, Italy. A novel and interesting approach of electrode-less technique to grip and transport micro objects driven by pyroelectric effect is demonstrated. The force is generated by applying thermal stimulus on Lithium Niobate crystal by an IR laser.

FMH6 • 17:45 ▶

Thermal Manipulation of Water Droplets - A Path to Droplet Microfluidics, Sanhita Dixit¹, Gregory W. Faris¹; ¹SRI International, USA. Optical manipulation of water droplets in an oil matrix is important in the development of droplet microfluidics. In this report we demonstrate infrared laser based droplet manipulation using the thermal Marangoni effect and thermal convection.

FMI • Novel Metamaterials and Plasmonic Structures—Continued**FMI6 • 17:30** ▶

Surface Plasmons at Graded Metal-Dielectric Interfaces, Brett A. Kruger¹, Joyce Poon^{1,2}; ¹Electrical and Computer Engineering, University of Toronto, Canada; ²Institute for Optical Sciences, University of Toronto, Canada. Surface plasmons at metal-dielectric interfaces with graded permittivity are studied. Dispersion relations, field profiles, and losses are derived analytically and numerically. Interface gradation causes anomalous dispersion and increased losses.

FMI7 • 17:45 ▶

Transverse Electromagnetic Modes in Aperture Waveguides Containing a Metamaterial with Extreme Anisotropy, Peter B. Catrysse¹, Shanhui Fan¹; ¹Edward L. Ginzton Laboratory, Stanford University, USA. We show that all modes supported by simply connected apertures containing a metamaterial with extreme anisotropy are purely transverse electromagnetic, dispersion-free, and without cutoff frequency.

FMJ • Special Symposium on Novel X-ray and EUV Light Sources and Sciences; Extreme Ultraviolet and Soft X-Ray Small-Scale Sources: Science and Applications—Continued**FMJ4 • 17:30** **Invited** ▶

Inductively Driven, Electrodeless Z-pinch Sources for EUV and Soft X-ray Applications, Matthew Partlow, Steve Horne, Donald Smith; *Energetiq Technology, Inc., USA*. Z-pinch discharge plasmas can be inductively driven without the use of electrodes, producing photons in the range from ~ 1 to 120 nm. Our z-pinch light source has been utilized in soft x-ray microscopy and extreme ultraviolet lithography applications.

FMJ5 • 18:00 **Invited** ▶

Phase Matching of Attosecond-to-Zeptosecond Kilo-electronvolt X-ray Supercontinua from High Harmonic Generation, Tenio Popmintchev, Margaret Murnane, Henry Kapteyn; *University of Boulder Colorado, USA, JILA*. We demonstrate bright coherent X-ray supercontinua generated through fully phase-matched upconversion of mid-IR laser light into the keV spectral region. The ultrabroad bandwidths can support pulse durations of few attoseconds, scalable to zeptosecond time scales.

FMK • Three-Dimensional Structure Design, Fabrication, and Nanopatterning I—Continued**FMK6 • 17:30**

Synthesis of Mesoporous TiO₂ Nanowire Film for High Performance PbS/TiO₂ Heterojunction Photovoltaic Devices, Fan Xu¹; ¹electrical and computer engineering, university of delaware, USA. We report on the fabrication of mesoporous TiO₂ nanowire film for PbS/TiO₂ heterojunction solar cells. We achieved improved short circuit current and a remarkable power converting efficiency of 5.5% under 8.5 mW/cm² white light illumination.

FMK7 • 17:45

A Contra-Directional Coupling based Waveguide Mode Converter in 3D Photonic Crystals, Jian Wang¹, Minghao Qi¹; ¹Electrical and Computer Engineering, Purdue University, USA. We designed a 25µm-long photonic crystal waveguide mode converter for 3D photonic circuits, which has greater than 95% conversion efficiency over a 20nm bandwidth at a center wavelength of 1550nm.

FML • Fluorescence and Other Imaging Techniques—Continued**FML5 • 17:45** ▶

How to Enhance the Two-Photon Brightness of Fluorescent Proteins? Mikhail Drobizhev¹, Nikolay Makarov¹, Shane Tillo², Thomas Hughes³, Aleksander Rebane⁴; ¹Physics, Montana State University, USA; ²Cell Biology and Neuroscience, Montana State University, USA. Fluorescent proteins (FPs) are widely used in two-photon laser microscopy as genetically-targeted probes. We provide the guidelines for increasing their peak 2PA cross section by tuning (via mutations) local electric field inside protein.

FML6 • 18:00 **Invited** ▶

Spectrally Encoded Imaging, Dongkyun Kang¹, Brett Bouma¹, Tearney Guilermo¹; ¹Massachusetts General Hospital and Harvard Medical School, USA. Spectrally encoded imaging is a high-speed endoscopic imaging technology that encodes a transverse coordinate of the sample in the wavelength. We will discuss spectrally encoded confocal microscopy and spectrally encoded endoscopy.

18:30–20:30 **OSA and SPS Student Member Reception, The Britannia Arms Downtown San Jose, 173 W. Santa Clara St., San Jose, CA 95113, Phone: 408.278.1400**

Hillsborough

Atherton

Sacramento

Piedmont

Glen Ellen

FiO

LS

FMM • Compressed Sensing—Continued

FMN • Novel Fibers and Applications II—Continued

LMF • Towards Clinical Applications of Nonlinear Microscopy—Continued

LME • Coherence and Control in Energy Transfer II—Continued

LMG • Laser Science Symposium on Undergraduate Research II—Continued

FMN6 • 17:30

Raman Response Function of Phosphosilicate Fiber, Alejandro Martinez-Rios¹, Guillermo Salceda-Delgado¹, Ismael Torres-Gomez¹, Victor Manuel Duran-Ramirez²; ¹*Division de Fotonica, Centro de Investigaciones en Optica, Mexico*. The Raman response function of phosphosilicate fiber is calculated and used to model the Raman self-frequency shift of a pulse. A speeding up of the Raman shift is observed when compared to standard fiber.

LMF4 • 17:30 Invited

Technology Development For Multiphoton Endoscopy: Superresolution, Min Gu¹; ¹*Swinburne University of Technology, Australia*. We show that superresolution endoscopic imaging is possible by using a photonic crystal fibre. It is demonstrated that resolution in multiphoton imaging modes can be improved to be better than $\lambda/10$.

18:30–20:30 OSA and SPS Student Member Reception, *The Britannia Arms Downtown San Jose, 173 W. Santa Clara St., San Jose, CA 95113, Phone: 408.278.1400*

Monday, 17 October