CLEO: QELS-Fundamental Science

08:00–10:00
QM1A • Active and Nonlinear Metamaterials

Presider: Benjamin Eggleton; University of Sydney, Australia

QM1A.1 • 08:00
Limits of Plasmonic Enhancement of Third Order Nonlinear Optical Effects, Jacob Khurgin[1], Gregory Sun[2]; *[1]Johns Hopkins Univ., USA; [2]University of Massachusetts Boston, USA.* We present a rigorous theory to show that while tremendous enhancement of $\chi(3)$ can be obtained in nanoplasmonic metamaterials, the overall efficiency remains very small, making them irrelevant for photonic switching and wavelength conversion applications.

QM1A.2 • 08:15
Four Wave Mixing Propagation in Fishnet Metamaterials, Haim Suchowski[1], Kevin O'Brien[1], Zi Jing Wong[1], Xiaobo Yin[1], Xiang Zhang[1]; *[1]University of California Berkeley, USA.* We experimentally investigate the nonlinear propagation in thick optical negative index materials. The ratio of the forward to backward four wave mixing generation was shown to follow the prediction of the phase-matching relations.

QM1A.3 • 08:30
Second Harmonic Generation in Transition Metamaterials, Zhaxylyk Kudyshev[1], Ildar R. Gabitov[2], Andrei I. Maimistov[3], Natalia M. Litchinitser[1]; *[1]Department of Electrical Engineering, The State University of New York at Buffalo, USA; [2]Department of Mathematics, University of Arizona, USA; [3]Department of General Physics, Moscow Institute of Physics and Technology, Russian Federation.* We show that resonant field enhancement of obliquely incident light in a quadratically nonlinear metamaterial with refractive index gradually changing from positive to negative values enables efficient second harmonic generation at significantly reduced input intensities.

08:00–10:00
QM1B • Near-field Imaging & Spectroscopy

Presider: Jessie Chin; University of Stuttgart, Germany

QM1B.1 • 08:00
Strong Interaction between a Single Carbon Nanotube and an Optical Microresonator, Mian Zhang[1], Arthur Barnard[2], Gustavo S. Wiederhecker[3], Paul L. McEuen[2,4], Michal Lipson[1,4]; *[1]Electric and Computer Engineering, Cornell University, USA; [2]Laboratory of Atomic and Solid State Physics, Cornell University, USA; [3]Instituto de Fisica Gleb Wataghin, Universidade Estadual de Campinas, Brazil; [4]Kavli Institute at Cornell, Cornell University, USA.* We couple a single suspended carbon nanotube to the near field of a free standing optical microdisk. The strong interaction between the nanotube and the microcavity produces an ultrahigh photocurrent response as large as 0.35mA/W.

QM1B.2 • 08:15
Nanoscale Temperature Mapping of Photonic and Plasmonic Devices, Boris Desiatov[1], Ilya Goykhman[1], Mor Tzur[1], Uriel Levy[1]; *[1]Hebrew University of Jerusalem, Israel.* We experimentally demonstrate nanoscale thermal mapping of light induced heat in photonic and plasmonic devices using a thermocouple AFM tip. Numerical simulations results and nanoscale temperature measurements are presented and discussed.

QM1B.3 • 08:30
Nonlinear ultrasonics in gold-cobalt bilayer structures probed with femtosecond surface plasmons, Vasily V. Temnov[1], Christoph Klieber[2], Keith A. Nelson[2], Tim Thomay[3], Vanessa Knittel[3], Alfred Leitenstorfer[3], Denys Makarov[4], Manfred Albrecht[4], Rudolf Bratschitsch[4]; *[1]Institut des Molécules et Matériaux du Mans, CNRS, France; [2]Department of Chemistry, MIT, USA; [3]Department of Physics and Applied Photonics, University of Konstanz, Germany; [4]Institute of Physics, Chemnitz University of Technology, Germany.* Giant (1%) picosecond strain pulses are generated in a fs-laser-irradiated cobalt transducer sandwiched between a gold layer and sapphire substrate. Ultrafast plasmonic interferometry reveals nonlinear acoustic propagation effects in the (111) gold film.

08:00–10:00
QM1C • Nonclassical & Nonlocal Quantum States

Presider: William Munro; NTT Basic Research Laboratories, Japan

QM1C.1 • 08:00 Tutorial
Non-Classical States of Light: Toward Scalable Photonic Quantum Networks, Ian A. Walmsley[1]; *[1]University of Oxford, United Kingdom.* Non-classical states of light enable new modes of new modes of communications, sensing and computation. I describe current research on the construction of a scalable photonic quantum network that will facilitate the preparation of distributed quantum correlations among light beams.

Ian Walmsley is the Hooke Professor of Experimental Physics at the University of Oxford, where is also the Pro-Vice-Chancellor for Research and University Collections. His group's research covers a broad range of optical science and engineering, especially in the areas of ultrafast, nonlinear and quantum optics. In these areas the group has contributed to the development of methods for characterizing quantum states and ultrafast optical fields, and applied these to the study of the generation and utilization of nonclassical light and to the control of the interaction of quantum light and matter. These are used to investigate fundamental phenomena in quantum physics and toward realizing quantum information processing protocols.

08:00–10:00
QM1D • Coherent Effects in Excitons and Polaritons

Presider: Hrvoje Petek; University of Pittsburgh, United States

QM1D.1 • 08:00 Invited
Time-resolved Terahertz Mapping of a Cold Exciton-Polariton Gas, Jean-Michel Menard[1], Christoph Poellmann[1], Michael Porer[1], Elisabeth Galopin[2], Aristide Lemaître[2], Alberto Amo[2], Jacqueline Bloch[2], Rupert Huber[1]; *[1]Physics, Universität Regensburg, Germany; [2]CNRS-Laboratoire de Photonique et Nanostructures, France.* Time-resolved terahertz absorption by intra-excitonic 1s-2p transitions traces the matter part of cavity polaritons while they cool into a condensed phase. The population dynamics close to the zero-momentum state is correlated with simultaneous angle-resolved photoluminescence.

QM1D.2 • 08:30
Room Temperature Spin-Polarized Polariton Lasers, Feng-kuo Hsu[1], Yi-Shan Li[2], Sheng-Di Lin[2], Chih-Wei Lai[1]; *[1]Physics and Astronomy, Michigan State University, USA; [2]Electronic Engineering, National Chiao Tung University, Taiwan.* We report room temperature spin-polarize polariton lasing characteristics and dynamics of a planar InGaAs/GaAs microcavity under non-reasonant circularly polarized picosecond optical excitation.

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

08:00–10:00
QM1E • Novel Phenomena in Photonic Lattices
Presider: Zhigang Chen; San Francisco State Univ, United States

QM1E.1 • 08:00
Supersymmetric optics: Continuous and discrete 1D structures for selective mode filtering, Matthias Heinrich[1], Mohammad-Ali Miri[1], Simon Stützer[2], Ramy El-Ganainy[3], Stefan Nolte[2], Alexander Szameit[2], Demetrios N. Christodoulides[1]; [1]*CREOL The College of Optics and Photonics, University of Central Florida, USA;* [2]*Institute of Applied Physics, Friedrich-Schiller-University, Germany;* [3]*Department of Physics, University of Toronto, Canada.* We demonstrate that supersymmetry can furnish apparently dissimilar optical structures with the same scattering and guided-wave characteristics. We explore continuous one-dimensional SUSY arrangements in order to design a new class of versatile integrated filters.

QM1E.2 • 08:15
Photonic Topological Insulator-Solitons, Yaakov Lumer[1], Mikael C. Rechtsman[1], Yonatan Plotnik[1], Moti Segev[1]; [1]*Physics, Technion, Israel.* We present photonic topological insulator-solitons: self-trapped wavepackets that form a self-localized edge states residing in the bulk of a photonic topological insulator (helical waveguide honeycomb lattice), while continuously rotating with a given directionality.

QM1E.3 • 08:30
Hybrid Bloch-Anderson localization of light, Simon Stützer[1], Yaroslav V. Kartashov[2,3], Victor A. Vysloukh[4], Andreas Tünnermann[1], Vladimir V. Konotop[5], Stefan Nolte[1], Lluis Torner[2], Alexander Szameit[1]; [1]*Friedrich-Schiller-Universität, Institute of Applied Physics, Germany;* [2]*ICFO-Institut de Ciencies Fotoniques,, Universitat Politecnica de Catalunya, Spain;* [3]*Russian Academy of Sciences, Institute of Spectroscopy, Russian Federation;* [4]*Universidad de las Americas, Departamento de Fisica y Matematicas, Mexico;* [5]*Faculdade de Ciencias Universidade de Lisboa, Centro de Física Teórica e Computacional and Departamento de Física, Portugal.* We investigate the interplay of two qualitatively different localization mechanisms: Bloch oscillations and Anderson localization in a system of weakly-coupled optical waveguides.

08:00–10:00
CM1F • Microresonators I
Presider: Yoshi Okawachi, Cornell University, USA

CM1F.1 • 08:00
Integrated high-quality factor silicon-on-sapphire resonators for Mid-infrared applications, Raji Shankar[1], Irfan Bulu[1], Marko Loncar[1]; [1]*SEAS, Harvard University, USA.* We demonstrate high-quality (Q) factor grating-coupled silicon-on-sapphire ring resonators, operating around 4.5 µm. Total Q-factors of 151,000 and intrinsic Q-factors of 278,000 are measured, enabling applications in nonlinear wavelength generation and other areas.

CM1F.2 • 08:15
Multi-modal optical microcavities for loss avoidance, Jeffrey M. Shainline[1], Jason Orcutt[2], Mark T. Wade[1], Roy Meade[3], Ofer Tehar-Zehav[4], Zvi Sternberg[4], Vladimir Stojanovic[2], Milos Popovic[1]; [1]*Electrical, Computer, and Energy Engineering, University of Colorado, USA;* [2]*Research Laboratory of Electronics, Massachusetts Institute of Technology, USA;* [3]*Micron Technologies, USA;* [4]*Micron Semiconductor, Israel.* We present optical cavities wherein multiple guided modes interfere to avoid loss at sidewall contacts. Cavities with 62 silicon contacts show resonances with intrinsic quality factors near 40,000 across an 80nm spectral range.

CM1F.3 • 08:30 Invited
SNAP: Fabrication of Ultra-low-loss Miniature Photonic Circuits with Sub-angstrom Precision, Misha Sumetsky[1]; [1]*OFS Laboratories, USA.* The SNAP (Surface Nanoscale Axial Photonics), a technological platform enabling fabrication of miniature photonic circuits with record low loss and high precision, is reviewed.

08:00–10:00
CM1G • Advanced Modulation Formats & Digital Signal Processing
Presider: Ivan Djordjevic; University of Arizona, United States

CM1G.1 • 08:00
Generation of Optical 32QAM using Two Tandem IQ Modulators with Simplified Electronics, Guo-Wei Lu[1], Takahide Sakamoto[1], Tetsuya Kawanishi[1]; [1]*Natl. Inst. of Info. & and Comm. Tech., Japan.* We propose and demonstrate an optical 32QAM transmitter, consisting of two tandem IQ modulators driven by binary and 3-level electronics. Compared with the single-IQ modulator scheme requiring 6-level electronics, the complexity in electronics is reduced.

CM1G.2 • 08:15
Opto-Electronic Multi-Level Signal Regeneration, Masayuki Matsumoto[1], Sansa Kou[2], Shuhei Tanaka[2]; [1]*Wakayama University, Japan;* [2]*Osaka University, Japan.* A simple 3R DQPSK regenerator is demonstrated, where the input signal drives a dual-parallel Mach-Zehnder modulator after demodulation, balanced-detection and limiting amplification. Required bandwidth of the limiting amplifier is numerically examined.

CM1G.3 • 08:30
On-chip single-shot and real-time self-referenced phase characterization of GHz-rate telecommunication signals, Hamed Pishvai Bazargani[1], Jean-Baptiste Quélène[1], Patrick Dumais[2], Antonio Malacarne[3], Matteo Clerici[1], Roberto Morandotti[1], Claire Callender[2], Jose Azana[1]; [1]*Institut National de la Recherche Scientifique - Energie, Matériaux et Télécommunications (INRS-EMT),, Canada;* [2]*Communications Research Centre Canada (CRC),, Canada;* [3]*National Laboratory of Photonic Networks - CNIT, Italy.* Phase Reconstruction using Optical Ultrafast Differentiation (PROUD) is implemented using an integrated Mach-Zehnder Interferometer, demonstrating self-referenced phase characterization of GHz-rate complex (up to 4-level amplitude and 4-level phase) modulation signals in a single-shot and real-time.

08:00–10:00
CM1H • Laser Writing and Patterning
Presider: Emmanuel Haro-Poniatowski; Physics Department, UAM-Iztapalapa, Mexico

CM1H.1 • 08:00
Femtosecond laser direct writing of 3D high-aspect-ratio nanofluidic channels in glass: a new platform for DNA analysis, Yang Liao[1], Changning Liu[1], Fei He[1], Lingling Qiao[1], Ya Cheng[1], Koji Sugioka[2], Katsumi Midorikawa[2]; [1]*Shanghai Inst of Optics and Fine Mech, China;* [2]*RIKEN - Advanced Science Institute, Japan.* We report on controllable production of 3D high-aspect-ratio (length to width ratio > 1,000) nanochannel with a width of ~40 nm in glass by femtosecond laser direct writing, and demonstrate its applicability for DNA analysis.

CM1H.2 • 08:15
Integrated Laser Processed Silver Nanowire Transparent Electrodes with Organic Electronic Devices, Joshua Spechler[1,2], Ken Nagamatsu[1,3], James C. Sturm[1,3], Craig B. Arnold[1,2]; [1]*Princeton Institute for Materials Science Technology, Princeton University, USA;* [2]*Mechanical and Aerospace Engineering, Princeton University, USA;* [3]*Electrical Engineering, Princeton University, USA.* UV pulsed laser irradiation coupled into a metal nanowire network through plasmonic absorption leads to localized welding of junction points. This approach enables direct integration of transparent metal films with organic photovoltaic and light emitting devices.

CM1H.3 • 08:30
Femtosecond Laser-Written Couplers in Fused Silica Fiber: Towards Fiber Cladding Optical Circuits, Ho Yiu Cheng[1], Jason Grenier[1], Peter R. Herman[1]; [1]*The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, University of Toronto, Canada.* Various means for coupling light from fiber core waveguide is examined to enable integration with fiber cladding optical circuits written by oil-immersion with femtosecond lasers. Coreless optical fiber and in-fiber Mach Zehnder interferometers are introduced.

CLEO: Science & Innovations

08:00–10:00
CM1I • Mode-locked Fiber Lasers
Presider: Shinji Yamashita; University of Tokyo, Japan

CM1I.1 • 08:00
Passively Mode-Locked Fiber Laser Incorporating Adaptive Filtering and Dispersion Management, Xin Yang[1], Hammani Kamal[1], David J. Richardson[1], Periklis Petropoulos[1]; [1]*Optoelectronic Research Centre, University of Southampton, United Kingdom.* We demonstrate a passively mode-locked Erbium (Er)-doped fiber ring laser with a net dispersion which can be adjusted through a programmable filter placed inside the laser cavity.

CM1I.2 • 08:15
Supermode noise suppression in an actively mode-locked fiber laser with pulse intensity feed-forward, Ruixin Wang[1], Kun Xu[1], Yitang Dai[1], Feifei Yin[1], Jianqiang Li[1], Yuefeng Ji[1], Jintong Lin[1]; [1]*Beijing Univ of Posts & Telecom, China.* The supermode noise in an actively mode-locked laser is suppressed for the first time by pulse intensity feed-forward technique. Pulse train with >80 dB supermode-suppression ratio and 22.7-fs timing jitter (100 Hz-10 MHz) is obtained.

CM1I.3 • 08:30
Multi-Bound Pulse State in a 250 GHz Mode-Locked Fiber Laser Based on a Silicon Micro-Ring Resonator, Siao-Shan Jyu[1], Ling-Gang Yang[1], Chien-Hung Yeh[3,4], Chi-Wai Chow[1], Hon Ki Tsang[2], Yinchieh Lai[1]; [1]*Photonics, Electro-Optical Engineering National Chiao Tung University, Taiwan;* [2]*Electronic Engineering, Electro-Optical Engineering Chinese University of Hong Kong, Hong Kong;* [3]*Information and Communications Research Laboratories, Industrial Technology Research Institute (ITRI, Taiwan;* [4]*Graduate Institute of Applied Science and Engineering, Fu Jen Catholic University, Taiwan.* A 250 GHz passive mode-locked Er-doped fiber laser with a silicon-based micro-ring resonator is demonstrated experimentally. Besides the single pulse operation at 250 GHz, we also observe an interesting multi-bound pulse operation state.

08:00–10:00
CM1J • THz Metamaterials & Plasmonics I
Presider:TBA

CM1J.1 • 08:00 **Tutorial**
Terahertz Nano Antennas: Fundamentals and Applications, Dai-Sik Kim[1]; [1]*Department of Physics and Chemistry, Seoul National University, South Korea.* Terahertz waves focus onto nano antennas, resulting in field enhancements of 100-10,000. Kirchhoff integral and Poynting theorem will be used to decipher energy-field relationships, and Fermi's golden-rule will lead to giant terahertz molecular cross sections.

Dai-Sik Kim is a professor of physics at Seoul National University. He heads Center for Subwavelength Optics, funded by the National Research Foundation. He got his B. S. in physics from Seoul National University (1985). He obtained M. A. degree in biophysics (1986) and Ph. D. in physics (1990), both from U. C. Berkeley. He continued to work on ultrafast spectroscopy of semiconductors at AT&T Bell Laboratories (Holmdel) and at Oklahoma State University (Stillwater), before he joined the physics department of Seoul National University. His current research interests include terahertz spectroscopy of metal nanostructures and nano antennas on dielectric substrate or strongly correlated systems such as VO2, where l/10.000-l/1,000,000 feature sizes are routine. Another interest of his is the detection of the magnetic field of light. He is an OSA fellow and an APS fellow.

08:00–10:00
CM1K • Mid-infrared QCL's
Presider: Mikhail Belkin; University of Texas at Austin, United States

CM1K.1 • 08:00
High frequency modulation of Mid-infrared Quantum Cascade Laser embedded into a micro-strip line, ariane calvar[1], Maria Amanti[1], Margaux Renaudat Saint-Jean[1], Pierre Gellie[1], Stefano Barbieri[1], Alfredo Bismuto[2], Mattias Beck[2], Emilio Gini[2], Jérôme Faist[2], Carlo Sirtori[1]; [1]*MPQ University Paris 7, France;* [2]*Institute for Quantum Electronics, ETH Zurich, Switzerland.* We present a Mid-infrared quantum cascade laser embedded into a micro-strip line for high frequency modulation. Modulating with less than 10mW at the round trip frequency, we observe beat-note injection locking within a range in the order of 1 MHz.

CM1K.2 • 08:15
High-speed Modulation Characteristic of a Quantum Cascade Laser, Andreas Hangauer[1], Georg Spinner[1,2], Michal Nikodem[1,3], Gerard Wysocki[1]; [1]*Princeton University, USA;* [2]*ETH Zurich, Switzerland;* [3]*Wroclaw Research Centre EIT+, Poland.* A high-frequency (100kHz-1GHz) modulation of the quantum cascade laser amplitude and phase is presented. Plasma-effect tuning with coefficients in 0.5-1.7MHz/mA range is observed depending on bias current. Carrier dynamics effects appear at frequencies >100MHz.

CM1K.3 • 08:30
Physical Origin of Frequency Noise and Linewidth in Mid-IR DFB Quantum Cascade Lasers, Lionel Tombez[1], Stéphane Schilt[1], Gianni Di Domenico[1], Stéphane Blaser[2], Antoine Muller[2], Tobias Gresch[2], Borislav Hinkov[3], Mattias Beck[3], Jérôme Faist[3], Daniel Hofstetter[1]; [1]*University of Neuchatel, Switzerland;* [2]*Alpes Lasers SA, Switzerland;* [3]*ETH Zurich, Switzerland.* Frequency noise and linewidth properties of different Mid-infrared DFB-QCLs using buried-heterostructures and ridge waveguides are compared. The physical origin of frequency noise and the impact of the different lasers parameters are discussed.

08:00–10:00
CM1L • NLO in Microresonators and Waveguides
Presider: Valdas Pasiskevicius; Royal Institute of Technology (JORCEP), Sweden

CM1L.1 • 08:00
Spectral broadening of microresonator based frequency combs for self-referencing, Tobias Herr[1], John D. Jost[1], Victor Brasch[1], Martin H. P. Pfeiffer[1], Christine Y. Wang[1], Michael Gorodetsky[2], Tobias J. Kippenberg[1]; [1]*École Polytechnique Fédérale de Lausanne (EPFL), Switzerland;* [2]*Faculty of Physics, Moscow State University, Russian Federation.* We demonstrate spectral broadening of a low noise microresonator based near-infrared frequency comb to almost two thirds of an octave as required for self-referencing. The low noise properties of the unbroadened spectrum are preserved.

CM1L.2 • 08:15
Improved spectral flatness and sub-two-cycle pulse generation in octave-spanning Kerr frequency combs using microresonators with two zero-dispersion wavelengths, Lin Zhang[1], Jianwei Mu[1], Vivek Singh[1], Pao T. Lin[1], Neil Patel[1], Anu Agarwal[1], Lionel Kimerling[1], Jurgen Michel[1]; [1]*MIT, USA.* We show spectral flatness of Kerr frequency combs can be improved with a power fluctuation of <20 dB over one-octave bandwidth, using flattened dispersion profile with two ZDWs. Sub-two-cycle optical pulses are generated from combs.

CM1L.3 • 08:30
On-chip high sensitivity laser frequency sensing with Brillouin mutually-modulated cross-gain modulation, Feng Gao[1,2], Ravi Pant[1], Enbang Li[1], Christopher G. Poulton[1,3], Duk-Yong Choi[4], Steve J. Madden[4], Barry Luther-Davies[4], Benjamin J. Eggleton[1]; [1]*Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS), Institute of Photonics and Optical Science (IPOS), School of Physics, The University of Sydney, Australia;* [2]*MOE Key Laboratory of Weak-Light Nonlinear Photonics, TEDA Applied Physics School and School of Physics, Nankai University, China;* [3]*School of Mathematical Sciences, University of Technology Sydney, Australia;* [4]*CUDOS, Laser Physics Centre, Australian National University, Australia.* We report the first demonstration of a photonic-chip based laser frequency sensor using Brillouin mutually-modulated cross-gain modulation (MMXGM) in a 7cm long chalcogenide waveguide. A large sensitivity (9.45mrad/kHz) of the modulation phase shift was demonstrated.

CLEO: Science & Innovations

JOINT

08:00–10:00
CM1M • Optofluidic Particle Manipulation

Presider: Dmitry Dylov, GE Global Research, USA

CM1M.1 • 08:00
Microparticle Guiding and Acceleration in Optical Lattices Generated by Silicon-on-Insulator Multimode-Interference Waveguide-based Arrayed Optical Tweezers (SMART), Ting Lei[1], Andrew W. Poon[1]; [1]*Electronic and Computer Engineering, The Hong Kong University of Science and Technology, Hong Kong.* We demonstrate optical guiding and acceleration of 2.2um polystyrene particles in a fluidic flow using uniform and non-uniform optical lattices generated at 1550nm wavelengths by silicon-on-insulator multimode-interference waveguide-based arrayed optical tweezers (SMART).

CM1M.2 • 08:15
Single nano-particle sensing exploiting crossed polarizers to improve the signal-to-noise ratio, Jon Olav Grepstad[1], Peter Kaspar[2], Olav Solgaard[3], Ib-Rune Johansen[4], Aasmund Sudbo[5]; [1]*Electronics and Telecommunications, Norwegian University of Science and Technology, Norway;* [2]*Electronics Laboratory, ETH Zurich, Switzerland;* [3]*Electrical Engineering, Stanford University, USA;* [4]*ICT, Microsystems and Nanotechnology, SINTEF, Norway;* [5]*Physics, University in Oslo, Norway.* Crossed polarized excitation and detection has been used to improve signal-to-noise ratio in an optical nano-particle sensor exploiting guided-resonance-modes in photonic crystal membranes. The sensor can detect particles with a diameter less than 40 nm.

CM1M.3 • 08:30
3D Pulsed Laser Triggered High Speed Microfluidic Fluorescence Activated Cell Sorter, Yue Chen[1], Ting-Hsiang Wu[1,2], Yu-Chun Kung[1], Michael A. Teitell[2], Pei-Yu Chiou[1]; [1]*Mechanical and Aerospace Engineering, UCLA, USA;* [2]*Pathology and Laboratory Medicine, UCLA, USA.* We report a 3D PDMS microfluidic pulsed laser triggered fluorescence activated cell sorter capable of sorting at 11,000 cells/sec with >95% purity or at 45,000 cells/sec with 45% purity within a single channel.

08:00–10:00
CM1N • Concepts for Scaling & Extending Laser Performance

Presider: Karoly Osvay; ELI-HU Nonprofit Kft., United States

CM1N.1 • 08:00
Power Scaling Concept for Solid-State Lasers Based on a Rotating Cavity Configuration, Matthew Eckold[1], Jacob I. Mackenzie[1], W. Andrew Clarkson[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* A laser architecture for scaling output power and avoiding deleterious thermal effects based on a resonator with a rotating periscope is described. Preliminary results for continuous-wave and Q-switched operation are presented.

CM1N.2 • 08:15
Energy-scaling of DPSS Picosecond Amplifiers for OPCPA Pumping, Andreas Vaupel[1,2], Nathan Bodnar[1], Benjamin Webb[1], Lawrence Shah[1], Eric Cormier[2], Martin Richardson[1]; [1]*CREOL - The College of Optics and Photonics, University of Central Florida, USA;* [2]*Centre Lasers Intenses et Applications (CELIA), Université de Bordeaux 1, France.* High power, high energy, picosecond amplifier systems are required for the next generation of OPCPA systems. We address energy scaling and challenges of thermal loading and depolarization in high repetition rate amplifiers for OPCPA pumping.

CM1N.3 • 08:30 Invited
Plasma as an Amplifying Medium: Chirped Pulse Raman Amplification and the Transition to the Nonlinear Regime, Dino A. Jaroszynski[1]; [1]*Univ. of Strathclyde, United Kingdom.* A density echelon exited in plasma is a robust amplifying medium. Raman CPA in plasma is studied in both the low and high pump power regimes where gains of up to seven orders of magnitude are measured and the nonlinear regime explored.

08:00–10:00
JM10 • Symposium on Novel Light Sources for Biomedical Applications: Light Sources for Optical Coherence Tomography

Presider: Mircea Mujat; Physical Sciences Inc., United States

JM10.1 • 08:00 Invited
OCT Sources: Current Limitations and Future Development Needs, Benjamin J. Vakoc[1]; [1]*Harvard Medical School, USA.* Swept-wavelength laser sources are an essential and enabling technology in the growing clinical adoption of optical coherence tomography (OCT). In this talk, we will review the advantages and limitations of available OCT source technologies.

JM10.2 • 08:30 Invited
High Speed Wavelength-swept Laser for Next Generation Optical Coherence Tomography, Wang-Yuhl Oh[1]; [1]. Development of high-speed wavelength-swept lasers is one of the essentials for recent advances of the second generation OCT technology. In this talk, we will briefly review key wavelength-swept laser developments in the past decade and discuss its future direction for the next generation OCT.

CLEO: QELS-Fundamental Science

QM1A • Active and Nonlinear Metamaterials—Continued

QM1A.4 • 08:45
Ultralow-threshold cavity Raman laser via free-space excitation, Xue-Feng Jiang[1], Qihuang Gong[1], Yun-Feng Xiao[1]; *[1]Department of Physics, Peking University, China.* We observed ultralow-threshold Raman lasing using direct free-space excitation of whispering gallery modes in a deformed microtoroid. This simple and robust excitation method can overcome the inadequacies of taper coupling.

QM1A.5 • 09:00
Second Harmonic Generation with Optical Vortices in Negative-Index Metamaterials, Mikhail I. Shalaev[1], Zhaxylyk A. Kudyshev[1], Alexander Cartwright[1], Natalia M. Litchinitser[1]; *[1]Electrical Engineering, The State University of New York, University at Buffalo, USA.* We discuss the backward phase-matched process in negative index metamaterials with quadratic nonlinearity, resulting in generation of a backward propagating vortex with simultaneously doubled frequency, orbital angular momentum and reversed rotation direction of the wavefront.

QM1A.6 • 09:15
Electrically-driven Permeability-controlled Optical Modulator using Mach-Zehnder Interferometer with Metamaterial, Tomo Amemiya[1], Toru Kanazawa[1], Atsushi Ishikawa[2], Seiji Myoga[1], Eijun Murai[1], Takahiko Shindo[1], JoonHyung Kang[1], Nobuhiko Nishiyama[1], Yasuyuki Miyamoto[1], Takuo Tanaka[2], Shigehisa Arai[1]; *[1]Tokyo Institute of Technology, Japan; [2]RIKEN, Japan.* An electrically-driven permeability-controlled GaInAsP/InP optical modulator was experimentally demonstrated using Tri-gate metamaterial structure. An extinction ratio of 6.9 dB was obtained at 1550-nm wavelength with a gate swing of 2-12 V.

QM1B • Near-field Imaging & Spectroscopy—Continued

QM1B.4 • 08:45
Sub-diffraction Imaging of Resonant Scattering Labels Using Polarization Spectro-Tomography, Farbod Shafiei[1], Chihhui Wu[1], Xiaoqin Li[1], Gennady Shvets[1]; *[1]University of Texas at Austin, USA.* We propose and experimentally realize a far-field imaging technique, polarization spectro-tomography, capable of detecting small resonant objects (quantum dots, plasmonic nanorods) on the surface of a plasmonic nanosphere. The technique is based on Fano interference.

QM1B.5 • 09:00
Broadband Near-Field Detection with Multi-Frequency Probe Microscopy, Dana C. Kohlgraf-Owens[1], Léo Greusard[2], Sergey Sukhov[1], Yannick De Wilde[2], Aristide Dogariu[1]; *[1]CREOL, The College of Optics and Photonics, University of Central Florida, USA; [2]Institut Langevin, France.* Using scanning probe microscopy with modulated illumination, we demonstrate simultaneous measurement of topography and optical forces exerted on a probe. Broadband optical field detection is possible using a single probe.

QM1B.6 • 09:15
Near field imaging of complex metal nanostructures based on the use of azobenzene nanomotors, Renaud Bachelot[1], Jerome Plain[1]; *[1]LNIO, Universite de technologie de Troyes, France.* We present a review on the use of molecular nanomotors to probe the near field of metal nanoparticles. Both the experimental and theoretical point of view will be presented and discussed.

QM1C • Nonclassical & Nonlocal Quantum States—Continued

QM1C.2 • 09:00
Towards a loophole free Bell test, Siddarth Koduru Joshi[1], Chen Ming Chia[1], Qixiang Leong[2], Antia Lamas-Linares[3], Sae Woo Nam[3], Christian Kurtsiefer[1,2]; *[1]Center for Quantum Technologies, National University of Singapore, Singapore; [2]Physics Department, National University of Singapore, Singapore; [3]National Institute of standards and Technology, USA.* Using a highly efficient (74%) PPKTP source of narrowband polarization entangled photon pairs (as measured with TES detectors) together with a fast polarization modulator (11 ns) we should be capable of a loophole free Bell test

QM1C.3 • 09:15
Violation of Continuous Variable EPR Steering with Discrete Measurements, James Schneeloch[1], P. Ben Dixon[2], Gregory A. Howland[1], Curtis J. Broadbent[1,3], John C. Howell[1]; *[1]Physics and Astronomy, University of Rochester, USA; [2]Research Laboratory of Electronics, Massachusetts Institute of Technology, USA; [3]Rochester Theory Center, University of Rochester, USA.* We create a stronger EPR-steering inequality for continuous variables using entropic uncertainty. We explore the asymmetry in this inequality and develop a new symmetric inequality. We also violate these inequalities in experiment.

QM1D • Coherent Effects in Excitons and Polaritons—Continued

QM1D.3 • 08:45
Observation of BKT Transition in BEC of Exciton-Polaritons in a Semiconductor Microcavity, Wolfgang H. Nitsche[1], Na Young Kim[1], Georgios Roumpos[1,2], Sven Hoefling[3], Alfred Forchel[3], Yoshihisa Yamamoto[1,4]; *[1]E. L. Ginzton Laboratory, Stanford University, USA; [2]JILA, University of Colorado, USA; [3]Technische Physik, Universitaet Wuerzburg, Germany; [4]National Institute for Informatics, Japan.* The first-order spatial correlation function of a Bose-Einstein condensate of exciton-polaritons in a semiconductor microcavity is measured. It behaves as the Berezinskii-Kosterlitz-Thouless theory predicts and decays with a power-law.

QM1D.4 • 09:00
All-optical polariton transistor, Dario Ballarini[1,2], Milena De Giorgi[1,2], Emiliano Cancellieri[3], Romuald Houdré[4], Elisabeth Giacobino[5], Roberto Cingolani[1], Alberto Bramati[5], Giuseppe Gigli[2,6], Daniele Sanvitto[1,2]; *[1]Istituto Italiano Tecnologia, Italy; [2]CNR- NANO, Italy; [3]Universidad Autonoma de Madrid, Spain; [4]EPFL, Switzerland; [5]CNRS-LKB, France; [6]University of Salento, Italy.* We experimentally demonstrate the working principle of an all-optical transistor in semiconductor planar microcavities, based on the non-linear interactions between two polariton fluids. The operation as AND/OR gate is shown, validating the connectivity of the system.

QM1D.5 • 09:15
Bright soliton and shock waves in an exciton polariton condensate, Lorenzo Dominici[1,2], Milena De Giorgi[1,2], Dario Ballarini[1,2], Emiliano Cancellieri[3], Fabrice Laussy[4], Elisabeth Giacobino[3], Alberto Bramati[3], Giuseppe Gigli[1,2], Daniele Sanvitto[1,2]; *[1]IIT-Lecce, Istituto Italiano di Tecnologia, Italy; [2]NNL, Istituto Nanoscienze, CNR, Italy; [3]Laboratoire Kastler Brossel, UPMC-Paris 6, École Normale Supérieure et CNRS, France; [4]Fisica Teorica de la Materia Condensada, Universidad Autonoma de Madrid, Spain.* We demonstrate for the first time the generation of shock waves and standing bright soliton in an exciton polariton condensate resonantly created in a semiconductor microcavity, showing few ps rise time and 20ps persistence after 100fs excitation.

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QM1E • Novel Phenomena in Photonic Lattices—Continued

QM1E.4 • 08:45
Beam dynamics in optical mesh lattices, Mohammad-Ali Miri[1], Alois Regensburger[2], Ulf Peschel[2], Demetrios N. Christodoulides[1]; [1]*CREOL, College of Optics and Photonics,, University of Central Florida, USA;* [2]*Institute of Optics, Information and Photonics,, University of Erlangen-Nuernberg, Germany.* We study propagation dynamics in a new class of optical lattices which are bi-periodic and discrete in both coordinates. These mesh structures exhibit peculiar linear and nonlinear properties which are unattainable in traditional optical lattices.

QM1E.5 • 09:00
Compact Fano states embedded in the continuum of waveguide arrays, Steffen Weimann[1], Yi Xu[2], Roert Keil[1], Andrey E. Miroshnichenko[2], Stefan Nolte[1], Andrey A. Sukhorukov[2], Yuri S. Kivshar[2], Alexander Szameit[1]; [1]*Institut für angewandte Physik, Freidrich-Schiller-Universität Jena, Germany;* [2]*Nonlinear Physics Center, Australian National University, Australia.* We predict and observe a compact surface bound state in the continuum due to optical Fano resonances in waveguide arrays. Except in the 4 surface sites, the localized mode amplitude vanishes in the entire lattice.

QM1E.6 • 09:15
Generation of multipartite single photon W states in waveguide lattices, Armando P. Leija[1,2], Markus Gräfe[1], Julio Cesar Hernandez-Herrejon[1], Hector Moya-Cessa[1], Alexander Szameit[2], Demetrios N. Christodoulides[1]; [1]*University of Central Florida, CREOL, USA;* [2]*Ultrafast Optics, Institute of Applied Physics, Germany.* We propose a versatile platform for generating multipartite W-states in appropriately engineered on-chip photonic lattices. One and two dimensional waveguide configurations are investigated for producing W-states with predesigned probability amplitudes and relative phases.

CM1F • Microresonators I—Continued

CM1F.4 • 09:00
High-Q Resonators on Bi-Layer Si Platform Using Wafer Bonding, Hesam Moradinejad[1], Amir H. Atabaki[1], Amir H. Hosseinia[1], Ali Asghar Eftekhar[1], Ali Adibi[1]; [1]*Georgia Institute of Technology, USA.* We report the development of a high quality bi-layer silicon material platform using wafer bonding. We have experimentally demonstrated high quality-factor resonators (>200,000) in this material platform for both TE and TM polarizations.

CM1F.5 • 09:15
Improving the Dimensional Tolerance of Microrings with Adiabatically Widened Bends, Jared C. Mikkelsen[1], Wesley D. Sacher[1], Hasitha Jayatilleka[1], Richard J. Bojko[2], Joyce K. Poon[1]; [1]*Electrical and Computer Engineering, University of Toronto, Canada;* [2]*Microfabrication Laboratory, University of Washington, USA.* Silicon microrings with widened waveguides have higher dimensional tolerances than conventional designs with single-mode wire waveguides. We show microrings where the resonance wavelength shifts from waveguide width variations are reduced by a factor of 2.5.

CM1G • Advanced Modulation Formats & Digital Signal Processing—Continued

CM1G.4 • 08:45
Stokes Space Based Digital PolDemux for Polarization Switched-QPSK Signals, Nelson J. Muga[1,2], Fernando P. Guiomar[1,2], Armando N. Pinto[1,2]; [1]*Instituto de Telecomunicações, Portugal;* [2]*Department of Electronic, Telecommunications, and Informatics, University of Aveiro, Portugal.* A polarization demultiplexing technique for polarization-switched QPSK signals is proposed. Compared to existing methods, this Stokes space based technique permits a gain of more than one order of magnitude in terms of convergence speed.

CM1G.5 • 09:00
Transmission Reach Study of Three Optical Fibers for 200 Gb/s PM-16QAM Systems with 100 km Spans, John D. Downie[1], Jason Hurley[1], Dragan Pikula[1], Sergey Ten[1], Chris Towery[1]; [1]*Corning Incorporated, USA.* Transmission results are given for 256 Gb/s PM-16QAM systems over three optical fibers, using 100 km span lengths and EDFA amplification. Ultra-low loss, large effective area fiber provides ~85% reach advantage over standard single-mode fiber.

CM1G.6 • 09:15
Averaging of Phase Noise in NRZ-PSK Signals by Using an Optical and Electrical Feed-Forward Circuit, Kyo Inoue[1], Masato Ohta[1]; [1]*Osaka University, Japan.* We propose an optical and electrical feed-forward circuit that reduces phase noise in PSK signals by averaging the noise. A phase-fluctuating PSK signal is phase-modulated with a feed-forward signal from differential detectors and signal processing.

CM1H • Laser Writing and Patterning—Continued

CM1H.4 • 08:45
Polymer-Nanocomposite Anti-Reflective Coating Fabricated by Resonant IR Matrix-Assisted Pulsed Laser Evaporation, Daniel C. Mayo[1], Senthilraja Singaravelu[2], Hee K. Park[2], Costas P. Grigoropoulos[3], Kenneth E. Schriver[2], Richard F. Haglund[1,4]; [1]*Interdisciplinary Materials Science Program, Vanderbilt University, USA;* [2]*AppliFlex LLC, USA;* [3]*Mechanical Engineering, University of California, USA;* [4]*Physics and Astronomy, Vanderbilt University, USA.* We demonstrate a multilayer anti-reflective conformal coating for polycarbonate substrates, using a a polymer nanocomposite, fabricated by resonant infrared pulsed laser evaporation. The coating has 97% transmission, and less than 0.6% reflectivity over the visible spectrum.

CM1H.5 • 09:00 Invited
Ultrafast Lasers in Industrial Solutions, David M. Gaudiosi[1], Michael R. Greenberg[1], Dale Nussdorfer[1], Michael Shirk[1], Eric Juban[1], Michael M. Mielke[1], Tim Booth[1]; [1]*Raydiance Inc, USA.* Precision processing of a variety of materials, ranging from metals to dielectrics, has been demonstrated with a high degree of reliability and repeatability, at industrially feasible processing speeds.

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CM1I • Mode-locked Fiber Lasers—Continued

CM1I.4 • 08:45
285 mW High Power, Dissipative-Soliton Mode-Locked, Er-doped Fiber Laser using Carbon Nanotube, Yuto Nozaki[1], Norihiko Nishizawa[1], Hiromichi Kataura[2,3], Emiko Omoda[2], Youichi Sakakibara[2,3]; *[1]Electrical Engineering and Computer Science, Nagoya University, Japan; [2]AIST, Japan; [3]JST CREST, Japan*. Dissipative soliton mode-locked Er-doped ultrashort pulse fiber laser using carbon nanotube polyimide film was investigated both experimentally and numerically. The highest output power of 285 mW was achieved for passively mode-locked nanotube fiber laser.

CM1I.5 • 09:00
A Low-Loss Carbon-Nanotube-Based Linear Cavity Fiber Laser for High Energy Pulse Generation, Huan Huan Liu[1], Ye Yang[1], Kin Kee Chow[1]; *[1]School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore.* We demonstrate a low-loss linear cavity fiber laser incorporating carbon-nanotubes for high energy pulse generation. A pump efficiency of 47% for the intra-cavity power is obtained with an output pulse energy of 114 nJ.

CM1I.6 • 09:15
Dissipative Soliton Resonance in an All-Normal-Dispersion Graphene Oxide Mode-Locked Yb-Doped Fiber Laser, Zhaochen Cheng[1], Wu Sida[2], Shi Hongxing[1], Jia Xu[1], Quan-hong Yang[2], Pu Wang[1]; *[1]Beijing University of Technology, China; [2]Tianjin University, China.* We observed dissipative soliton resonance in graphene oxide mode-locked Yb-doped fiber laser, which delivered square-shaped nanosecond pulses of 0.52ns~60.8ns and single pulse energy of 137.1nJ at 1064.9nm. The 3dB-bandwidth of Lorentz-shaped spectrum was 0.19nm.

CM1J • THz Metamaterials & Plasmonics I—Continued

CM1J.2 • 09:00
Active Metamaterial Diffraction Grating, Nicholas Karl[1], Kimberly S. Reichel[1], Hou-Tong Chen[2], Antoinette Taylor[2], Igal Brener[3], Alexander Benz[3], John L. Reno[3], Rajind Mendis[1], Daniel Mittleman[1]; *[1]Electrical and Computer Engineering, Rice University, USA; [2]Los Alamos National Laboratory, USA; [3]Sandia National Laboratories, USA.* We design and test a switchable diffraction grating based on active metamaterials for terahertz modulation. We observe off-axis diffraction which permits operation of the device as a narrowband high-contrast modulator.

CM1J.3 • 09:15
Metamaterial-Based, Gradient Index Beam Steerer for Terahertz Radiation, Jens Neu[1], Marco H. Rahm[1]; *[1]Electrical and Computer Engineering, University of Kaiserslautern, Germany.* We designed and fabricated a metamaterial-based beam steerer that deflects an incident terahertz beam by 4.2° due to an implemented gradient index structure. We characterized it using THz-TDS with three-dimensional subwavelength spatial resolution.

CM1K • Mid-infrared QCL's—Continued

CM1K.4 • 08:45
Electrically pumped Mid-infrared random lasers, Houkun Liang[1], Bo Meng[2], Guozhen Liang[2], Qijie Wang[2], Ying Zhang[1]; *[1]Precision measurement Group, Singapore Institute of Manufacturing Technology, Singapore; [2]School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore.* Electrically pumped random lasers in the Mid-infrared regime at λ~ 10 μm have been demonstrated for the first time to our knowledge. The laser is based on a quantum cascade (QC) gain media with designed filling fractions of scatterers.

CM1K.5 • 09:00
High Power Continuous Wave Operation of Distributed Bragg Reflector Quantum Cascade Laser, Feng Xie[1], Catherine Caneau[1], Herve LeBlanc[1], Ming-tsung Ho[1], Lawrence C. Hughes[1], Chung-en Zah[1]; *[1]Corning Incorporated, USA.* We demonstrate 2W CW output power with a DBR QCL mounted epi-down at 20 °C, with a CW WPE of 10.3 %. Single mode operation with a SMSR of 30 dB was achieved with the wavelength around 4.48 μm.

CM1K.6 • 09:15
Room-Temperature Operation of Index-Coupled Distributed-Feedback 4.75 μm Quantum Cascade Lasers Fabricated without Epitaxial Regrowth, Ryan M. Briggs[1], Clifford Frez[1], Carl E. Borgentun[1], Siamak Forouhar[1]; *[1]JPL, USA.* We demonstrate single-mode distributed-feedback quantum cascade lasers at 4.75 μm with etched index-coupled surface gratings and spin-on dielectric infilling. We observe continuous wave laser emission at room temperature with 5 W of electrical power consumption.

CM1L • NLO in Microresonators and Waveguides—Continued

CM1L.4 • 08:45
Supercontinuum generation in the Mid-infrared using dispersion engineered chalcogenide glass waveguides, Barry Luther-Davies[1], Xin Gai[1], Steve J. Madden[1], Duk-Yong Choi[1], Zhiyong Yang[1], Rongping Wang[1], Pan Ma[1], Ivy Yu[1]; *[1]CUDOS, Australian National University, Australia.* We report the generation of a mid-IR supercontinuum created by passing ≈8psec duration pulses at ≈3260nm through dispersion-engineered As2S3 and Ge11.5As24Se64.5 waveguides.

CM1L.5 • 09:00
Four-Wave Mixing in Si3N4-Clad Silicon-on-Insulator Waveguides for the Mid-infrared Region, Ryan K. Lau[1], Michael Menard[2], Yoshitomo Okawachi[1], Michal Lipson[2,3], Alexander L. Gaeta[1,3]; *[1]School of Applied and Engineering Physics, Cornell University, USA; [2]School of Electrical and Computer Engineering, Cornell University, USA; [3]Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We introduce novel SOI waveguides with a Si3N4 top cladding for nonlinear photonics in the Mid-infrared wavelength region. We demonstrate continuous-wave frequency conversion via four-wave mixing and obtain a conversion bandwidth of over 300 nm.

CM1L.6 • 09:15
Modal phase-matching of second-order nonlinearities at silicon-oxy-nitride interfaces in multilayer waveguides, Dylan Logan[1], Ali B. Alamin Dow[1], Dmitri Stepanov[2], Payam Abolghasem[1], Nazir P. Kherani[1,2], A. S. Helmy[1]; *[1]The Edward S. Rogers Department of Electrical and Computer Engineering, University of Toronto, Canada; [2]Department of Materials Science and Engineering, University of Toronto, Canada.* We establish multi-layer dielectric waveguides as a platform for exploiting interface second-order nonlinearities. We demonstrate phase-matched second-harmonic generation in a silicon-oxy-nitride waveguide with an external efficiency of ~6×10^{-4} %/W.

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JOINT

CM1M • Optofluidic Particle Manipulation—Continued

CM1M.4 • 08:45
Biophotonic Device for On-Chip Trapping and Spectroscopic Analysis, Francesca Bragheri[1,4], Carlo Liberale[2], Geo Cojoc[3,5], Paolo Minzioni[1], Gerardo Peroziello[3], Rosanna La Rocca[2], Lorenzo Ferrara[1,2], Vijayakumar Rajamanickam[2], Enzo Di Fabrizio[2,3], Ilaria Cristiani[1]; [1]*Electrical, Computer and Biomedical Engineering, Universita degli Studi di Pavia, Italy;* [2]*Nanostructures, Istituto Italiano di Tecnologia, Italy;* [3]*Medicina Sperimentale e Clinica, Università Magna Graecia di Catanzaro, Italy;* [4]*Istituto di Fotonica e Nanotecnologie, CNR, Dip. Fisica, Politecnico di Milano, Italy;* [5]*Molecular Cell Biology and Genetics, Max Planck Institute, Germany.* Here we report on a novel and fully-integrated biophotonic system exploiting a miniaturized fiber-based optical-tweezer to produce 3D-trapping of single cells. We also demonstrate its use for fluorescence and Raman measurements of single cells

CM1M.5 • 09:00 Invited
Optical Manipulation of Particles using Silicon Photonics, Andrew W. Poon[1], Ting Lei[1], Jiawei Wang[1]; [1]*Hong Kong Univ of Science & Technology, Hong Kong.* We will review our recent progress in dynamically buffering, trapping, dropping and sorting particles on silicon nitride optofluidic circuits. We will also discuss particle transport and sensing on silicon nitride coupled-resonator optical waveguides.

CM1N • Concepts for Scaling & Extending Laser Performance

CM1N.4 • 09:00
Scaling Few-Cycle OPCPAs to the 4-8 µm Spectral Range: Prospect for 2 µm Pump Lasers, Michaël Hemmer[1], M. Baudish[1], Jens Biegert[1,2]; [1]*ICFO, Institut de Ciencies Fotoniques, Spain;* [2]*ICREA, Institucio Catalana de Recerca i Estudis Avancats, Spain.* The potential of Ho^{3+}, Tm^{3+} and Cr^{2+}-doped gain media are investigated as amplifying media for the implementation of 2 µm wavelength beam lines meeting the requirements of OPCPA pumping.

CM1N.5 • 09:15
Double-Raman Gain for Realizing a Superluminal Ring Laser, Ye Wang[1], Tony Abi-Salloum[2], Joshua Yablon[1], Shih Tseng[1], Yanfei Tu[1], Selim M. Shahriar[1,3]; [1]*EECS, Northwestern University, USA;* [2]*Physics & Astronomy, Widener University, USA;* [3]*Physics and Astronomy, Northwestern University, USA.* We show how a dual-peak gain produced via optical pumping and non-degenerate Raman pumps in a single vapor cell can be used to realize a superluminal ring laser with enhanced sensitivity for gyroscopy and accelerometry.

JM1O • Symposium on Novel Light Sources for Biomedical Applications: Light Sources for Optical Coherence Tomography

JM1O.3 • 09:00 Invited
Miniature, Fast Wavelength-Swept Sources Based on External Grating Cavity with Resonant MEMS Mirror, Kevin Hsu[1], Stefan Gloor[1], Adrian H. Bachmann[1], Marc Epitaux[1], Tim V. Niederhäusern[1], Philipp Vorreau[1], Nicolai Matuschek[1], Marcus Duelk[1], Christian Velez[1]; [1]*Exalos AG, Switzerland.* We report a broad range of swept source performances based on a highly-flexible external cavity laser architecture embodied within a compact butterfly package. Multiple spectral regions from 830nm to 1630nm and sweep frequencies from 1kHz to 200kHz are demonstrated.

Thank you for attending CLEO: 2013. Look for your post-conference survey via email and let us know your thoughts on the program.

CLEO: QELS-Fundamental Science

QM1A • Active and Nonlinear Metamaterials—Continued

QM1A.7 • 09:30
Negative differential thermal emitter, Mikhail Kats[1], Romain Blanchard[1], Shuyan Zhang[1], Patrice Genevet[1], Changhyun Ko[1], Shriram Ramanathan[1], Federico Capasso[1]; [1]*School of Engineering and Applied Sciences, Harvard University, USA.* We experimentally demonstrate a thermal emitter comprising sapphire and a vanadium dioxide thin film, which exhibits large negative differential emittance: over a temperature range of > 10 °C, the thermal emittance decreases by over 10%.

QM1A.8 • 09:45
Functional Metamaterials for Wireless Phase Conjugation, Alexander Katko[1], Steven Cummer[1]; [1]*Department of Electrical and Computer Engineering, Duke University, USA.* Functional metamaterials provide useful properties for the design of electromagnetic devices. In this work we demonstrate that functions including high nonlinearity and amplification can be included in metamaterials to realize time reversal imaging.

QM1B • Near-field Imaging & Spectroscopy—Continued

QM1B.7 • 09:30
Tailored Superoscillatory Beams: Controlling Symmetry, Broadening, Width, and Orientation, Elad Greenfield[1], Ilan Hurwitz[1], Ran Schley[1], Mordechai Segev[1]; [1]*Physics, Technion Israel Institute of Technology, Israel.* We present, theoretically and experimentally, non-broadening optical beams having arbitrarily small superoscillatory features. Our design facilitates control over the symmetry, width, and rotational orientation of the superoscillating beams.

QM1B.8 • 09:45
Super-oscillatory optical needle for heat assisted magnetic recording, Guanghui Yuan[1], Edward Rogers[2], Brendan Lafferty[3], Marcus Mooney[3], Zexiang Shen[1], Nikolay Zheludev[1,2]; [1]*Centre for Disruptive Photonic Technologies, Nanyang Technological University, Singapore;* [2]*Optoelectronics Research Centre and Centre for Photonic Metamaterials, University of Southampton, United Kingdom;* [3]*Seagate Technologies, Ireland.* We demonstrate an alternative to plasmonic focusing, a super-oscillatory focusing lens capable of producing a 51nm spot for optical heating in heat assisted magnetic recording using a diode laser operating at 473 nm wavelength.

QM1C • Nonclassical & Nonlocal Quantum States—Continued

QM1C.4 • 09:30
Optical Hybrid Quantum Information: Example of a Continuous-Variable Trustworthy Witness for Single-Photon Entanglement, Olivier MORIN[1], Jean-Daniel Bancal[2], Melvyn Ho[2], Pavel Sekatski[2], Virginia D'Auria[1], Claude Fabre[1], Nicolas Gisin[2], Julien Laurat[1], Nicolas Sangouard[2]; [1]*Laboratoire Kastler Brossel, Université Pierre et Marie Curie, France;* [2]*Group of Applied Physics, University of Geneva, Switzerland.* We demonstrate a novel trustworthy witness for single-photon entanglement based only on local homodyne measurements. This operational test is well suited for quantum networks, and highlights the potential of the optical hybrid approach.

QM1C.5 • 09:45
Demonstration of nonlocal dispersion cancellation in Franson interferometry, Tian Zhong[1], Franco N.C. Wong[1]; [1]*Research Laboratory of Electronics, Massachusetts Institute of Technology, USA.* We report the first demonstration of nonlocal cancellation of differential dispersion between the long-short paths of a fiber-based Franson interferometer, restoring the otherwise limited visibility to an unprecedented 99.6% for time-energy entangled photons.

QM1D • Coherent Effects in Excitons and Polaritons—Continued

QM1D.6 • 09:30
Superfluorescence from a Dense Electron-Hole Plasma in Pulsed High Magnetic Fields, Gary T. Noe II[1], Hiroyuki Nojiri[2], Jean Leotin[3], Gary Woods[1], Alexey Belyanin[4], Junichiro Kono[1]; [1]*Department of Electrical and Computer Engineering, Rice University, USA;* [2]*Institute for Materials Research, Tohoku University, Japan;* [3]*Laboratoire National des Champs Magntiques Intenses, CNRS-UJF-UPS-INSA, France;* [4]*Department of Physics, Texas A&M University, USA.* We have observed intense superfluorescent emission from a high-density electron-hole plasma in semiconductor quantum wells in high magnetic fields up to 30 T by developing a unique magneto-optical system with a table-top mini-coil pulsed magnet.

QM1D.7 • 09:45
Realization of sub-100 mK excitons in cuprous oxide for a stable Bose-Einstein condensate, Yusuke Morita[1], Kosuke Yoshioka[1], Kenta Fukuoka[2], Makoto Kuwata-Gonokami[1,3]; [1]*Department of physics, the University of Tokyo, Japan;* [2]*Department of applied physics, the University of Tokyo, Japan;* [3]*Photon Science Center, the University of Tokyo, Japan.* We demonstrate generation of trapped ultracold paraexcitons in bulk Cu2O. The unprecedentedly low exciton temperature is realized by a newly found cooling channel. It is ideal for experiments on exciton Bose-Einstein condensates.

10:00–10:30 Coffee Break, *Concourse Level*

NOTES

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QM1E • Novel Phenomena in Photonic Lattices—Continued

QM1E.7 • 09:30
Speckle Statistics of Anderson-localized Light in Disordered Waveguide Arrays, Hasan E. Kondakci[1], Ayman F. Abouraddy[1], Bahaa Saleh[1]; [1]*University of Central Florida, CREOL, USA.* We show that coherent light travelling through a 1-D lattice of waveguides with off-diagonal disorder exhibits super-thermal statistics (g^(2)>2), a manifestation of constrained disorder with underlying symmetries. Sub-thermal statistics may be exhibited for diagonal disorder.

QM1E.8 • 09:45
Supersymmetric optics: SUSY fibers for integrated angular momentum multiplexing, Mohammad-Ali Miri[1], Matthias Heinrich[1], Ramy El-Ganainy[2], Demetrios N. Christodoulides[1]; [1]*CREOL The College of Optics and Photonics, University of Central Florida, USA;* [2]*Department of Physics, University of Toronto, Canada.* We show that supersymmetry can provide a versatile platform for a new class of optical structures. Here we introduce SUSY to two-dimensional fiber geometries that could pave the way towards integrated optical angular-momentum multiplexing schemes.

CM1F • Microresonators I—Continued

CM1F.6 • 09:30
Light Scattering from Silicon Nitride Microdisks, David McCloskey[1,2], John Donegan[1,2]; [1]*School of Physics, Trinity College Dublin, Ireland;* [2]*Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN), Trinity College Dublin, Ireland.* High intensity sub-wavelength spots and low divergence nanojets are observed in a system of 400 nm thick Si3N4 microdisks with diameters ranging from 1μm to 10μm, illuminated with linearly polarised light of wavelength 532 nm.

CM1F.7 • 09:45
Effect of Rotation on Resonant Modes of Deformed Dielectric Microcavities, Raktim Sarma[1], Li Ge[2], Hui Cao[1]; [1]*Applied Physics, Yale University, USA;* [2]*Electrical Engineering, Princeton University, USA.* We showed numerically rotation causes much larger changes of quality factor and emission pattern of resonant modes than frequency shift in open dielectric microcavities, providing possible alternative schemes of rotation sensing than using Sagnac effect.

CM1G • Advanced Modulation Formats & Digital Signal Processing—Continued

CM1G.7 • 09:30
Optimum Signal Constellation Design and Mapping Rule for Few-Mode Fiber based LDPC-Coded CO-OFDM, Ding Zou[1], Tao Liu[1], Ivan B. Djordjevic[1], Ting Wang[2]; [1]*University of Arizona, USA;* [2]*NEC Labs, USA.* We propose an OSCD-based LDPC-coded mode-multiplexed CO-OFDM system as multi-Tb/s enabling technology, and demonstrate that 16-OSCD with optimized mapping rule outperforms the 16-QAM by 0.9dB over 1000km of few-mode fiber in strong coupling regime.

CM1G.8 • 09:45
Rate-Adaptive Irregular QC-LDPC Codes from Pairwise Balanced Designs for Ultra-High-Speed Optical Transport, Ivan B. Djordjevic[1], Ting Wang[2]; [1]*ECE Dept., College of Engineering; College of Optical Sciences, University of Arizona, USA;* [2]*Optical Networking, NEC Labs, USA.* A rate-adaptive coded-modulation scheme based on irregular-quasi-cyclic-LDPC codes designed using the concept of pairwise-balanced-designs is proposed. Proposed scheme outperforms the corresponding scheme based on regular-LDPC codes, and eliminates the error-floor phenomenon of regular-LDPC codes.

CM1H • Laser Writing and Patterning—Continued

CM1H.6 • 09:30
Laser annealing and simulation of a:Si thin films for solar cell applications, Ioanna Zergioti[1]; [1]*National Technical University of Athens, Greece.* Laser annealing experiments for the crystallization of amorphous silicon layer and improvement of its solar cell efficiency are presented here. Temperature simulation to define the depth profile distribution was also performed.

CM1H.7 • 09:45
Nanosecond Pulsed Laser Color Marking of Titanium: Analysis of Oxide Layer Phase, David Adams[1], Ryan Murphy[1], Mark Rodriguez[1], Deidre Hirschfeld[1], David Saiz[1]; [1]*Sandia National Laboratories, USA.* Nanosecond-pulsed, infrared laser irradiation has been used to create metal oxide coatings on the surface of polished Ti for application as unique tags/identifiers. X-ray diffraction and electron microscopy demonstrate that coatings are titanium monoxide.

10:00–10:30 Coffee Break, *Concourse Level*

NOTES

CLEO: Science & Innovations

CM1I • Mode-locked Fiber Lasers—Continued

CM1I.7 • 09:30
Directly Imprinted Graphite Nano-Particle with Improved Quality for Sub-400 fs Passively Mode-Locked Fiber Laser, Yung-Hsiang Lin[1], Gong-Ru Lin[1]; [1]*Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan.* The continually exfoliated graphite nano-particle with reduced layer number achieved by two contacted fiber connecter is demonstrated as a fast saturable absorber to passively mode-lock an erbium-doped fiber laser for obtaining sub-400 fs pulsewidth.

CM1I.8 • 09:45
High-energy noise-like pulses generated by a dispersion-mapped Yb-doped fiber laser, Alexey Zaytsev[1], Chih-Hsuan Lin[2], Yi-Jing You[2], Chia-Chun Chung[1], Chi-Luen Wang[3], Ci-Ling Pan[1,2]; [1]*Department of Physics, National Tsing Hua University, Taiwan;* [2]*Institute of Photonics Technologies, National Tsing Hua University, Taiwan;* [3]*Cleverwave Tech. Inc., Taiwan.* Noise-like pulses (NLP) up to 45 nJ are generated in a dispersion-mapped Yb-doped fiber laser. A spatial spectral filter is used to control temporal and spectral characteristics of generated NLP.

CM1J • THz Metamaterials & Plasmonics I—Continued

CM1J.4 • 09:30 Invited
Light-matter Interaction in Terahertz Meta-atoms, Daniel Dietze[1], Karl Unterrainer[1], Juraj Darmo[1]; [1]*Institute of Photonics, Vienna University of Technology, Austria.* Effective coupling between intersubband optical transitions and planar metallic resonators is presented. We discuss and demonstrate features unique to such a system and point out the consequences for active terahertz metamaterial devices

CM1K • Mid-infrared QCL's—Continued

CM1K.7 • 09:30
Single Mode Tuning in Quantum Cascade Lasers with Asymmetric Mach-Zehnder Interferometer-type Cavities, Mei Chai Zheng[1], Peter Q. Liu[1,2], Xiaojun Wang[3], Jun-Yu Fan[3], Mariano Troccoli[3], Claire F. Gmachl[1]; [1]*Electrical Engineering, Princeton University, USA;* [2]*Institute of Quantum Electronics, Switzerland;* [3]*AdTech Optics Inc., USA.* Two separate contacts are incorporated into the different arms of Quantum Cascade lasers with asymmetric Mach-Zehnder interferometer type cavities. Preliminary results reveal an almost-continuous single mode tuning range of 20 cm^-1 at 80K.

CM1K.8 • 09:45
Importance of Growth Direction in Mid-infrared Quantum Cascade Lasers, Pierre M. Bouzi[1], YenTing Chiu[1], Christoph Deutsch[1,2], Vadim Tokranov[3], Serge Oktyabrsky[3], Claire F. Gmachl[1]; [1]*Electrical Engineering, Princeton University, USA;* [2]*Photonics Institute, Vienna Institute of Technology, Austria;* [3]*College of Nanoscale Science and Engineering, University at Albany-SUNY, USA.* We report on the effect of growth direction in Quantum Cascade lasers by using symmetric structures. Dopant migration causes strong wave-function overlap with dopants for positively biased devices, resulting in ~40% lower performance than those biased negatively.

CM1L • NLO in Microresonators and Waveguides—Continued

CM1L.7 • 09:30
Wavelength-Selective All-Optical Switching in Cascaded Silicon Micro-rings, Yanan H. Wen[1], Lian-Wee Luo[2], Michal Lipson[2,3], Alexander L. Gaeta[1,3]; [1]*Applied & Engineering Physics, Cornell University, USA;* [2]*Electrical & Computer Engineering, Cornell University, USA;* [3]*Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We demonstrate all-optical modulation of individual resonances of a two-ring silicon micro-resonator switching fabric using Raman-induced loss. The number of unique output states for such a switching fabric scales exponentially with the number of signals.

CM1L.8 • 09:45
Raman Scattering Emission in High Q Factor As2S3 Microspheres, Francis Vanier[1], Martin Rochette[2], Yves-Alain Peter[1]; [1]*Department of Engineering Physics, Ecole Polytechnique de Montreal, Canada;* [2]*Department of Electrical and Computer Engineering, McGill University, Canada.* We present measurements of Raman scattering emission in high Q factor As2S3 microspheres. Emission is observed for input powers down to 120 μW and for resonances with Q factor below 10^7.

10:00–10:30 Coffee Break, *Concourse Level*

NOTES

CLEO: Science & Innovations

JOINT

CM1M • Optofluidic Particle Manipulation—Continued

CM1M.6 • 09:30
Trapping and guiding microparticles with self-accelerating vortex beams, juanying zhao[1,2], Peng Zhang[1,4], Jingjiao Liu[2], Ioannis Chremmos[5], Dongmei Deng[1,6], Yuanmei Gao[1,7], Nikos Efremidis[5], Demetrios N. Christodoulides[3], Zhigang Chen[1,8]; [1]*San Francisco State University, USA;* [2]*Beijing Institute of Technology, China;* [3]*CREOL/College of Optics, University of Central Florida, USA;* [4]*4Currently with NSF Nanoscale Science and Engineering Center, University of California, USA;* [5]*University of Crete, Greece;* [6]*South China Normal University, China;* [7]*Shandong Normal University, China;* [8]*Nankai Univ., China.* We demonstrate theoretically and experimentally that optical vortices can be navigated along arbitrary trajectories with a preserving donut-shaped main lobe. The possibility of using such self-accelerating vortex-Bessel-like optical beams for particle manipulation is also illustrated.

CM1M.7 • 09:45
Clinical Detection of Viral Infection on an Optofluidic Chip, Philip Measor[1,2], Lynnell U. Zempoaltecatl[3], Josh Parks[1], Samia Naccache[4], Steve Miller[4], Charles Chiu[4], Aaron Hawkins[3], Holger Schmidt[1]; [1]*School of Engineering, University of California Santa Cruz, USA;* [2]*LiquiLume Diagnostics, Inc., USA;* [3]*Electrical and Computer Engineering, Brigham Young University, USA;* [4]*Laboratory Medicine and Medicine, University of California San Francisco, USA.* We demonstrate strain-specific detection of single virus nucleic acid molecules from clinical influenza samples using an optofluidic chip. We observe a limit of detection of 10,000 virus copies/mL and 10 orders of magnitude dynamic range.

CM1N • Concepts for Scaling & Extending Laser Performance

CM1N.6 • 09:30
A State of the Art Diode Laser System for Matter Wave Interferometry in Microgravity, Christoph Grzeschik[1], Max Schiemangk[1,2], Kai Lampmann[1], Markus Krutzik[1], Achim Peters[1,2]; [1]*Institut für Physik, Humboldt-Universität zu Berlin, Germany;* [2]*Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik, Germany.* Future projects for fundamental research with atom interferometry in space demand for compact and robust laser systems. We present highly integrated diode laser based systems for high precision matter wave interferometry experiments in microgravity.

CM1N.7 • 09:45
Ab Initio Theory of Injection Locking of Lasers, Alexander Cerjan[1], A. Douglas Stone[1]; [1]*Yale University, USA.* A theory is presented of injection locking in laser cavities which includes spatial hole-burning of the gain medium. Qualitatively new behavior near the locking transition is found.

JM1O • Symposium on Novel Light Sources for Biomedical Applications: Light Sources for Optical Coherence Tomography

JM1O.4 • 09:30 Invited
Tailoring Lasers for Specific Swept Source OCT Applications, Brian Goldberg[1]; [1]*AXSUN Technologies Inc, USA.* We report on recent progress in the design and understanding of next generation swept sources and systems for optical coherence tomography and discuss methods for tailoring lasers for specific swept source OCT applications.

10:00–10:30 Coffee Break, *Concourse Level*

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JOINT

CLEO: QELS-Fundamental Science

10:30–12:30
JM2A • Symposium on Fundamentals of Absorption and Emission in Nanostructures and Composites: Novel Optics in Plasmonic and Hyperbolic Systems

Presider: Viktor Podolskiy; University of Massachusetts Lowell, United States

JM2A.1 • 10:30 Invited

Taming light-matter interaction on the nanoscale, Romain Quidant[1]; [1]*ICFO- Institut de Ciencies Fotoniques, Spain.* We first present different experimental strategies to accurately control the interaction of top-down metallic nanostructures with few to single molecules or artificial atoms. We then discuss some applications to different areas including nanochemistry and quantum optics.

JM2A.2 • 11:00

Control of Förster energy transfer with hyperbolic metamaterials and metallic surfaces, Thejaswi Tumkur[1], John K. Kitur[1], Carl E. Bonner[1], Evgenii E. Narimanov[2], Mikhail A. Noginov[1]; [1]*Center for Materials Research, Norfolk State University, USA;* [2]*Department of Electrical and Computer Engineering, Purdue University, USA.* We show that Förster energy transfer is inhibited in the vicinity of hyperbolic metamaterials and metals - the environments, which enhance spontaneous emission rates. The effect is attributed to high local densities of photonic states.

10:30–12:30
QM2B • Novel Quantum Systems

Presider: Michal Bajcsy; Stanford University, United States

QM2B.1 • 10:30

Optical State Transfer via Optomechanical Dark Mode, Hailin Wang[1], Chunhua Dong[1], Victor Fiore[1], Mark C. Kuzyk[1]; [1]*University of Oregon, USA.* We demonstrate an optomechanical dark mode that converts fields between two optical modes, but is decoupled from the mechanical oscillator. The dark mode can enable mechanically-mediated quantum-state-transfer, without cooling the mechanical system to its ground state.

QM2B.2 • 10:45

Ground state cooling of mechanical motion through coupled cavity interactions in the unresolved sideband regime, Yong-Chun Liu[1,2], Yun-Feng Xiao[1], Xingsheng Luan[2], Chee Wei Wong[2]; [1]*State Key Laboratory for Mesoscopic Physics and School of Physics, Peking University, China;* [2]*Optical Nanostructures Laboratory, Columbia University, USA.* We describe coupled-cavity scheme to achieve ground-state cooling of mechanical motion in highly-unresolved sideband regimes. Through EIT lineshapes, both quantum Langevin and master equations confirm the quantum noise characteristics and achieve κ/ωm greater than 10000.

QM2B.3 • 11:00

Towards observation of quantum optomechanical correlations, Daniel Garcia Sanchez[1], Alexandros Tavernarakis[1], Aurélien G. Kuhn[1], Leonhard Neuhaus[1], Salim Zerkani[1], Thibaut Karassouloff[1], Jean Teissier[1], Samuel Deleglise[1], Pierre-Francois Cohadon[1], Tristan Briant[1], Antoine Heidmann[1]; [1]*Laboratoire Kastler Brossel, France.* The quantum radiation pressure noise gives rise to mirror displacement fluctuations and sets a limit in the displacement sensitivity. We have designed a table-top experiment to demonstrate this effect and realize quantum optomechanical experiments.

10:30–12:30
QM2C • Single Photon Sources

Presider: Ian Walmsley; University of Oxford, United Kingdom

QM2C.1 • 10:30

Quantum Feedback Preparation and Stabilization of Photon Number States of Light in a Cavity, Igor Dotsenko[1], Xingxing Zhou[1], Bruno Peaudecerf[1], Theo Rybarczyk[1], Stefan Gerlich[1], Sebastien Gleyzes[1], Michel Brune[1], Jean-Michel Raimond[1], Serge Haroche[1,2]; [1]*Laboratoire Kastler Brossel, C.N.R.S., France;* [2]*College de France, France.* We present a cavity QED experiment on quantum feedback in a microwave superconducting cavity with Rydberg atoms used as quantum sensors and actuators. Our feedback scheme prepares and stabilizes against decoherence photon-number states of light.

QM2C.2 • 10:45

Deterministic Generation of an on-Demand Photon Fock State from a solid-state system, Keyu Xia[1], Jason Twamley[1], Gavin K. Brennen[1], Demosthenes Ellinas[2]; [1]*ARC Centre for Engineered Quantum Systems, Physics and Astronomy, Macquarie University, Australia;* [2]*Department of Sciences MΦQ Research Unit, Technical University of Crete, Greece.* Using an optical toroidal cavity coupled to a Nitregon-vacancy center in a nanodiamond, we present a method to deterministically and on-demand generate photon Fock states with high photon occupation in the visible light frequency.

QM2C.3 • 11:00

A Room Temperature Single Photon Source in Silicon Carbide, stefania castelletto[1], Brett Johnson[2,5], Victor Ivady[3], Nikolas Stavrias[2], Takaede Umeda[4], Adam Gali[3], Takeshi Oshima[5]; [1]*Physics, Macquarie University, Australia;* [2]*University of Melbourne, Australia;* [3]*Hungarian Academy of Sciences,, Hungary;* [4]*University of Tsukuba, Japan;* [5]*Japan Atomic Energy Agency, Japan.* We report the first observation of stable single photon sources in an electronic and photonic device-friendly material, silicon carbide (SiC). SiC is a viable material for implementing quantum communication, computation and photonic technologies.

10:30–12:30
QM2D • Dynamics of Excitons and Plasmons

Presider: Steven Cundiff; NIST/ University of Colorado, United States

QM2D.1 • 10:30

Sequential Superfluorescent Bursts from a Dense Electron-Hole Plasma via Fermi-Edge Gain Enhancement, Ji-Hee Kim[1], Tim Noe[1], Junichiro Kono[1], Yongrui Wang[2], Aleksander Wojcik[2], Alexey Belyanin[2], Stephen McGill[3]; [1]*Electrical and Computer Engineering, Rice Univeristy, USA;* [2]*Physics and Astronomy, Texas A&M University, USA;* [3]*National High Magnetic Field Lab, USA.* A high-density electron-hole plasma in InGaAs/GaAs quantum wells emits a series of sequential bursts of intense superfluorescent radiation with photon energies corresponding to the separation between the electron and hole quasi-Fermi energies.

QM2D.2 • 10:45

Manybody-Correlated Tunneling in Mixed-Type Quantum Wells at High Magnetic Field, Thomas K. Baldwin[1], Stephen McGill[2], Hailin Wang[1]; [1]*Department of Physics, University of Oregon, USA;* [2]*National High Magnetic Field Laboratory, USA.* We report on optical studies of interlayer hole tunneling effects in Mixed-Type Quantum Wells (MTQW) in high magnetic fields.

QM2D.3 • 11:00 Invited

Transient Excitons at Metal Surfaces, Hrvoje Petek[1]; [1]*Department of Physics and Astronomy, Univ. of Pittsburgh, USA.* We employ multiphoton photoemission to study resonant and nonresonant transitions between the occupied and unoccupied surface states at noble metal surfaces. At resonance, nondispersive bands give evidence for the existence of transient excitons at metal surfaces.

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

10:30–12:30
QM2E • Self-accelerating Beams
Presider: Oded Yaakobi, INRS-EMT, University of Quebec, Canada

QM2E.1 • 10:30 Invited

Self-Accelerating Beams in Photonic Crystal Slabs, Ido Kaminer[1], Jonathan Nemirovsky[1], Konstantinos G. Makris[2], Mordechai Segev[1]; *[1]Technion Israel Institute of Technology, Israel; [2]Princeton University, USA.* We find beams that self-bend to highly nonparaxial angles in a general periodic optical system, demonstrating how light can be guided in structures by only tailoring the incoming field, without altering the structure itself.

QM2E.2 • 11:00

Mathieu and Weber accelerating beams beyond the paraxial limit, Peng Zhang[1], Yi Hu[2,3], Tongcang Li[1], Drake Cannan[4], Xiaobo Yin[1,5], Roberto Morandotti[2], Zhigang Chen[3,4], Xiang Zhang[1,5]; *[1]University of California, USA; [2]Institut National de la Recherche Scientifique, Canada; [3]TEDA Applied Physics School, Nankai University, China; [4]Department of Physics and Astronomy, San Francisco State University, USA; [5]Materials Science Division, Lawrence Berkeley National Laboratory, USA.* We demonstrate nonparaxial Mathieu and Weber accelerating beams, generalizing the concept of previously found accelerating beams. Such beams bend into large angles along elliptical or parabolic trajectories but still retain nondiffracting and self-healing capabilities.

10:30–12:30
CM2F • Nanoantennas and Plasmonics
Presider: Wolfgang Freude, Karlsruhe Institute of Technology (KIT), Germany

CM2F.1 • 10:30 Invited

Nano-plasmonics on Silicon and their Applications, Sailing HE[1,2]; *[1]Department of Electromagnetic Engineering, KTH Royal Institute of Technology, Sweden; [2]Centre for Optical and Electromagnetic Research, JORCEP,, Zhejiang University, China.* Our recent theoretical and experimental work on hybrid nano-plasmonic structures and devices will be reviewed. Effects of nonlocal optical response, etc., are presented, as well as some applications including guiding and harvesting of light.

CM2F.2 • 11:00

Inverse Design of Optical Antennas for Sub-Wavelength Energy Delivery, Samarth Bhargava[1], Owen Miller[1], Vidya Ganapati[1], Eli Yablonovitch[1]; *[1]Electrical Engineering and Computer Science, UC Berkeley, USA.* We report using Inverse Electromagnetic Design to computationally optimize optical antenna shapes. Optimized antennas deliver 10% of incident power to a 50x40x10 nm3 spot in a practical magnetic recording medium for Heat Assisted Magnetic Recording.

10:30–12:30
CM2G • Approaching Fundamental Limits in Optical Communication
Presider: David Caplan; Massachusetts Inst of Tech Lincoln Lab, United States

CM2G.1 • 10:30 Invited

The Pursuit of Ultimate Photon Efficiency, Xiang Liu[1]; *[1]Bell Labs, USA.* We review recent advances in the pursuit of photon-efficient modulation and detection for optical communications. Hybrid modulation superimposing coherent modulation on pulse-position-modulation and 4-dimensional modulation are presented. Applications will be discussed.

CM2G.2 • 11:00

Polar Coded Optical Communications with Weak Coherent States, Jonathan L. Habif[1], Zachary Dutton[1], Saikat Guha[1]; *[1]Quantum Information Processing Group, Raytheon BBN Technologies, USA.* We present results from an optical communications testbed demonstrating polar coded pulse position modulation transmitted to a direct detection receiver. Using weak coherent states we achieve a photon information efficiency of 4.8 bits per received photon.

10:30–12:30
CM2H • Microcavity Optofluidic Sensors
Presider: Ofer Levi, Univ. of Tronto, Canada

CM2H.1 • 10:30

Microfluidic Optomechanics, Kyu Hyun Kim[1], Gaurav Bahl[2], Wonsuk Lee[1,3], Jing Liu[3], Matthew Tomes[1], Xudong Fan[3], Tal Carmon[1]; *[1]EECS, University of Michigan, USA; [2]MSE, University of Illinois at Urbana-Champaign, USA; [3]BME, University of Michigan, USA.* We bridge between optomechanics and microfluidics by experimentally demonstrating optically excited vibrations. Our device enables extending optomechanics to non-solid phases of matter in a fluid containing microcapillary.

CM2H.2 • 10:45

Highly Sensitive Optofluidic FRET Lasers with Genetically Encoded Fluorescent Protein Pairs, Qiushu Chen[1], Xingwang Zhang[2], Yuze Sun[1], Mike Ritt[3], Sivaraj Sivaramakrishnan[3], Xudong Fan[1]; *[1]Biomedical Engineering, University of Michigan, USA; [2]Department of Optical Science and Engineering, Fudan University, China; [3]Department of Cell and Developmental Biology, University of Michigan, USA.* We achieved optofluidic FRET lasers using genetically encoded fluorescent protein pairs linked by length-tunable peptides. 10-fold enhancement in the FRET sensing signal was demonstrated with the optofluidic FRET laser compared to the conventional FRET detection.

CM2H.3 • 11:00

Gain Controlled Optofluidic Lasers with Self-assembled DNA Tetrahedron, Qiushu Chen[1], Huajie Liu[2], Wonsuk Lee[1,3], Yuze Sun[1], Dan Zhu[2], Hao Pei[2], Chunhai Fan[2], Xudong Fan[1]; *[1]Biomedical Engineering, University of Michigan, USA; [2]Laboratory of Physical Biology, Shanghai Institute of Applied Physics, China; [3]Department of Electrical Engineering and Computer Science, University of Michigan, USA.* Using self-assembled DNA tetrahedron, we were able to precisely control the gain in optofluidic FRET lasers. 3.8 times reduction in the lasing threshold and 28-fold enhancement in the lasing efficiency were demonstrated.

CLEO: Science & Innovations

10:30–12:30
CM2I • Ultrafast Fiber Sources
Presider: Axel Ruehl; Center for Free Electron Laser Science, Germany

CM2I.1 • 10:30
Extended Self-Similar Pulse Evolution in a Laser with Dispersion-Decreasing Fiber, Hui Liu[1], Fei Yu[2], Andy Chong[3], Jonathan C. Knight[2], Frank W. Wise[1]; [1]*Applied and Engieering Physics, Cornell University, USA;* [2]*Physics, University of Bath, United Kingdom;* [3]*Physics & Electro-Optics, University of Dayton, USA.* A mode -locked fiber laser with self-similar pulse evolution in a segment of dispersion-decreasing fiber is demonstrated. Generation of ~6-cycle pulses shows the promise of the approach.

CM2I.2 • 10:45
Ytterbium Fiber Oscillator with Higher-Order-Mode Fiber Generating 7-nJ, 60-fs Pulses at 1035 nm, Alma Fernández[1], Lingxiao Zhu[1], Vladimir Kalashnikov[1], Aart Verhoef[1], Dusan Lorenc[1], Andrius Baltuska[1]; [1]*Institut für Photonik, Technische Universität Wien, Austria.* We present a mode-locked Yb-fiber oscillator with higher-order-mode fiber operating in the normal-dispersion regime, delivering 7.2 nJ pulses compressible down to 62 fs. Theoretical predictions reveal an operation regime with highest pulse fidelity.

CM2I.3 • 11:00
Mode-locked Nd-doped fiber laser at 930 nm, Ammar Hideur[1], Kai Qian[1], Hongjie Wang[1], Mathieu Laroche[2]; [1]*CNRS UMR 6614 CORIA, France;* [2]*CIMAP, France.* We report on a passively mode-locked Neodymium-doped oscillator featuring a double-clad W-type fiber and emitting around 930 nm. The laser generates 4.5 ps pulses with 24 mW average power corresponding to 1.8 nJ energy.

10:30–12:30
CM2J • THz Metamaterials & Plasmonics II
Presider: Juraj Darmo; Technische Universität Wien, Austria

CM2J.1 • 10:30 Invited
Terahertz Plasmonics and Metamaterial-Based Optics, T. Fip[1], M. Volk[1], B. Reinhard[1], Jens Neu[1], M. Hoh[1], Marco H. Rahm[1]; [1]*Technische Univ. Kaiserslautern, Germany.* We demonstrate gradient index optics for terahertz radiation based on passive and active metamaterials. Furthermore, we experimentally investigate the tailored focusing of a highly confined terahertz surface wave on a gradient index meta-surface.

CM2J.2 • 11:00
Tunable Graphene-based Metamaterial Terahertz Modulators, Rusen Yan[1], Subrina Rafique[1], Wei Li[2,3], Xuelei Liang[3], Debdeep Jena[1], Lei Liu[1], Berardi Sensale-Rodriguez[1], Huili Xing[1]; [1]*Department of Electrical Engineering, University of Notre Dame, USA;* [2]*Semiconductor and Dimensional Metrology Division, National Institute of Standards and Technology (NIST), USA;* [3]*Key Laboratory for the Physics and Chemistry of Nano Devices, Peking University, China.* We demonstrate metamaterial-based electro-absorption THz modulators employing frequency-selective-surfaces (FSS) and graphene. By placing the graphene layer at an optimal distance from the FSS, the sensitivity of THz transmittance can be greatly enhanced.

10:45–12:15
CM2K • Mid-infrared Semiconductor Lasers
Presider: Paul Crump, FBH-Berlin, Germany

CM2K.1 • 10:30
Withdrawn

CM2K.2 • 10:45
Low threshold interband cascade lasers in the wavelength range between 3 and 6 µm, Robert Weih[1], Martin Kamp[1], Sven Hoefling[1]; [1]*Chair of Applied Physics, University of Wuerzburg, Germany.* Within the last decade interband cascade lasers have strongly improved their performance. The latest design variations together with record threshold current densities in the MIR wavelength region are presented.

CM2K.3 • 11:00
Tuning Curves of Parametric Light Generated using $\chi^{(2)}$ Nonlinearities in Semiconductor Lasers, Payam Abolghasem[1], Bhavin J. Bijlani[1], A. S. Helmy[1]; [1]*Electrical and Computer Engineering, University of Toronto, Canada.* This work explains the observed parametric fluorescence tuning curves generated in the first semiconductor lasers where $\chi^{(2)}$ is phase-matched. These curves exhibited dispersion opposite to previously reported fluorescence due to effects including temperature and free carriers.

10:30–12:30
CM2L • Ultrafast Parametric Sources
Presider: Antoine Godard; ONERA - the French Aerospace Lab, France

CM2L.1 • 10:30
500-MHz Mid-IR Frequency Comb Source Based on a Compact Subharmonic OPO, Kirk Ingold[1], Alireza Marandi[1], Charles W. Rudy[1], Vladimir Pervak[2], Robert Byer[1], Konstantin Vodopyanov[1]; [1]*Stanford University, USA;* [2]*Ludwig-Maximilians-Universität München, Germany.* We demonstrate a degenerate Mid-infrared frequency comb OPO with a fractional cavity length pumped by an ultrafast 100-MHz Er-fiber laser. This produces a 600-nm wide output near 3µm with a repetition rate of 500 MHz.

CM2L.2 • 10:45
Carrier Envelope Offset of Nondegenerate, Doubly-Resonant, Midinfrared GaAs Optical Parametric Oscillators, Kevin Lee[1], Jie Jiang[1], Christian Mohr[1], Jens Bethge[1], Nick Leindecker[1,2], Konstantin Vodopyanov[2,3], Peter G. Schunemann[4], Martin E. Fermann[1], Ingmar Hartl[1]; [1]*IMRA America, Inc., USA;* [2]*E.L. Ginzton Laboratory, Stanford University, USA;* [3]*CREOL, College of Optics and Photonics, Univ. Cent. Florida, USA;* [4]*BAE Systems, USA.* We demonstrate that the carrier-envelope offset frequency of a Mid-infrared frequency comb from a nondegenerate and doubly-resonant GaAs-based optical parametric oscillator is locked to that of the 2 µm thulium-fiber pump laser.

CM2L.3 • 11:00 Invited
High Average Power Few-cycle Pulses in the Mid-IR, Self-compression and Continuum Generation, Michaël Hemmer[1], Alexandre Thai[1], M. Baudish[2], Francisco Silva[1], Dane R. Austin[1], Hideki Iskizuki[2], Takunori Taira[2], Arnaud Couairon[3], Daniele Faccio[4], Jens Biegert[1,5]; [1]*ICFO -The Institute of Photonic Sciences, Spain;* [2]*Laser Research Center for Molecular Science, Inst. for Molecular Science, Japan;* [3]*Centre de Physique Théorique, CNRS, École Polytechnique, France;* [4]*Heriot-Watt University, Edinburgh Campus, United Kingdom;* [5]*ICREA - Institució Catalana de Recerca i Estudis Avançats, Spain.* We present latest results towards a high average power and CEP-stable few-cycle mid-IR OPCPA for extreme nonlinear optics and strong field physics. Supercontinuum generation and self-compression to 3-cycles will be highlighted.

CLEO: Science & Innovations

10:30–12:30
CM2M • Fundamentals of Laser-Material Interactions

Presider: Wayne Hess; Pacific Northwest National Laboratory, United States

CM2M.1 • 10:30 Tutorial

Mechanisms of Nanoscale Materials Modification by Photon Beams, Alexander Shluger[1]; [1]*Physics and Asronomy, Univ. College London, United Kingdom*. The tutorial will introduce the mechanisms of materials modification by electronic excitation and will describe theoretical methods and models used for studying the behavior of atoms inside solids and at surfaces under laser excitation.

Alexander Shluger graduated from the Latvia State University, Riga, USSR in 1976, received Ph.D and Doctor of Science degrees from the L. Karpov Physics and Chemistry Research Institute, Moscow in 1981 and 1988, respectively. He joined the Royal Institution of Great Britain, London in 1991 and the faculty of the University College London in 1996, where he is a Professor of Physics from 2004. He has been appointed a head of Condensed Matter and Materials Physics group in 2006. He is a Fellow of the Institute of Physics and of the American Physical Society, a Foreign Member of the Latvian Academy of Sciences and a Principal Investigator at the WPI-Advanced Institute of Materials Research, Tohoku University, Japan. Main research interests concern the mechanisms of defect related processes in the bulk and at surfaces of insulators and the mechanisms of photo-induced processes in metals and insulators.

JOINT

10:30–12:30
JM2N • Optical Resonators for Laser Systems and Metrology

Presider: Todd Clatterbuck; Raytheon SAS, United States

JM2N.1 • 10:30

Absolute Frequency Stability Measurements of a Semiconductor-based, Etalon-stabilized 10 GHz Optical Frequency Comb, Josue Davila-Rodriguez[1], Peter J. Delfyett[1]; [1]*University of Central Florida, CREOL, USA*. We present a semiconductor optical frequency comb stabilized to an intracavity, 10,000 Finesse etalon which is held in a vacuum chamber and temperature stabilized. The frequency instability is <90 kHz in >12 min of operation.

JM2N.2 • 10:45

Crystalline coatings for ultra-low-noise optical cavities, Garrett D. Cole[1,2], Wei Zhang[3], Michael J. Martin[3], Jun Ye[3], Markus Aspelmeyer[2]; [1]*Crystalline Mirror Solutions GmbH, Austria;* [2]*Vienna Center for Quantum Science and Technology (VCQ), Faculty of Physics, University of Vienna, Austria;* [3]*JILA, National Institute of Standards and Technology, and University of Colorado, USA*. We demonstrate substrate-transferred crystalline coatings, based on epitaxial Bragg mirrors directly-bonded to fused silica, exhibiting an unprecedented tenfold reduction in Brownian noise. These mirrors promise a significant advancement in the performance of precision optical interferometers.

JM2N.3 • 11:00

Coherent control of microresonator comb generation via parametric-gain seeding, Scott Papp[1], Pascal Del'Haye[1], Daniel Cole[1], Scott A. Diddams[1]; [1]*Time and Frequency Division, NIST, USA*. We discuss coherent control of parametric frequency-comb generation in microresonators. Pumping a microresonator with multiple optical frequencies enables not only robust control over the resulting comb's line spacing, but also access to low-noise comb spectra.

10:30–12:30
JM2O • Symposium on Novel Light Sources for Biomedical Applications: Multimodal Imaging Light Sources and Applications

Presider: Nicusor Iftimia; Physical Sciences Inc., United States

JM2O.1 • 10:30 Invited

Employing Supercontinuum Technology for Biomedical Applications, Carsten L. Thomsen[1]; [1]*Koheras A/S, Denmark*. Supercontinuum sources continue to experience a strong growths within biomedical applications as they span both the visible and near infrared spectrum, and thereby offers unprecedented flexibility with respect to spectral coverage, and continuous multi-wavelength tuning.

JM2O.2 • 11:00

Highly Nonlinear Robust Step-Index Chalcogenide Nanotapers for Octave-Spanning Supercontinuum Generation, Soroush Shabahang[1], Guangming Tao[1], Peter J. Delfyett[1], Ayman F. Abouraddy[1]; [1]*University of Central Florida, CREOL, USA*. We fabricate highly nonlinear and mechanically robust step-index chalcogenide nanotapers with high index contrast for stable Mid-infrared supercontinuum generation. By pumping the nanotapers with low peak-power pulses, one-octave of spectral broadening was generated.

JM2A • Symposium on Fundamentals of Absorption and Emission in Nanostructures and Composites: Novel Optics in Plasmonic and Hyperbolic Systems—Continued

JM2A.3 • 11:15 Invited

Quantum Plasmonics and Plexcitonics, Peter J. Nordlander[1]; [1]*Rice Univ., USA.* Plasmons in strongly coupled nanostructures can induce strong electric fields and enhance electron transfer processes. A quantum mechanical description of this process reveals several novel effects that would be absent in classical modeling.

JM2A.4 • 11:45

Zeroth-Order Transmission Resonance in Hyperbolic Metamaterials, ZUN HUANG[1,2], Evgenii E. Narimanov[1,2]; [1]*Purdue University, USA;* [2]*Birck Nanotechnology Center, USA.* We describe a novel resonance in planar hyperbolic metamaterials. In conventional Fabry-Perot mode numbering, the resonance corresponds to 0-th order, and can be observed in planar hyperbolic media with arbitrary small thickness.

QM2B • Novel Quantum Systems—Continued

QM2B.4 • 11:15

Manipulating NV centers with Optomechanical Crystals, Behzad Khanaliloo[1,2], Paul E. Barclay[1,2]; [1]*Institute for Quantum Science and Technology, University of Calgary, Canada;* [2]*National Institute for Nanotechnology, National Research Council, Canada.* Nanophotonic optomechanical devices allow efficient control of localized, high quality factor, nanoscale mechanical resonances. By optically actuating these resonances, the properties of embedded diamond nitrogen vacancy centers can be modulated with far off resonance photons.

QM2B.5 • 11:30

Observation of the Quantum Zeno Effect on the Nitrogen Vacancy Center in Nanodiamond, Janik Wolters[1], Max Strauss[1], Rolf S. Schönfeld[1], Oliver Benson[1]; [1]*Humboldt Universität zu Berlin, Germany.* We observe the quantum Zeno effect on a solid state spin, namely the nitrogen vacancy center in nanodiamond. A semi-classical model is analyzed to support our experimental findings.

QM2B.6 • 11:45

Top-Down, Scalable Fabrication of High Purity Fluorescent Nanodiamonds, Matthew Trusheim[1], Luozhou Li[3], Ophir Gaathon[2], Edward H. Chen[1], Dirk Englund[1]; [1]*EECS, MIT, USA;* [2]*APAM, Columbia University, USA;* [3]*EE, Columbia University, USA.* We demonstrate a fabrication technique for high volume production of high quality nanocrystals from bulk chemical vapor deposition diamond. Ramsey and Spin-Echo measurements confirm the long spin coherence of nitrogen vacancy centers in these nanocrystals.

QM2C • Single Photon Sources—Continued

QM2C.4 • 11:15

Temporal filtering via amplitude modulation to improve quantum dot single photon sources, Imad Agha[1,2], Serkan Ates[1,2], Angelo Gulinatti[3], Ivan Rech[3], Antonio Badolato[4], Kartik Srinivasan[1]; [1]*Center for Nanoscale Science and Technology, National Inst of Standards & Technology, USA;* [2]*Maryland Nanocenter, University of Maryland, USA;* [3]*Dipartimento di Elettronica e Informazione, Politecnico di Milano, Italy;* [4]*department of Physics and Astronomy, University of Rochester, USA.* Starting with a single InAs quantum dot in a fiber-coupled microdisk cavity, we demonstrate significant improvement in both indistinguishability and purity of the single photon emission by employing temporal filtering via synchronized amplitude modulation.

QM2C.5 • 11:30

Erasing spectral distinguishability in quantum dot based single photon sources using quantum frequency conversion, Serkan Ates[1,2], Imad Agha[1,2], Angelo Gulinatti[3], Ivan Rech[3], Matthew T. Rakher[1], Antonio Badolato[4], Kartik Srinivasan[1]; [1]*Center for Nanoscale Science and Technology, National Inst of Standards & Technology, USA;* [2]*Maryland NanoCenter, University of Maryland, USA;* [3]*Dipartimento di Elettronica e Informazione, Politecnico di Milano, Italy;* [4]*$Department of Physics and Astronomy, University of Rochester, USA.* Using background-free quantum frequency conversion, two spectrally separate excitonic transitions from a single semiconductor quantum dot are converted to a single wavelength, and two-photon interference on the frequency-converted signal is demonstrated.

QM2C.6 • 11:45

Demonstrating High Symmetric Single-Mode Single-Photon Heralding Efficiency in Spontaneous Parametric Downconversion, Jingyun Fan[1]; [1]*National Inst of Standards & Technology, USA.* We demonstrate a symmetric, single-spatial mode, single-photon heralding efficiency of 84% for a type-II spontaneous parametric downconversion process. High efficiency, single-spatial mode collection is key to enabling many quantum information processing and quantum metrology applications

QM2D • Dynamics of Excitons and Plasmons—Continued

QM2D.4 • 11:30

Observation of Coherent Acoustic Plasmons in Photoexcited GaAs, Prashant Padmanabhan[1], Steve Young[1], Meredith Henstridge[1], Sishir Bhowmick[2], Pallab K. Bhattacharya[2], Roberto Merlin[1]; [1]*Physics, University of Michigan, USA;* [2]*Electrical Engineering & Computer Science, University of Michigan, USA.* We report on the observation of confined coherent acoustic plasmon waves in photoexcited GaAs using ultrafast pump probe experiments. Results are in good agreement with theoretical predictions under the random phase approximation.

QM2D.5 • 11:45

Coupling in InGaAs Double Quantum Wells Studied with 2D Fourier Transform Spectroscopy, Gaël Nardin[1], Rohan Singh[1,2], Travis M. Autry[1,2], Galan Moody[1,2], Hebin Li[1], François Morier-Genoud[3], Steven T. Cundiff[1,2]; [1]*JILA, University of Colorado & NIST, USA;* [2]*Department of Physics, University of Colorado, USA;* [3]*ICMP, EPFL, Switzerland.* We study asymmetric double InGaAs quantum well samples, featuring three different barrier widths, using optical two-dimensional Fourier transform spectroscopy. Depending on the barrier width, we observe different coupling mechanisms between the two wells.

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QM2E • Self-accelerating Beams—Continued

QM2E.3 • 11:15
Nonspreading Electron-Beams that Balance Self-Repulsion, Ido Kaminer[1], Dikla Oren[1], Maor Mutzafi[1], Levi Schächter[1], Mordechai Segev[1]; *[1]Technion Israel Institute of Technology, Israel.* By introducing concepts of beam shaping from nonlinear optics into quantum mechanics, we show how interference of electrons wavefunctions can exactly balance the nonlinear self-repulsion of an electron-beam, creating nonspreading shape-preserving propagation in free-space.

QM2E.4 • 11:30
Free-space Trajectory Management of Self-Accelerating Beams Through Fourier-space Phase Engineering, Yi Hu[1], Domenico Bongiovanni[1], Zhigang Chen[2,3], Roberto Morandotti[1]; *[1]INRS-EMT, Canada; [2]TEDA Applied Physics School, Nankai University, China; [3]Department of Physics and Astronomy, San Francisco State University, USA.* We propose and demonstrate a scheme to control the trajectories of single/multiple self-accelerating beams through analyzing the Fourier-space phase in both the paraxial and non-paraxial regimes. Our method is also applicable to vector self-accelerating beams.

QM2E.5 • 11:45
Self-accelerating Bessel-like beams along arbitrary trajectories, juanying zhao[1,2], Ioannis Chremmos[4], Peng Zhang[1], Jingjiao Liu[2], Dongmei Deng[1,5], Yuanmei Gao[1,6], Nikos Efremidis[4], Demetrios N. Christodoulides[3], Zhigang Chen[1,7]; *[1]San Francisco State University, USA; [2]Beijing Institute of Technology, China; [3]CREOL/College of Optics, University of Central Florida, USA; [4]University of Crete, Greece; [5]South China Normal University, China; [6]Shandong Normal University, China; [7]TEDA Applied Physics School, Nankai University, China.* We theoretically and experimentally demonstrate self-accelerating Bessel-like optical beams propagating along arbitrary trajectories in free space. Such beams possess nearly symmetric nondiffracting main lobes and exhibit self-healing properties, promising for a variety of applications.

CM2F • Nanoantennas and Plasmonics—Continued

CM2F.3 • 11:15
Ultrathin Plasmonic Subtractive Color Filters, Beibei Zeng[1], Yongkang Gao[1], Filbert J. Bartoli[1]; *[1]ECE, Lehigh University, USA.* We present the design and demonstration of ultra-thin plasmonic color filters, providing a powerful approach for subtractive color filtering with high spatial resolution and ultra-compact architectures on sub-micrometer scales.

CM2F.4 • 11:30
Experimental Demonstration of an Integrated Hybrid Plasmonic Polarization Rotator, Jan Niklas Caspers[1], Mo Mojahedi[1]; *[1]Department of Electrical and Computer Engineering, University of Toronto, Canada.* We demonstrate an ultra-compact (4.5 μm long) hybrid plasmonic polarization rotator operating at telecommunication wavelength for integrated silicon photonic circuits. The polarization is rotated with >11 dB polarization extinction ratio and a low total insertion losses of 3.6 dB.

CM2F.5 • 11:45
Enhancement of Raman Scattering Efficiency by a Metallic Nano-antenna on Top of a High Index Contrast Waveguide, Frédéric Peyskens[1], Ananth Subramanian[1], Ashim Dhakal[1], Nicolas Le Thomas[1], Roel Baets[1]; *[1]Photonics Research Group, Ghent University, Belgium.* We theoretically study coupling of dipole radiation into integrated Si_3N_4 strip waveguides functionalized with a nanoplasmonic antenna. This structure enables efficient coupling of enhanced Raman signals into the fundamental TE-mode of the waveguide.

CM2G • Approaching Fundamental Limits in Optical Communication—Continued

CM2G.3 • 11:15
Fundamental limits on the energy consumption in fiber-optic communications, Cristian Antonelli[1], Antonio Mecozzi[1], Mark Shtaif[2], Peter J. Winzer[3]; *[1]Department of Physical and Chemical Sciences, Universita degli Studi dell'Aquila, Italy; [2]Tel Aviv University, Israel; [3]Alcatel Lucent Bell Labs, USA.* We show that optically amplified multi-span transmission systems are suboptimal in terms of fundamental energy consumption. Using generalized on-off keying with photon-counting inline regeneration improves the fundamental energy consumption by orders of magnitude.

CM2G.4 • 11:30 Invited
Experimental Turbulence Effects on Crosstalk and System Power Penalty over a Free Space Optical Communication link using Orbital Angular Momentum Multiplexing, Yongxiong Ren[1], Hao Huang[1], Guodong Xie[1], Nisar Ahmed[1], Baris I. Erkmen[2], Nivedita Chandrasekaran[3], Martin Lavery[4], Jeffrey H. Shapiro[3], Nicholas Steinhoff[5], Moshe Tur[6], Miles Padgett[4], Robert W. Boyd[7], Alan E. Willner[1]; *[1]Department of Electrical Engineering, University of Southern California, USA; [2]Jet Propulsion Laboratory, California Institute of Technology, USA; [3]Research Laboratory of Electronics, Massachusetts Institute of Technology, USA; [4]School of Physics and Astronomy, University of Glasgow, United Kingdom; [5]The Optical Sciences Company, USA; [6]School of Electrical Engineering, Tel Aviv University, Israel; [7]Department of Physics and Astronomy, The Institute of Optics, University of Rochester, USA.* The atmospheric turbulence effects on crosstalk and system penalty over an OAM-based multiplexed FSO link is experimental investigated. Our results shows that the power penalty for OAM multiplexed system is >10 dB at weak turbulence condition due to the severe turbulence induced crosstalk.

CM2H • Microcavity Optofluidic Sensors—Continued

CM2H.4 • 11:15
Single Molecule Detection with an Yb-doped Microlaser, Tao Lu[2,1], Hansuek Lee[1], Tong Chen[1], Steven Herchak[2]; *[1]Applied Physics, California Institute of Technology, USA; [2]Electrical and Computer Engineering, University of Victoria, Canada.* We demonstrate the detection of single protein molecules in an aqueous environment with an Yb-doped silica microlaser. With the employment of a real-time spectrum analyzer, a fast sampling speed of sub-milliseconds per spectrum was adopted.

CM2H.5 • 11:30
reflection detection of nanoparticles using whispering gallery microresonators, Jiangang Zhu[1], Sahin K. Ozdemir[1], Lan Yang[1]; *[1]Electrical and System Engineering, Washington University, USA.* We report real time detection of individual nanoparticles down to R=20 nm using a high-Q whispering gallery mode (WGM) microresonator. The detection is based on resonance enhanced particle induced reflection and does not require monitoring resonance spectra.

CM2H.6 • 11:45
A Self-Referencing Biosensor Based upon a Dual-Mode External Cavity Laser, meng zhang[1], Chun Ge[2], Meng Lu[2], Zhixiong Zhang[3], Brian T. Cunningham[2,4]; *[1]Department of Physics, University of Illinois at Urbana-Champaign, USA; [2]Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, USA; [3]Department of Electronic Engineering, Tsinghua University, China; [4]Department of Bioengineering, University of Illinois at Urbana-Champaign, USA.* We demonstrated a dual-mode external cavity laser biosensor, and developed a self-referencing technique utilizing one of the two lasing modes as reference signal. This system achieves high-Q resonance, high sensitivity label-free detection and eliminates common-mode sources of sensor noise.

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CM2I • Ultrafast Fiber Sources—Continued

CM2I.4 • 11:15
3 GHz, femtosecond Raman soliton source, Guoqing Chang[1,2], Hung-Wen Chen[1], Jinkang Lim[1], Shanhui Xu[3], Zhongmin Yang[3], Franz X. Kärtner[1,2]; [1]*Electrical Engineering and computer Science, MIT, USA;* [2]*CFEL, DESY, University of Hamburg, Germany;* [3]*Institute of Optical communication materials, South China University of Technology, China.* A 3-GHz femtosecond Raman soliton source (tunable between 1.06-1.22 μm) is demonstrated based on an Yb-fiber laser. The resulting source produces 350-mW average power at 1.22 μm with 40-nm bandwidth and ~100 fs pulse duration.

CM2I.5 • 11:30
110 MHz Soliton Mode-Locked High Power Er-doped Fiber Laser using Carbon Nanotube Polyimide Film, Hiroyuki Kawagoe[1], Shutaro Ishida[1], Mitsutoshi Aramaki[1], Youichi Sakakibara[2,3], Emiko Omoda[2], Hiromichi Kataura[2,3], Norihiko Nishizawa[1]; [1]*Nagoya University, Japan;* [2]*AIST, Japan;* [3]*JST CREST, Japan.* 110 MHz high repetition rate soliton mode-locked fiber laser with 40 mW high average power was demonstrated using carbon nanotube polyimide film. Super continuum at 1.7 um was generated and ultrahigh resolution OCT was demonstrated.

CM2I.6 • 11:45
Enhanced Bandwidth Generation in an Er Amplifier Similariton Fiber Laser, Hui Liu[1], Frank W. Wise[1]; [1]*Applied and Engineering Physics, Cornell University, USA.* The addition of a passive nonlinear segment to a similariton laser allows the bandwidth to be enhanced significantly. Numerical and experimental results for an Er fiber laser are presented.

CM2J • THz Metamaterials & Plasmonics II—Continued

CM2J.3 • 11:15
Near-Field Probe Mapping of the THz Electric Field Distribution on Metallic Surfaces, Michele Natrella[1], Oleg Mitrofanov[1], Raimund Mueckstein[1], Chris Graham[1], Cyril Renaud[1], Alwyn Seeds[1]; [1]*Electronic & Electrical Engineering, University College London, United Kingdom.* We demonstrate for the first time the accuracy of the interpretation of images detected by the sub-wavelength aperture near-field THz probe, which enables mapping the distribution of THz electric field on antennas and metallic surfaces.

CM2J.4 • 11:30
THz near-field microscopy of graphene nano-ribbon arrays, Oleg Mitrofanov[1,3], Robert Thompson[1], Igal Brener[2,3], Wei Pan[2], Wenlong Yu[4], Clair Berger[4,5], Walt deHeer[4], Zhigang Jiang[4]; [1]*UCL, United Kingdom;* [2]*Sandia National Lab, USA;* [3]*CINT, SNL, USA;* [4]*Georgia Institute of Technology, USA;* [5]*CNRS/Institut Neel, France.* We use THz near-field microscopy with broadband THz pulses to image graphene nano-ribbons and to probe surface plasmon excitation and uniformity of graphene response. 3.3nm and 7nm thick graphene layers induce (~10%) absorption from 0.5-2.5THz.

CM2J.5 • 11:45
Spatial confinement of broadband THz pulses with a twin-needle probe for THz spectroscopy, Oleg Mitrofanov[1], Cyril Renaud[1], Alwyn Seeds[1]; [1]*UCL, United Kingdom.* Spatial confinement of broadband terahertz (THz) pulses to a 10 micrometer spot is achieved using a twin-needle probe. Combined with a THz subwavelength aperture near-field probe, it enables broadband THz spectroscopy of single micrometer-size objects.

CM2K • Mid-infrared Semiconductor Lasers—Continued

CM2K.4 • 11:15
GaInAsSb-AlGaAsSb laterally coupled distributed-feedback metamorphic laser grown on a GaAs substrate at 2 μm, Paveen Apiratikul[1,2], Lei He[1,2], Christopher Richardson[1]; [1]*Laboratory for Physical Sciences, USA;* [2]*Electrical Engineering, University of Maryland at College Park, USA.* We report a metamorphic GaSb-based laterally coupled distributed-feedback laser grown on a GaAs substrate that operates continuous wave at room temperature with a total output power of 40 mW.

CM2K.5 • 11:30
3 μm GaSb-based Type-I Quantum-well Diode Lasers with Cascade Pumping Scheme, Rui Liang[1], Takashi Hosoda[1], Gela Kipshidze[1], Leon Shterengas[1], Gregory Belenky[1]; [1]*Department of Electrical and Computer Engineering, State University of New York at Stony Brook, USA.* GaSb-based type-I quantum-well diode lasers with two-cascade active region were designed and fabricated. The devices operate in continuous wave at room temperature and demonstrate improved injection efficiency.

CM2K.6 • 11:45
Mid-infrared Lasing in a Single Lead Sulfide Subwavelength Wire at 180 K, Fan Fan[1]; [1]*Electrical Engineering, Arizona State University, USA.* We report Mid-infrared lasing around 3 μm from a single PbS subwavelength wire, with a cavity volume less than the wavelength cubed at 0.44 λ^3. The maximal lasing temperature is 180 K under pulse operation.

CM2L • Ultrafast Parametric Sources—Continued

CM2L.4 • 11:30
New Design Opportunities for Ultrafast Devices Based On Quasi-Phasematching, Christopher R. Phillips[1,2], Lukas Gallmann[2], Martin Fejer[1]; [1]*Stanford University, USA;* [2]*ETH Zurich, Switzerland.* We will discuss new quasi-phasematching design techniques and opportunities, including OPCPA gain-narrowing suppression and custom pulse synthesis, based on convex optimization. We will also discuss how apodization can be performed systematically for chirped-QPM devices

CM2L.5 • 11:45
Demonstration of Bandwidth and Conversion Efficiency Improvements beyond Phase-Matching Limitations in Cavity-Enhanced Optical Parametric Chirped Pulse Amplification, Aleem M. Siddiqui[1], Kyung-Han Hong[1], Jeffrey Moses[1], Franz X. Kärtner[1,2]; [1]*Massachusetts Institute of Technology, USA;* [2]*Center for Free-Electron Laser Science, DESY and Dept. of Physics, University of Hamburg, Germany.* Cavity-enhanced optical parametric chirped-pulse amplification (OPCPA) extends the capabilities of nonlinear crystals beyond material property limitations, namely nonlinear-coefficient and dispersion. Here we show a dramatic increase in conversion and a three-fold increase in gain bandwidth.

Monday, 10 June

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JOINT

CM2M • Fundamentals of Laser-Material Interactions—Continued

CM2M.2 • 11:30
3/2 Harmonic Generation - The Clue to the Mechanism of Ultrafast Laser Nanostructuring, Aabid Patel[1], Mindaugas Gecevičius[1], Rokas Drevinskas[1], Martynas Beresna[1], Peter G. Kazansky[1]; *[1]Optoelectronics Research Centre, University of Southampton, United Kingdom.* The correlation between (3/2)ω harmonic generation and self-assembling nanostructuring during ultrafast laser writing in glass has been observed. Interference between light and two-plasmon decay is proposed.

CM2M.3 • 11:45
Evidence of New High-Pressure Silicon Phases in Fs-Laser Induced Confined Microexplosion, Ludovic Rapp[1], Bianca Haberl[2], Jodie E. Bradby[2], Eugene G. Gamaly[1], Jim S. Williams[2], Saulius Juodkazis[3], Andrei V. Rode[1]; *[1]Laser Physics Centre, Research School of Physics and Engineering, Australian National University, Australia; [2]Electronic Materials Engineering, Research School of Physics and Engineering, Australian National University, Australia; [3]Swinburne University of Technology, Australia.* We report on formation of high-pressure polymorphs of Si in confined microexplosion experiments. The results show that Si has undergone pressure-induced transitions into the realm of the metallic phases conventionally formed above 11 GPa.

JM2N • Optical Resonators for Laser Systems and Metrology—Continued

JM2N.4 • 11:15
Stablization of fiber lasers using chip-based high-Q optical resonators, Myoung-Gyun Suh[1], Hansuek Lee[1], Jiang Li[1], Scott Diddams[2], Kerry J. Vahala[1]; *[1]Laboratory of Applied Physics, California Institute of Technology, USA; [2]Time and Frequency Division, National Institute of Standards and Technology, USA.* High-Q disk resonators are used to frequency stabilize two fiber lasers. The improved phase noise of the devices is measured by heterodyne detection and compared to theoretical limits set by thermo-refractive noise.

JM2N.5 • 11:30
upconversion lasing for index sensing and strong amplitude modulation of wgms in Er-Yb co-doped tellurite spheres, Yinlan Ruan[1], Keiron Boyd[1], Hong Ji[1], Heike Ebendorff-Heidepriem[1], Jesper Munch[1], Monro M. Tanya[1]; *[1]Institute of Photonics and Advancing Sensing, University of Adelaide, Australia.* We fabricated Er-Yb codoped tellurite spheres for strong upconversion WGM lasing with Q up to 27,000 for 15um diameter and achieved the index sensitivity of 8.8nm/RIU. Strong amplitude modulation in the modes was also observed.

JM2N.6 • 11:45
Sub 100 fs pulse generation via a Si3N4 micro-resonator based frequency comb, James F. McMillan[1], Shu-Wei Huang[1], Jinghui Yang[1], Heng Zhou[1], Mingbin Yu[2], Dim-lee Kwong[2], Chee Wei Wong[1]; *[1]Columbia University, USA; [2]Institute of Microelectronics, Singapore.* Ultrashort optical pulses have been generated on chip from a frequency comb generated within a Si3N4 micro-resonator. The pulses are measured using frequency resolved optical gating and found to have a FWHM of 74 fs.

JM2O • Symposium on Novel Light Sources for Biomedical Applications: Multimodal Imaging Light Sources and Applications—Continued

JM2O.3 • 11:15
Two-photon fluorescence imaging with 30 fs laser system tunable around 1 micron, Bojan Resan[1], Rodrigo Aviles-Espinosa[2], Sarah Kurmulis[1], Jacob Licea-Rodriguez[3], Felix Brunner[1], Andreas Rohrbacher[1], Hubert Ammann[1], David Artigas[2], Pablo Loza-Alvarez[2], Kurt J. Weingarten[1]; *[1]Time-Bandwidth Products AG, Switzerland; [2]Institute of Photonic Sciences, Spain; [3]Department of Optics, CICESE, Mexico.* We performed high signal-to-noise ratio TPF imaging of mouse intestine with a laser system exhibiting 30 fs, tunable within 800-1200 nm, 50 mW average power, based on a compact Yb-doped laser seeding a microstructured fiber.

JM2O.4 • 11:30
Nonlinear Optical Microscopy with Few-Cycle Laser Pulses, Gabriel Tempea[1], W. Hui[2], S. Gomes da Costa[2], H. B. De Aguiar[2], A. Volkmer[2]; *[1]FEMTOLASERS Produktions GmbH, Austria; [2]3. Institute of Physics, University of Stuttgart, Germany.* Near bandwidth-limited 7-fs-pulses were delivered at the foci of high-NA objectives by employing broadband mirrors for dispersion compensation. The impact of 7-fs-pulses on the signal generation efficiency and contrast in nonlinear optical imaging was investigated.

JM2O.5 • 11:45
A simple method of imaging through strongly scattering mediums, hu li[1], Jianhong Shi[1], Guihua Zeng[1]; *[1]ShangHai Jiaotong University, China.* We demonstrate an experiment of imaging through strongly scattering layers based on period diffraction correlation imaging. The implementation of this experiment is quite simple. This technique could find applications in imaging biological tissues.

JOINT

JM2A • Symposium on Fundamentals of Absorption and Emission in Nanostructures and Composites: Novel Optics in Plasmonic and Hyperbolic Systems—Continued

JM2A.5 • 12:00 Invited

Real-time observation of ultrafast Rabi oscillations between excitons and plasmons in J-aggregate/metal hybrid nanostructures, Christoph Lienau[1], Parinda Vasa[1,2], Robert Pomraenke[1], Wei Wang[1], Melanie Lammers[1], Margherita Maiuri[3], Cristian Manzoni[3], Giulio Cerullo[3]; [1]*Institut f. Physik, Carl V. Ossietzky Univ Oldenburg, Germany;* [2]*Department of Physics, Indian Institute of Technology Bombay, India;* [3]*IFN-CNR, Dipartimento di Fisica, Politecnico di Milano, Italy.* We report the first real-time observation of ultrafast Rabi oscillations in J-aggregate/metal nanostructures, evidencing coherent energy transfer between excitonic quantum emitters and SPP fields. This presents a new approach towards coherent, all-optical ultrafast plasmonic devices.

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QM2B • Novel Quantum Systems—Continued

QM2B.7 • 12:00

Wide-field multispectral super-resolution imaging using spin-dependent fluorescence in nanodiamonds, Edward H. Chen[1], Ophir Gaathon[1], Matthew Trusheim[1], Dirk Englund[1]; [1]*Electrical Engineering and Computer Science, and Research Lab of Electronics, Massachusetts Institute of Technology, USA.* By modulating the fluorescence brightness of nitrogen-vacancy (NV) defect centers in nanodiamonds, we demonstrate a `deterministic emitter switch microscopy' (DESM) technique that enables super-resolution imaging with localization down to 47 nm across a 4x4 μm^2 area.

QM2B.8 • 12:15

3D Optical Manipulation of a Single Electron Spin, Michael Geiselmann[1], Mathieu L. Juan[1], Jan Renger[1], Jana M. Say[2], Louise J. Brown[2], Javier Garcia de Abajo[3], Frank Koppens[1], Romain Quidant[1,4]; [1]*ICFO - The Institute of Photonic Sciences, Spain;* [2]*Department of Chemistry & Biomolecular Sciences, Macquarie University, Australia;* [3]*Instituto de Química-Física "ROCASOLANO", CSIC, Spain;* [4]*ICREA - Institució Catalana de Recerca i Estudis Avançats, Spain.* We optically trap individual nanodiamonds hosting a single Nitrogen Vacancy center and demonstrate a novel route for both non-invasive 3D vectorial magnetometry and sensing of the local density of states in a liquid environment.

QM2C • Single Photon Sources—Continued

QM2C.7 • 12:00

Engineered Phase-Matching for Quantum Photonics, P. Ben Dixon[1], Jeffrey H. Shapiro[1], Franco N.C. Wong[1]; [1]*Research Laboratory of Electronics, Massachusetts Institute of Technology, USA.* We demonstrate Gaussian-shaped quasi-phase matching of a nonlinear optical crystal via custom duty-cycle modulation on its grating structure. Our analysis shows this crystal can generate heralded single photons with 97% spectral purity.

QM2C.8 • 12:15

High Photon Information Efficient Imaging Using Single Photon Source, Reihaneh Shahrokhshahi[1], Niranjan Sridhar[1], Olivier Pfister[1], Jonathan L. Habif[2], Saikat Guha[2], Aaron Miller[3], Sae Woo Nam[4], Adriana E. Lita[4], Brice Calkins[4], Thomas Gerrits[4], Antia Lamas-Linares[4]; [1]*Physics, University of Virginia, USA;* [2]*Raytheon-BBN, USA;* [3]*Albion College, USA;* [4]*NIST, USA.* We report progress towards information efficient quantum imaging, here at 2 bits per photon. A heralded single photon source is used to image a Hadamard phase array encoded in a 4x4 multiport interferometer.

QM2D • Dynamics of Excitons and Plasmons—Continued

QM2D.6 • 12:00

Pattern Formation in the Exciton Inner Ring, mikas remeika[1], Aaron T. Hammack[1], Sergey Poltavtsev[1,4], Joe Wilkes[2], Alexei Ivanov[2], Micah Hanson[3], Arthur C. Gossard[3]; [1]*Physics, University of California San Diego, USA;* [2]*Physics and Astronomy, Cardiff University, United Kingdom;* [3]*Materials, University of California Santa Barbara, USA;* [4]*Spin Optics Laboratory, St-Petersburg State University, Russian Federation.* We report on pattern formation in the exciton inner ring. The effect is explained in terms of exciton transport and thermalization.

QM2D.7 • 12:15

Excitonic Frequency-Frequency Correlation Functions in a GaAs Quantum Well, Rohan Singh[1,2], Galan Moody[1,2], Mark Siemens[3], Hebin Li[1], Steven T. Cundiff[1,2]; [1]*JILA, University of Colorado & NIST, USA;* [2]*Physics, University of Colorado, USA;* [3]*Physics and Astronomy, University of Denver, USA.* The frequency-frequency correlation function for excitons in a GaAs quantum well is measured using optical two-dimensional Fourier transform spectroscopy and a numerical fitting procedure. We also report frequency-frequency correlation functions for biexciton and two-exciton states.

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

NOTES

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QM2E • Self-accelerating Beams—Continued

QM2E.6 • 12:00
Linear and Nonlinear Accelerating Beams in Curved Space, Rivka Bekenstein[1], Jonathan Nemirovsky[1], Ido Kaminer[1], Mordechai Segev[1]; [1]*Physics, Technion, Israel.* We present the first study on linear and nonlinear accelerating beams in curved space. These shape-invariant wavepackets propagate along various trajectories arising from the interplay between the curvature of space and the interference effects.

QM2E.7 • 12:15
Generation and propagation of partially spatially incoherent Airy beams, Yi Liang[1], Daohong Song[1], Cibo Lou[1], Xinzheng Zhang[1], Jingjun Xu[1], Zhigang Chen[1,2]; [1]*The MOE Key Laboratory of Weak-Light Nonlinear Photonics, and TEDA Applied Physics School and School of Physics, Nankai University, China;* [2]*Department of Physics and Astronomy, San Francisco State University, USA.* We present an experimental study of partially-spatially incoherent Airy beams. Our results suggest that spatial coherence affects the exponential truncation factor and self-healing property of Airy beams but has little effect on their self-acceleration trajectories.

CM2F • Nanoantennas and Plasmonics—Continued

CM2F.6 • 12:00
All-Semiconductor Plasmonic Perfect Absorber, Stephanie Law[1], Christopher Roberts[2], Torin Kilpatrick[1], Lan Yu[1], Troy Ribaudo[3], Eric Shaner[3], Viktor A. Podolskiy[2], Daniel Wasserman[1]; [1]*Electrical and Computer Engineering, University of Illinois, USA;* [2]*Physics and Applied Physics, University of Massachusetts Lowell, USA;* [3]*Sandia National Labs, USA.* We demonstrate a Mid-infrared perfect absorber fabricated only from highly-doped semiconductors. A strong (>98%) absorption resonance is observed which is effectively independent of lateral geometry, but highly dependent on the vertical profile.

CM2F.7 • 12:15
Surface-Normal Plasmonic Modulation for Three-Dimensional Optical Interconnects, Fanghui Ren[1], Xiangyu Wang[1], Alan X. Wang[1]; [1]*Electrical Engineering and Computer Science, Oregon State University, USA.* We present theoretical design and experimental demonstration of surface-normal modulation on a gold metallic photonic crystal slab. It requires a moderate index modulation of 0.0043 that is induced by thermal-optical effects of the glass substrate.

CM2G • Approaching Fundamental Limits in Optical Communication—Continued

CM2G.5 • 12:00
Efficient Crosstalk Mitigation of OAM Based 400-Gbit/s QPSK Data Transmission in 1.1-km Vortex Fiber by Using Soft-Decision LDPC codes, Yongxiong Ren[1], Yequn Zhang[2], Yang Yue[1], Nenad Bozinovic[3], Guodong Xie[1], Hao Huang[1], Moshe Tur[4], Poul Kristensen[5], Ivan B. Djordjevic[2], Siddharth Ramachandran[3], Alan E. Willner[1]; [1]*University of Southern California, USA;* [2]*Department of Electrical and Computer Engineering, University of Arizona, Tucson, USA;* [3]*Boston University, USA;* [4]*School of Electrical Engineering, Tel Aviv University, Israel;* [5]*OFS-Fitel, Denmark.* The efficient mitigation of crosstalk effect-induced "error floor" in system performance by using soft-decoding LDPC codes in an OAM multiplexed fiber transmission system is experimentally studied. A significant coding gain of >15.5 dB is achieved.

CM2G.6 • 12:15
Wireless optical telecommunications using non trivial beams, Dimitris Papazoglou[1,2], Anastasia Giannakopoulou[1], Antigoni Papadaki[1], Stelios Tzortzakis[1,2]; [1]*Institute of Electronic Structure and Laser, Foundation for Research and Technology Hellas, Greece;* [2]*Materials Science and Technology Department, University of Crete, Greece.* We demonstrate using experiments and simulations that the use of accelerating optical beams such as Airy and ring-Airy beams, considerably benefits wireless optical telecommunications both in respect of range and robustness to atmospheric turbulence.

CM2H • Microcavity Optofluidic Sensors—Continued

CM2H.7 • 12:00
Enhancement of the Sensitivity of an Open Micro-Cavity Based Optoacoustic Sensor, Ralph Peterson[1], Steven Solis[1], Bailin Zhang[1], He Huang[1], Jing Yong Ye[1]; [1]*University of Texas at San Antonio, USA.* We present a new method for sensitive ultrasound detection using an open-cavity optoacoustic sensor. Our results have demonstrated significant enhancement of detection sensitivity when the open-cavity sensor is used in media with large isothermal compressibility.

CM2H.8 • 12:15
High Sensitivity Biosensing Based on Symmetric Coupled Cavity Structure of Photonic Crystal Microcavities, Cheng-Chih Hsieh[1], Swapnajit Chakravarty[2], Yi Zou[1], Liang Zhu[1], Ray T. Chen[1]; [1]*UT Austin, USA;* [2]*Omega Optics Inc., USA.* We demonstrate that coupled cavity-waveguide architectures can lead to enhanced experimentally measured detection limit of 300 fM (20pg/ml) for sensing the binding of avidin to biotin in photonic crystal micro-cavity based biosensor.

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

NOTES

CLEO: Science & Innovations

CM2I • Ultrafast Fiber Sources—Continued

CM2I.7 • 12:00
Stable frequency comb derived from a narrowband Yb-fiber laser: pre-chirp management for self-referenced fCEO stabilization, Jinkang Lim[1], Hung-Wen Chen[1], Guoqing Chang[1,2], Franz X. Kärtner[1,2]; *[1]EECS, Massachusetts Institute of Technology, USA; [2]DESY, University of Hamburg, Germany.* We demonstrate the feasibility of implementing frequency combs from a narrowband (5-nm, 415-fs transform-limited pulse) laser, paving the way for large line-spacing frequency combs based on multi-GHz lasers which emit long (>200 fs) pulses.

CM2I.8 • 12:15
All-fiber fundamentally mode locked 12 GHz laser comb for stable microwave generation, Rajesh Thapa[1], Eric Wilson[1], Dan Nguyen[1], Jie Zong[1], Arturo Chavez-Pirson[1]; *[1]NP Photonics Inc, USA.* We have developed a compact, yet very stable all-fiber fundamentally mode-locked 12 GHz laser system. The passively mode-locked laser centered at 1535 nm has temporal bandwidth of ~2 ps, average power of 3mW and timing jitter of 44 fs/pulse.

CM2J • THz Metamaterials & Plasmonics II—Continued

CM2J.6 • 12:00
Terahertz cross-phase modulation of an optical mode, Andrei V. Lavrinenko[1], Andrey Novitsky[1,2], Maksim Zalkovskij[1], Radu Malureanu[1], Peter U. Jepsen[1]; *[1]Department of Photonics Engineering, Technical University of Denmark, Denmark; [2]Department of Theoretical Physics and Astrophysics, Belarusian State University, Belarus.* We discuss an optical scheme which facilitates modulation of an optical waveguide mode by metallic-nanoslit-enhanced THz radiation. The waveguide mode acquires an additional phase shift due to THz nonlinearity with fields reachable in experiments.

CM2J.7 • 12:15
High-resolution THz Reflection Measurements of Resonant Hole-arrays, Yuping Yang[1,2], Daniel R. Grischkowsky[2]; *[1]School of Science, Minzu University of China, China; [2]Oklahoma State University, USA.* The high-resolution THz amplitude spectrum as well as the phase shift of the reflection of a thin metal hole-array are measured, and an unexpected Wood's anomaly dip, as well as an unusual step-like 2 pi phase shift are observed.

CM2K • Mid-infrared Semiconductor Lasers—Continued

CM2K.7 • 12:00
Optimized All-optical Amplitude and Frequency Modulation of Quantum Cascade Laser, Tao Yang[1], Gang Chen[2], Chao Tian[1], Rainer Martini[1]; *[1]Department of Physics and Engineering Physics, Stevens Institute of Technology, USA; [2]Key Laboratory for Optoelectronic Technology & System-Education Ministry of China, School of Optoelectronic Engineering, Chongqing University, China.* We demonstrate that by optimizing excitation photon energy in optical modulation of quantum cascade laser, both amplitude and frequency modulation depth are increased. Also, optical switch on and off can be controlled by excitation wavelength.

CM2L • Ultrafast Parametric Sources—Continued

CM2L.6 • 12:00
Tunable Supercontinuum-Seeded 130fs OPA for NIR and MIR with 25 nJ Pulse Energy and 5 MHz Repetition Rate, Thomas Hansel[1], Wolfgang Köhler[2], Andreas Assion[2], Jens Bethge[1], Edlef Büttner[1]; *[1]APE Angewandte Physik & Elektronik GmbH, Germany; [2]Femtolasers Produktions GMBH, Austria.* A novel 5 MHz OPA based femtosecond light source tunable in the NIR and MIR spectral region with 25nJ maximum pulse energy is presented. The system generates a supercontinuum in a YAG-crystal for self-seeding.

CM2L.7 • 12:15
Chirp optimization of pulsed parametric amplifier, Andreas O. Wiberg[1], Zhi Tong[1], Lan Liu[1], Evgeny Myslivets[1], Nikola Alic[1], Stojan Radic[1]; *[1]University of California San Diego, USA.* We have investigated the pump-chirp impact on idler generation in a pulsed fiber-optic parametric amplifier in transparency, broadband operation. The optimization of idler chirp (spectral width) is important in many applications.

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

NOTES

CLEO: Science & Innovations

CM2M • Fundamentals of Laser-Material Interactions—Continued

CM2M.4 • 12:00

Surpassing the Optical Diffraction Limit with Photo-Inhibited Super-Resolution (PInSR) Lithography, Darren Forman[1], Michael Cole[1], Robert McLeod[1]; [1]*University of Colorado at Boulder, USA.* We present our progress towards nano-patterning with focused visible and near-UV light, using a novel photo-polymerizable resist. Special attention will be given to the difficulties presented by diffusion of reactive photo-generated molecules.

CM2M.5 • 12:15

Condensation of polaritons through optical confinement: increased coherence and reduced threshold, Alexis Askitopoulos[1], Hamid Ohadi[1], Pavlos Savvidis[3,4], Hatzopoulos Zaharias[2,4], Alexey Kavokin[1], Pavlos Lagoudakis[1]; [1]*Faculty of Physics and Astronomy, University of Southampton, United Kingdom;* [2]*Department of Phyics, University of Crete, Greece;* [3]*Department of Materials science and Technology, University of Crete, Greece;* [4]*Institue of Electronic Structure and Laser, Foundation of Research and Technology - Hellas, Greece.* We report on a fully optically confined polariton condensate, spatially separated from the pump induced excitonic reservoir. The optically trapped condensate has improved coherence features and an order of magnitude lower excitation density threshold with respect to previous excitation schemes.

JOINT

JM2N • Optical Resonators for Laser Systems and Metrology—Continued

JM2N.7 • 12:00

High-efficiency, monolithic coupling to optomechanical cavities for quantum-limited position detection, Justin D. Cohen[1], Sean M. Meenehan[1], Oskar Painter[1]; [1]*Thomas J. Watson, Sr. Laboratory of Applied Physics, California Institute of Technology, USA.* We demonstrate a high-efficiency optical-fiber coupling platform for optomechanical cavities. Through adiabatic mode conversion, a continuous position measurement with an imprecision of only 0.7 phonons at the optimal standard quantum limit probe power is achieved.

JM2N.8 • 12:15

Observation and analysis of generalized higher-order Bessel-Gauss beams in optical resonators, Damian N. Schimpf[1,2], William P. Putnam[1], Jan Schulte[1], Franz X. Kärtner[1,2]; [1]*Massachusetts Institute of Technology, USA;* [2]*Center for Free-Electron Laser Science, DESY, Germany.* We propose and experimentally demonstrate new beam solutions in form of azimuthally symmetric higher-order Bessel-Gauss beams. We experimentally observe these beams as higher-order eigenmodes in optical resonators consisting of aspheric mirrors.

JM2O • Symposium on Novel Light Sources for Biomedical Applications: Multimodal Imaging Light Sources and Applications—Continued

JM2O.6 • 12:00 Invited

Multi-modal Imaging Using a Novel and Portable Ultrafast Laser Source, Tuan Le[1], Angelika Unterhuber[2], Boris Povazay[2,3], Hans Georg Breunig[4]; [1]*Femtolasers GmbH, Austria;* [2]*Medical University Vienna, Austria;* [3]*Bern University of Applied Sciences, Switzerland;* [4]*Jenlab, Germany.* A novel low-cost and portable fs laser designed for biomedical imaging is presented. The potential of the worlds smallest sub-10 fs Ti:sapphire laser to serve multi modal imaging applications is demonstrated.

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

NOTES

JOINT

13:30–15:30
JM3A • Symposium on Fundamentals of Absorption and Emission in Nanostructures and Composites: Optics of Low-dimensional and Quantum Structures

Presider: Peter Nordlander; Rice University, United States

JM3A.1 • 13:30 Invited

Classical and Quantum Effects in Graphene Plasmons, Javier Garcia de Abajo[1]; [1]*CSIC Inst de Estructura de la Materia, Spain.* We will review current results in graphene plasmonics and describe distinct features of these excitations that can only be understood from quantum theory.

JM3A.2 • 14:00

Quantum-limited, cavity-free nano-optomechanical vectorial coupling with SiC nanowires and Carbon nanotubes, Arnaud Gloppe[1], Pierre Verlot[1], Eva Dupont-Ferrier[1], Aurélien G. Kuhn[1], Benjamin Pigeau[1], Sven Rohr[1], Alessandro Siria[2], Philippe Poncharal[2], Pascal Vincent[2], Guillaume Bachelier[1], Olivier Arcizet[1]; [1]*Institut Néel, CNRS, France;* [2]*Laboratoire de Physique de la Matière Condensée et Nanostructures, CNRS, France.* We investigate the nano-optomechanical properties between a nanowire and a focused beam of light. Based on such a system, we report unprecedently sensitive vectorial detection of nanomechanical motion using SiC nanowires and Carbon nanotubes.

JM3A.3 • 14:15

Enhancing far-field thermal emission with thermal extraction, Yu Zongfu[1], Nicholas Sergeant[1], Torbjorn Skauli[1], Gang Zhang[1], Hailiang Wang[1], Shanhui Fan[1]; [1]*Stanford University, USA.* We show that the thermal emission of a finite-size blackbody emitter can be enhanced. We experimentally observe a four-fold enhancement of the far-field thermal emission of a carbon-black emitter having an emissivity of 0.85.

CLEO: QELS-Fundamental Science

13:30–15:30
QM3B • Quantum Optics with Quantum Dots

Presider: Oliver Benson; Humboldt University of Berlin, Germany

QM3B.1 • 13:30

Third-order photon correlations from a quantum dot coupled to a photonic-crystal nanocavity, Michal Bajcsy[1], Armand Rundquist[1], Arka Majumdar[2], Tomas Sarmiento[1], Konstantinos G. Lagoudakis[1], Jelena Vuckovic[1]; [1]*E. L. Ginzton Laboratory, Stanford University, USA;* [2]*Department of Physics, U C Berkeley, USA.* We measure the third-order autocorrelation function of a photon stream from a single quantum dot coupled to a photonic-crystal nanocavity. This is the first measurement of the higher-order photon correlation function on a solid state quantum emitter.

QM3B.2 • 13:45

Zeeman Splitting of Deterministically Charged Quantum Dots Coupled to Photonic Crystal Nanoresonators, Konstantinos Lagoudakis[1], Kevin Fischer[1], Arka Majumdar[2], Armand Rundquist[1], Michal Bajcsy[1], Jesse Lu[1], Tomas Sarmiento[1], Jelena Vuckovic[1]; [1]*E. L. Ginzton Laboratory, Stanford University, USA;* [2]*Department of Physics, University of California, USA.* We observe deterministic charging of quantum dots embedded in a p-n-i-n junction coupled to photonic crystal nanoresonators by spectroscopic means and demonstrate Zeeman splitting under applied magnetic field in the Voigt configuration.

QM3B.3 • 14:00

Fano Quantum Interference Effects in Exciton-Biexciton Coherently Coupled System in Quantum Dots, Hideki Gotoh[1], Haruki Sanada[1], Hiroshi Yamaguchi[1], Tetsuomi Sogawa[1]; [1]*NTT Basic Research Laboratories, Japan.* Optical nonlinear effects are examined using a two-color micro-photoluminescence method in a coherently-coupled exciton-biexciton system in a single quantum dot. The exciton nonlinear absorption spectrum shows an unusual asymmetric shape induced by Fano interference effects.

QM3B.4 • 14:15

Direct Detection of Optical Rabi Oscillations from a Single Quantum Dot, Alex Burgers[1], John Schaibley[1], Gregory McCracken[1], Duncan Steel[1], Daniel Gammon[2], Allan Bracker[2], Lu Sham[3]; [1]*Physics, University of Michigan, USA;* [2]*Naval Research Lab, USA;* [3]*Physics, University of California San Diego, USA.* We use coherent transient resonance fluorescence to follow the time evolution of Rabi oscillations in a semiconductor quantum dot. We obtain a lifetime limited decoherence rate.

13:30–15:30
QM3C • Solid State Quantum Information

Presider: Renato Renner, Eidgenossische Technische Hochschule Zurich, Switzerland

QM3C.1 • 13:30 Invited

Quantum Information and Simulation with Circuit-QED, Juan Jose Garcia-Ripoll[1]; [1]*Instituto de Fisica Fundamental, CSIC, Spain.* In this talk I will review a number of contributions to the field of superconducting quantum circuits, also known as circuit-QED. I will cover both fundamental topics, such as the design of artificial atoms and photons, and concrete applications to the fields of Quantum Optics, Quantum Simulation and Quantum Information. The emphasis will be set on the new tools that this exciting field provides: ultrastrong light-matter interactions, a precise control of propagating photons, and the engineering of photon interactions.

QM3C.2 • 14:00

Hybridization of superconducting flux qubits and diamond ensembles, William Munro[1,2], Shiro Saito[1], Xiaobo Zhu[1], Yuichiro Matsuzaki[1], Robert Amsüss[4,1], Kosuke Kakuyanagi[1], Takaaki Shimo-Oka[3], Norikazu Mizuochi[3], Kae Nemoto[2], Kouichi Semba[2]; [1]*NTT Basic Research Laboratories, Japan;* [2]*National Institute for Informatics, Japan;* [3]*University of Osaka, Graduate school of Engineering Science, Japan;* [4]*Vienna Center for Quantum Science and Technology, Austria.* Superconducting flux qubits are well known for their processing ability while electron-spin nitrogen-vacancy centers in diamond are a natural memory candidate. Here we report on the realization of a quantum memory operation.

QM3C.3 • 14:15

Quantum Device and Architecture based on NV Centers for Quantum Networks, Kae Nemoto[1], Simon Devitt[1], Joerg Schmiedmayer[3], Michael Trupke[3], William J. Munro[2,1]; [1]*National Institute of Informatics, Japan;* [2]*Basic Reserach Laboratories, NTT, Japan;* [3]*Vienna Center for Quantum Science and Technology, Austria.* We present a way to construct quantum networks based on NV- diamond centers. We discuss the physical imperfections and their effects to the network, and show how to control them with the required accuracy.

13:30–15:30
QM3D • Ultrafast Dynamics in 1D Systems

Presider: Rohit Prasankumar; Los Alamos National Laboratory, United States

QM3D.1 • 13:30

Exciton Localization Probed via Excited-State Resonant Impulsive Stimulated Raman Spectroscopy, Jason G. Mance[1], Josef J. Felver[1], Susan L. Dexheimer[1]; [1]*Washington State University, USA.* We probe the transition from a delocalized to a localized electronic state in a quasi-one-dimensional system by the change in vibrational frequency detected by resonant impulsive Raman excitation of the excited state in a pump-pump-probe measurement.

QM3D.2 • 13:45

Ultrafast optical-pump terahertz-probe spectroscopy of individual silicon nanowires, Taeyong Kim[1], Sangwan Sim[1], Jungmok Seo[1], Jaehong Lee[1], Heetak Han[1], Taeyoon Lee[1], Hyunyong Choi[1]; [1]*Yonsei University, Republic of Korea.* We present terahertz dynamics in individual silicon nanowires by ultrafast optical-pump and terahertz-probe spectroscopy. Density-dependent study reveals that surface traps play a major role in the carrier dynamics observing the conductivity changes.

QM3D.3 • 14:00

Auger-type Hole Trapping Process at Green Emission Centers of ZnO Nanowires, Tze Chien Sum[1], Mingjie Li[1], Guichuan Xing[1], Guozhong Xing[2], Tom Wu[1]; [1]*Division of Physics & Applied Physics, Nanyang Technological University, Singapore;* [2]*School of Materials Science and Engineering, The University of New South Wales, Australia.* Transient absorption spectroscopy uncovered the first experimental evidence of ZnO green emission originating from charge transitions of ZnO divacancies proposed recently in DFT calculations. Hole trapping to this state occurs via an ultrafast Auger-like process.

QM3D.4 • 14:15

Ultrafast intra-excitonic quasiparticle annihilation by exciton-exciton scattering in individually isolated single-walled carbon nanotubes, Sangwan Sim[1], Jeongmook Choi[1], Seongchu Lim[2], Young Hee Lee[2], Hyunyong Choi[1]; [1]*School of Electrical and Electronic Engineering, Yonsei University, Republic of Korea;* [2]*Department of Physics, Sungkyunkwan University, Republic of Korea.* We present direct measurement of exciton-exciton annihilation as fast photo-bleaching at exactly twice the lowest exciton energy in SWCNTs. Exciton-exciton scatterings were identified by determining the 1s-2p transition using ultrafast mid-IR intra-excitonic spectroscopy.

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

13:30–15:30
QM3E • Non-conventional Beams and Optical Vortices
Presider: Peng Zhang; University of California Berkeley, United States

13:30–15:30
CM3F • Nanolasers & Photodetectors
Presider: Sailing HE; KTH Royal Institute of Technology, China

13:30–15:30
CM3G • RF over Fiber
Presider: David Hillerkuss; ETH Zurich, Switzerland

13:30–15:30
CM3H • Laser Materials Processing with Shaped Beams
Presider: Richard Haglund; Vanderbilt University, United States

QM3E.1 • 13:30
Generation of femtosecond optical vortices by molecular modulation in a Raman-active crystal, Miaochan Zhi[1], Kai Wang[1], James Strohaber[1], Alexei Sokolov[1]; [1]*Texas A&M University, USA.* We have realized the coherent transfer of orbital angular momentum in PbWO4 crystal by using two-color femtosecond laser pulses. Ultrashort optical vortices at various wavelengths can be generated.

QM3E.2 • 13:45
Quasi-real-time Measurement of Orbital Angular Momentum Spectra of Ultra-broadband Optical Vortices from Fork-like Interferograms, Zhili Yang[1], Keisaku Yamane[1,2], Yasunori Toda[1,2], Ryuji Morita[1,2]; [1]*Hokkaido University, Japan;* [2]*JST CREST, Japan.* We experimentally demonstrate a simple and high-precision method for measuring orbital angular momentum spectra of femtosecond ultra-broadband optical-vortex pulses from fork-like interferograms. This method enables quasi-real-time OAM measurement for ultra-short or ultra-broadband optical vortices.

QM3E.3 • 14:00
Experimental Demonstration of Negative Optical Forces at Dielectric Interfaces, Veerachart Kajorndejnukul[1], Sergey Sukhov[1], Weiqiang Ding[2], Cheng-Wei Qiu[2], Aristide Dogariu[1]; [1]*University of Central Florida, CREOL, USA;* [2]*Electrical and Computer Engineering, National University of Singapore, Singapore.* We demonstrate for the first time that paraxial beams can exert long range optical pulling forces on objects at soft interfaces due to the increase of linear momentum of light in higher index dielectrics.

QM3E.4 • 14:15
Evolution dynamics of vectorial Bessel beams, Parinaz Aleahmad[1], Hector Moya Cessa[1,3], Mohammad-Ali Miri[1], Armando Perez-Leija[1], Ido Kaminer[2], Mordechai Segev[2], Demetrios N. Christodoulides[1]; [1]*CREOL/College of Optics, University of Central Florida, USA;* [2]*Physics Department and Solid State Institute, Technion-Israel Institute of Technology, Israel;* [3]*Coordinacion de Optica, INAOE, Mexico.* We investigate the acceleration dynamics of non-paraxial Bessel beams. We show that this acceleration behavior can persist even in the presence of evanescent components. Our study can be useful in plasmonic and other sub-wavelength settings.

CM3F.1 • 13:30
Dark State Lasers, Cale Gentry[1], Milos Popovic[1]; [1]*University of Colorado at Boulder, USA.* We propose a novel laser cavity based on imaginary-frequency resonance splitting in coupled resonators. Using different free-spectral ranges (FSRs), a Vernier-like effect where only one longitudinal mode lases allows for ultra-wide tuning of single-frequency lasers.

CM3F.2 • 13:45
Single Wavelength Microring Laser, Amir Arbabi[1], Lynford L. Goddard[1]; [1]*Univ of Illinois at Urbana-Champaign, USA.* We report a novel microring single mode laser that operates based on engineering radiation quality factors of its resonant modes using a second order grating. A theoretical description, fabrication details and measurement results are presented.

CM3F.3 • 14:00
Metal Cavities as the Efficiency Killer in Nanolasers and Spontaneous Light Sources, Dennis G. Deppe[1], Li Mingxin[1], Xu Yang[1]; [1]*University of Central Florida, CREOL, USA.* Here we show that nearly (all) recent studies of metal-coupled lasers or spontaneous light emitters leave out near-field interactions that seriously degrade the emission efficiency. This near field interaction limits the usefulness of metal cavity lasers and spontaneous light emitters.

CM3F.4 • 14:15
Plasmonic-Polarization Enhancement of Novel GaN/AlN Quantum Cascade Detector, Asaf Pesach[1], Salam Sakr[2], Etienne Giraud[3], Maria Tchernycheva[2], Meir Orenstein[1], Nicolas Grandjean[3], Francois Julien[2], Gad Bahir[1]; [1]*Department of Electrical Engineering, Technion-Israel Institute of Technology, Israel;* [2]*Institut d'Electronique Fondamentale, University of Paris-Sud, France;* [3]*Institute of Condensed Matter Physics, Ecole Polytechnique Fédérale de Lausanne, Switzerland.* A novel GaN/AlN quantum cascade detector with simplified alloy extractor is integrated with metallic holes' array. Rotation of polarization by surface plasmons under normal incidence results in ×10 enhancement of responsivity at room temperature.

CM3G.1 • 13:30
A Novel Full-Duplex 60-GHz Radio-over-Fiber Transmission System for Next-Generation Wireless Access Networks, Lan Rao[1,2], Cheng Liu[2], Ming Zhu[2], Jing Wang[2], Gee-Kung Chang[2]; [1]*Beijing Univ of Posts & Telecom, China;* [2]*School of ECE, Georgia Institute of Technology, USA.* A novel full-duplex LO-free 60-GHz radio-over-fiber (RoF) transmission system is proposed. Full-duplex error-free transmission without optical/electrical LO required in either remote antenna units or mobile terminals is successfully demonstrated for next generation wireless communications.

CM3G.2 • 13:45
60-GHz and 100-GHz Wireless Transmission of High-Definition Video Services in Converged Radio-over-Fiber Systems, Lin Cheng[1], Cheng Liu[1], Ze Dong[1,2], Jianjun Yu[2], Gee-Kung Chang[1]; [1]*Georgia Institute of Technology, USA;* [2]*ZTE USA, Inc., USA.* An end-to-end dual-band millimeter-wave radio-over-fiber access system with independent high-definition video services carried on both 60-GHz and 100-GHz radios is demonstrated for the first time based on converged radio-over-fiber techniques.

CM3G.3 • 14:00
Optical dual-pulse sampling for direct detection of vector modulated radio frequency signal, He Wen[1], Wang Ye[1], Xiaoping Zheng[1], Hanyi Zhang[1], Bingkun Zhou[1]; [1]*Tsinghua University, China.* Optical dual-pulse sampling for detection of vector signal is proposed to alleviate the bandwidth requirement on optoelectronic devices. An experiment on receiving 4-Gbaud QPSK 16-GHz radio over fiber has been demonstrated experimentally.

CM3G.4 • 14:15
A full-duplex CATV/RoF/16-QAM OFDM lightwave transport system, Po-Yi Wu[1], Chia-Yi Chen[1], Ying-Pyng Lin[1], Hai-Han Lu[1,2]; [1]*National Taipei University of Technology, Taiwan;* [2]*Tungnan University, Taiwan.* A full-duplex lightwave transport system based on intensity-modulated CATV, phase-modulated RoF, and intensity-remodulated 16-QAM OFDM signals is proposed and demonstrated. Our proposed systems present brilliant performances in transmitting hybrid CATV/RoF/16-QAM OFDM signals over fiber links.

CM3H.1 • 13:30
Formation and interaction of self-guided optical beams in a pre-engineered soft-matter system, Shima Fardad[1,2], Matthew Mills[1], Peng Zhang[2], Zhigang Chen[2,3], Demetrios N. Christodoulides[1], Weining Man[2]; [1]*CREOL/College of Optics, University of Central Florida, USA;* [2]*Department of Physics and Astronomy, San Francisco State University, USA;* [3]*TEDA Applied Physics School, Nankai University, China.* We demonstrate stable beam self-trapping in soft-matter systems with artificial saturable self-focusing nonlinearities. Our experiments reveal optical beam interactions that can vary from attractive to repulsive as well as an energy exchange.

CM3H.2 • 13:45
All-Optical Switch at Telecom Wavelength based on the Quantum Zeno Effect (QZE), Subramanian Krishnamurthy[1], Ye Wang[1], Yanfei Tu[1], Shih Tseng[1], Selim M. Shahriar[1]; [1]*Northwestern University, USA.* We present experimental realizations and numerical simulations of an optically controlled Polarizer and Waveplate at telecom wavelength using ladder transitions in 87Rb. When combined, it can be used to realize a QZE based all-optical switch

CM3H.3 • 14:00
Femtosecond Laser Desorption of Thin Polymer Films from a Dielectric Surface, Laurent Mercadier[1], Jiahui Peng[1], Yasir Sultan[2], David M. Rayner[1], Paul B. Corkum[1]; [1]*Joint University of Ottawa/National Research Council Laboratory for Attosecond Science, Canada;* [2]*Emerging Priorities Division, Environment Canada, Canada.* We desorb polymer films from fused silica with a femtosecond laser and characterize the results by atomic force microscopy. Our study as a function of beam geometry and energy reveals two ways of achieving spatially controlled nanodesorption.

CM3H.4 • 14:15
Explaining the Giant Difference in Surface Plasmon Enhancement of Fluorescence, Resonance and Non-Resonance Raman Scattering, Gregory Sun[1], Jacob Khurgin[2]; [1]*University of Massachusetts Boston, USA;* [2]*Johns Hopkins Univ., USA.* We present a comparative theory to show the origin of giant difference in the degrees of enhancement that have been observed in experimental measurements between fluorescence, resonance and non-resonance Raman scattering by surface plasmons.

Meeting Room 211D-B	Meeting Room 212A-C	Meeting Room 212D-B	Marriott San Jose Salon I & II
CLEO: Science & Innovations		JOINT	CLEO: Science & Innovations

13:30–15:30
CM3I • Special Fiber Design & Fabrication

Presider: Jacques Albert; Carleton University, Canada

CM3I.1 • 13:30
Angle splice of large-core kagome hollow-core photonic crystal fiber for gas-filled microcells, Chenchen Wang[1,2], Thomas Bradley[1,3], Yingying Wang[1,3], Kristan L. Corwin[2], Frédéric Gérôme[1], Fetah Benabid[1,3]; *[1]Gas-Phase Photonic and Microwave Materials, Xlim Research Institute, France; [2]Physics, Kansas State University, USA; [3]Physics, University of Bath, United Kingdom.* A repeatable, robust, low-loss angle splice between large-core kagome hollow-core photonic crystal fiber and a solid single-mode fiber is achieved. Saturated absorption spectroscopy is performed inside acetylene-filled kagome with one end angle spliced to SMF.

CM3I.2 • 13:45
Long rubidium vapor lifetime in aluminosilicate sol-gel coated hypocycloidal core shape kagome HC-PCF, Thomas Bradley[1,2], John J. McFerran[1], Jenny Jouin[3], Philippe Thomas[3], Fetah Benabid[1,2]; *[1]GPPMM, Xlim Research Institute, France; [2]CPPM, University of Bath, United Kingdom; [3]SPCTS UMR CNRS 7315, Centre Européen de la Céramique, 12 rue Atlantis, France.* We present aluminosilicate sol-gel coated rubidium-vapor loaded hollow core kagome fiber. We show experimentally that the rubidium vapor is preserved within the hollow core for greater than 500 hours with no vapor-source.

CM3I.3 • 14:00
Design of single-moded, large-mode-area fibers with symmetric bend compensation, John M. Fini[1], Jeffrey W. Nicholson[1]; *[1]OFS Laboratories, USA.* A partially bend-compensated index profile can accomplish robust single-modedness for fibers with Aeff~1000μm2, much larger than conventional designs, and does not require asymmetric fabrication or oriented deployment.

CM3I.4 • 14:15
Low-Loss, Single-Mode Propagation in Large-Mode-Area Leakage Channel Fiber from 1 to 2 μm, Clemence Jollivet[1], Kanxian Wei[2], Bryce Samson[2], Axel Schulzgen[1]; *[1]CREOL, the College of Optics and Photonics, University of Central Florida, USA; [2]Nufern, USA.* Recent design of large-mode-area leakage channel fiber is measured with low-attenuation and bend-induced single-mode propagation between 1 μm and 2 μm. We demonstrate remarkable low-loss, diffraction-limited output at 2 μm for coiling radii <30 cm.

13:30–15:30
CM3J • THz Spectroscopy and Sensing

Presider: Anders Kristensen, DTU Nanotech, Denmark

CM3J.1 • 13:30
THz Spinplasmonic Spectroscopy of Surface Magnetization States at Magnetic/Non-Magnetic Metal Interfaces, Abdulhakem Y. Elezzabi[1], Cameron E. Straatsma[1], Mark Johnson[2]; *[1]Electrical & Computer Engineering, University of Alberta, Canada; [2]Naval Research Laboratory, USA.* We report novel, unusual effects in sub-subwavelength spinplasmonic media using THz-TDS. THz field shape, amplitude, hysteretic effects, and time delay are sensitive to surface magnetization states and ferromagnetic/non-ferromagnetic (F/N) metallic junctions.

CM3J.2 • 13:45
Investigation of Photoexcited Carrier Responses in a Solar Cell with a Dynamic Terahertz Emission Microscope, Hidetoshi Nakanishi[1], Akira Ito[1], Kazuhisa Takayama[2], Iwao Kawayama[2], Hironaru Murakami[2], Masayoshi Tonouchi[2]; *[1]Dainippon Screen Mfg. Co.,Ltd, Japan; [2]Institute of Laser Engineering, Osaka University, Japan.* We applied a pump-probe laser terahertz emission microscope to investigate dynamic response of photoexited carriers in a solar cell. We could observe the change of terahertz radiation at the grain boundary in the polycrystalline silicon.

CM3J.3 • 14:00
Terahertz Conductivity of Lithium Salt-Succinonitrile Plastic Crystals, Daniel Nickel[1], Daniel Mittleman[1], Hongtao Bian[2], Junrong Zheng[2]; *[1]Electrical and Computer Engineering, Rice University, USA; [2]Chemistry, Rice University, USA.* The terahertz conductivity of succinonitrile decreases when doped with lithium salts, contrary to their DC behavior. In addition, a lattice phonon mode at 1.1THz is observed in only the crystalline phase of the undoped succinonitrile.

CM3J.4 • 14:15
Remote THz Monitoring of an Evolving Gas-Phase Mixture, Joseph Melinger[1], Yihong Yang[2], Maboubeh Mandeghar[2], Daniel R. Grischkowsky[2]; *[1]US Naval Research Laboratory, USA; [2]School of Electrical and Computer Engineering, Oklahoma State University, USA.* We show how THz time-domain spectroscopy can be used for the remote detection of an evolving gas phase mixture containing D2O and HDO and to characterize the reaction kinetics of: H2O + D2O -> 2HDO.

13:30–15:30
JM3K • Symposium on Mid-infrared Lasers: Mid-infrared Laser Sources I

Presider: Axel Ruehl; Center for Free Electron Laser Science, Germany

JM3K.1 • 13:30 Invited
Frequency comb sources and techniques for Mid-infrared spectroscopy and sensing, Scott A. Diddams[1]; *[1]National Inst of Standards & Technology, USA.* We review broad bandwidth Mid-infrared frequency comb sources based on Yb, Er, and Tm fiber-laser technology and describe their use in spectroscopic approaches aimed at quantitative detection of trace gases.

JM3K.2 • 14:00
Dual-comb Spectrometer Based on Mid-IR Quantum Cascade Laser Frequency Combs, Andreas Hugi[1], Gustavo Villares[1], Stéphane Blaser[2], H.c Liu[3], Jérôme Faist[1]; *[1]Institute for Quantum Electronics, ETH Zürich, Switzerland; [2]Alpes Lasers SA, Switzerland; [3]Key Laboratory of Artificial Structures and Quantum Control, Shanghai Jiao Tong University, China.* We realize a dual-comb spectrometer covering 14 cm−1 centered at 1430 cm−1. It is based on mid-IR QCL frequency combs featuring a frequency-modulated like output. The measured individual tooth linewidth is 4 MHz.

JM3K.3 • 14:15
Precision spectroscopy of NH_3 at 9.1 μm by a comb-referenced quantum cascade laser, Andrew Mills[1], Davide Gatti[2], Maria D. De Vizia[3], Ingmar Hartl[4], Livio Gianfrani[3], Martin E. Fermann[1], Marco Marangoni[2]; *[1]IMRA America, Inc, USA; [2]Politecnico di Milano and IFN-CNR, Italy; [3]Seconda Universita di Napoli, Italy; [4]Deutsches Elektronen-Synchrotron, Germany.* Absorption spectroscopy of NH_3 at 9.1 μm is demonstrated with a quantum-cascade-laser absolutely referenced to a Tm-fiber frequency-comb. Highly-accurate spectroscopic parameters are retrieved by a multiple-line fitting approach applied to the spectral manifold.

13:30–15:30
CM3L • Solitons and Nonlinear Propagation

Presider: Colin McKinstrie; Alcatel-Lucent Bell Labs, United States

CM3L.1 • 13:30
Accelerating Pulses via Multistage Four-Wave-Mixing, Alessandro Farsi[1], Moti Fridman[1], Alexander L. Gaeta[1]; *[1]Applied and Engineering Physics, Cornell University, USA.* Accelerating wavepackets in the time domain are demonstrated using four-wave-mixing (FWM). By incorporating two FWM interactions, acceleration of the wavepacket beyond the limit set by the temporal aperture of the pump pulse is achieved

CM3L.2 • 13:45
Coherent interference of nonlinearities in nanoscale silicon waveguides: The interplay between Kerr, free-carrier dispersion, and Brillouin nonlinear responses, Heedeuk Shin[1,2], Wenjun Qiu[3], Zheng Wang[4], Peter Rikich[2,1]; *[1]Sandia National Laboratories, USA; [2]Yale University, USA; [3]Massachusetts Institute of Technology, USA; [4]University of Texas at Austin, USA.* The nonlinear of a nanoscale Brillouin-active silicon waveguide is examined through heterodyne four-wave mixing experiments. The interference between Brillouin scattering, Kerr, and dispersive free-carrier nonlinearities are analytically described to explain the characteristic line-shapes observed.

CM3L.3 • 14:00
Ultrafast phase-resolved self-acceleration and frequency-chirp in silicon chip-scale slow-light solitons, Heng Zhou[1,2], Xiujian Li[1,3], Shu Wei Huang[1], James F McMillan[1], M. Yu[4], Dim Lee Kwong[4], Chee Wei Wong[1]; *[1]Columbia University, USA; [2]University of Electronic Science and Technology of China, China; [3]National University of Defense Technology, China; [4]The Institute of Microelectronics, Singapore.* We demonstrate the first soliton self-accelerations and frequency-shifts induced by Drude free-carrier dispersion in 1.5-mm silicon photonic crystals. Picojoule soliton center-of-mass advancement of 2-ps (about one FWHM) and wavelength blue-shift of 0.8-nm are observed via XFROG

CM3L.4 • 14:15
High energy pulse compression through two-pulse interaction mediated by stimulated Brillouin scattering in liquid fluorocarbon, Xiaozhen Xu[1], Chengyong Feng[1], Jean-Claude M. Diels[1]; *[1]University of New Mexico, USA.* High energy SBS pulse compression in liquid fluorocarbon from 10 to 1 ns is demonstrated with 75% efficiency in an energy-scalable generation-amplification setup. The two-pulse interaction dynamics is studied in both experiments and simulations.

Marriott San Jose Salon III

CLEO: Applications & Technology

13:30–15:30

AM3M • Symposium on Lab-on-a-Chip Applications: Lab on Chip I

Presider: Chris Myatt; Mbio Diagnostics, USA

AM3M.1 • 13:30 Invited

Computational On-Chip Imaging Toward Telemedicine Applications, Aydogan Ozcan[1]; [1]*Electrical and Bioengineering Departments, University of California Los Angeles, USA.* We review our recent work on computational on-chip imaging and its applications to telemedicine and high-throughput microscopy, including wide-field imaging of individual viruses on a chip

AM3M.2 • 14:00 Invited

Smartphone Based Optical Detection of Kaposi's Sarcoma Associated Herpesvirus DNA, Matthew Mancuso[1], David Erickson[2]; [1]*Department of Biomedical Engineering, Cornell University, USA;* [2]*Sibley School of Mechanical and Aerospace Engineering, Cornell University, USA.* We create a smartphone accessory that is capable of optically reading out a detection reaction in a microfluidic chip and test it using a colorimetric reaction targeted at DNA from Kaposi's sarcoma associated herpesvirus.

Marriott San Jose Salon IV

CLEO: Science & Innovations

13:30–15:30

CM3N • Attosecond & XUV Metrology

Presider: Nathan Newbury; National Inst of Standards & Technology, United States

CM3N.1 • 13:30 Tutorial

Attosecond Physics: The First Decade and Beyond, Ferenc Krausz[1]; [1]*Max-Planck-Institut for Quantenoptik, Germany.* We shall review the technologies that opened the door to accessing the hitherto immeasurably fast atomic-scale motion of electrons as well as light field oscillations and address future prospects of this young discipline.

Ferenc Krausz was born in Mor, Hungary, on 17 May 1962. He was awarded his M. S. in Electrical Engineering at Budapest University of Technology in 1985, his Ph. D. in Quantum Electronics at Vienna University of Technology in 1991, and his habilitation degree in the same field at the same university in 1993. He joined the Department of Electrical Engineering as an Associate Professor in 1998 and became Full Professor in the same department in 1999. In 2003, he was appointed Director of the Max-Planck-Institut für Quantenoptik in Garching, Germany, and in October 2004, he became Professor of Physics and took over the Chair of Experimental Physics - Laser Physics at Ludwig-Maximilians-Universität München. His research includes nonlinear light-matter interactions, ultrashort light-pulse generation from the infrared to the X-ray spectral range, and studies of ultrafast microscopic processes. By using chirped multilayer mirrors, his group made intense light pulses comprising merely a few wave cycles available for a wide range of applications and utilized them for pushing the frontiers of ultrafast science into the attosecond regime. His most recent research direction in attosecond physics is the control and real-time observation of the atomic-scale motion of electrons and the development of brilliant X-ray and charged-particle sources for applications in physics and biomedicine. He co-founded Femtolasers GmbH, a Vienna-based company specializing in Ti:sapphire femtosecond laser sources, and initiated Ultrafast Innovations GmbH, a joint venture of the Max Planck Society and the Ludwig-Maximilian-Universität München making cutting-edge ultrafast technologies available to research groups all over the world. Ferenc Krausz is a citizen of both Hungary and Austria and lives with his wife Angela and his children Anita and Martina in Garching, Germany. He feels greatly privileged to live at a time when borders between these and other countries in Europe are being peacefully dismantled.

Marriott San Jose Salon V & VI

JOINT

13:30–15:30

JM3O • Symposium on Novel Light Sources for Biomedical Applications: New Advances in Solid State and Semiconductor Lasers

Presider: Peter Moulton; Q-Peak, Inc., United States

JM3O.1 • 13:30 Invited

Nitride VECSELs as Light Sources for Biomedical Applications, Thomas Wunderer[1]; [1]*Palo Alto Research Center, USA.* Vertical-External-Cavity Surface-Emitting Lasers (VECSELs) allow both high optical output power and a nearly diffraction limited beam quality. We demonstrate the first time in-well pumped blue InGaN/GaN multiple quantum well VECSELs under pulsed operation.

JM3O.2 • 14:00

A Versatile Tool Box for the Deep-Ultraviolet Resonant Raman Spectroscopy, Vladislav Yakovlev[1], Georgi Petrov[1], Maria Troyanova-Wood[1]; [1]*Texas A&M University, USA.* We demonstrate an array of novel laser systems based on nonlinear optical conversion to achieve resonant Raman spectroscopy over a broad spectral and temporal range with unprecedented stability and reproducibility.

JM3O.3 • 14:15

High-speed Laser Scanner with Tunable Scan Rate, Wavelength Resolution and Spectral Coverage, Cheng Lei[1], Hongwei Chen[1], Minghua Chen[1], Sigang Yang[1], Shizhong Xie[1]; [1]*Department of Electronic Engineering, Tsinghua University, China.* Based on the recirculating frequency shifting structure, a high-speed laser scanner is proposed and experimentally demonstrated, where the scan rate, wavelength resolution and spectral coverage can be conveniently adjusted for various kinds of applications.

JOINT

CLEO: QELS-Fundamental Science

JM3A • Symposium on Fundamentals of Absorption and Emission in Nanostructures and Composites: Optics of Low-dimensional and Quantum Structures—Continued

JM3A.4 • 14:30 Invited

Non-Markovian Radiation Dynamics in Photonic Band Gap Materials, Christian Wolff[1], Kurt Busch[2,1]; [1]*Max Born Institut, Germany;* [2]*Humboldt Universitat zu Berlin, Germany.* The theoretical analysis of a recent experiment on the modified radiation dynamics of a magnetic dipole emitter embedded in a three-dimensional Photonic Band Gap material is presented. This analysis allows the first-time demonstration of non-Markovian dynamics.

JM3A.5 • 15:00

Polariton lasing in a zero dimensional hybrid photonic crystal cavity, Bo Zhang[1], Zhaorong Wang[1], Christian Schneider[2], Sebastian Brodbeck[2], Sven Hoefling[2], Martin Kamp[2], Hui Deng[1]; [1]*Department of Physics, University of Michigan, USA;* [2]*Technische Physik, Universität Würzburg, Germany.* We present the observation of the strong coupling phenomenon and discrete levels of zero dimensional lower polariton in the hybrid photonic crystal cavity (HPCC). We also report lasing of the HPCC lower polariton ground state.

JM3A.6 • 15:15

Transient Gain Spectroscopy in the Potent Single-Exciton Regime of Dense II-VI Colloidal Quantum Dot Films, Cuong H. Dang[1], Kwangdong Roh[1], Joonhee Lee[1], Craig Breen[2], Jonathan S. Steckel[2], Seth Coe-Sullivan[2], Arto Nurmikko[1]; [1]*School of Engineering, Brown University, USA;* [2]*QD Vision Inc., USA.* We have reached the long-sought single exciton gain regime in dense colloidal II-VI semiconductor quantum dot films. Transient spectroscopy details their exciton dynamics, informing further development of single material based lasers across the visible.

QM3B • Quantum Optics with Quantum Dots—Continued

QM3B.5 • 14:30

On-Chip Quantum Optics using Electrically Driven Quantum Dot - Micropillar Cavities, Caspar Hopfamnn[1], Ferdinand Albert[2], Erik Stock[1], Matthias Lermer[2], Christian Schneider[2], Sven Höfling[2], Alfred Forchel[2], Martin Kamp[2], Stephan Reitzenstein[1]; [1]*Technische Universität Berlin, Germany;* [2]*Universität Würzburg, Germany.* A novel concept for on-chip quantum optics using an internal electrically pumped microlaser is presented. The microlaser resonantly excites a quantum dot - microcavity system operating in the weak coupling regime of cavity quantum electrodynamics.

QM3B.6 • 14:45

Dynamic Stark effect in a quantum dot strongly coupled to a cavity, Kaushik Roy Choudhury[1], Ranojoy Bose[1], Edo Waks[1,2]; [1]*Electrical and Computer Engineering, University of Maryland, College Park, USA;* [2]*Joint Quantum Institute, University of Maryland, College Park, USA.* Effects beyond cw-Stark shift is investigated in a strongly coupled quantum dot-cavity system using the full quantum master equations, when the dot is dynamically detuned by an off-resonant laser pulse.

QM3B.7 • 15:00

Ultrafast downconversion quantum interface for a single quantum dot spin and 1550-nm single-photon channel, Leo Yu[1], Jason Pelc[1,5], Kristiaan De Greve[1,6], Peter L. McMahon[1], Chandra M. Natarajan[1,2], Na Young Kim[1], Eisuke Abe[1,4], Vahid Esfandyarpour[1], Sebastian Maier[3], Christian Schneider[3], Martin Kamp[3], Sven Hoefling[3], Robert H. Hadfield[2], Alfred Forchel[3], Martin Fejer[1], Yoshihisa Yamamoto[1,4]; [1]*E. L. Ginzton Laboratory, Stanford University, USA;* [2]*Scottish Universities Physics Alliance and School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom;* [3]*Technische Physik, Physikalisches Institut, Wilhelm Conrad Röntgen Research Center for Complex Material Systems, Universität Würzburg, Germany;* [4]*National Institute of Informatics, Japan;* [5]*Hewlett-Packard Laboratories, USA;* [6]*Dept. of Physics, Harvard University, USA.* We report an ultrafast downconversion quantum interface, where 910-nm single photons from a quantum dot are downconverted to the 1.5-μm telecom band with sub-10 picosecond pulses at 2.2-μm, enabling the demonstration of quantum-dot spin-photon entanglement.

QM3B.8 • 15:15

Polarization-Entangled Photons from Site Controlled Pyramidal Quantum Dots, Gediminas Juska[1], Valeria Dimastrodonato[1], Tung-Hsun Chung[1], Agnieszka Gocalinska[1], Emanuele Pelucchi[1]; [1]*Tyndall National Institute, Ireland.* For the first time, polarization-entangled photon emission is demonstrated from epitaxially grown site-controlled quantum dots. The predicted crystallographic high symmetry reproducibly allowed growing samples with regions with at least 15% of entangled photon emitters.

QM3C • Solid State Quantum Information—Continued

QM3C.4 • 14:30

Entanglement between a Quantum Dot Spin and a Photon, John Schaibley[1], Alex Burgers[1], Gregory McCracken[1], Luming Duan[1], Paul Berman[1], Duncan Steel[1], Allan Bracker[2], Daniel Gammon[2], Lu Sham[3]; [1]*Department of Physics, University of Michigan, USA;* [2]*Naval Research Laboratory, USA;* [3]*Department of Physics, University of California, San Diego, USA.* We demonstrate entanglement between an InAs quantum dot (QD) electron spin qubit and a photon. This valuable quantum information resource can be used to mediate spin-spin entanglement between distant nodes of a QD spin network.

QM3C.5 • 14:45

Exciton-Polariton Mediated Universal Quantum Computing, shruti puri[1], Na Young Kim[1], Yoshihisa Yamamoto[1,2]; [1]*Stanford University, USA;* [2]*National Institute of Informatics, Japan.* We propose a scheme for universal quantum computation with electron spin qubits. The scheme requires electrical control and manipulation of single spin qubit, along with exciton-polariton mediated two-qubit operation and single shot quantum non-demolition (QND) readout.

QM3C.6 • 15:00

Generating Robust Optical Entanglement via Optomechanical Coupling, Mark Kuzyk[1], Hailin Wang[1]; [1]*Physics, University of Oregon, USA.* A pulsed scheme for generating two-mode squeezed light via the coupling of two optical modes to a mechanical oscillator in an optomechanical system is proposed. The scheme can be robust against thermal mechanical motion.

QM3C.7 • 15:15

Entangled Mechanical Cat States From Conditional Optomechanics, Uzma Akram[1], Warwick P. Bowen[1], Gerard J. Milburn[1]; [1]*University of Queensland, Australia.* We condition the interaction of a single photon in an interferometer with two optomechanical systems. Conditioning on long detection times of the photon from the composite system results in an entangled mechanical cat state.

QM3D • Ultrafast Dynamics in 1D Systems—Continued

QM3D.5 • 14:30

Long-Range Exciton Diffusion in Single-Walled Carbon Nanotubes, Mitchell Anderson[1], Yee-fang Xiao[1], James M. Fraser[1]; [1]*Physics, Engineering Physics & Astronomy, Queen's University at Kingston, Canada.* We develop an analytic model of exciton dynamics that agrees well with contrasting studies of suspended single-walled carbon nanotubes. Exciton intrinsic diffusion length (1.3-4.7 μm) is much longer than observed with encapsulated samples.

QM3D.6 • 14:45

Withdrawn

QM3D.7 • 15:00

Formation of hybrid polaritons in an organic-inorganic microcavity at room temperature, Michael Slootsky[1], Xiaoze Liu[2,3], Stephen R. Forrest[1,4], Vinod M. Menon[2,3]; [1]*Dept. of Physics, University of Michigan, Ann Arbor, USA;* [2]*Dept. of Physics, Graduate School and University Center of the City University of New York (CUNY), USA;* [3]*Laboratory for Nano and Micro Photonics, Dept. of Physics, Queens College of the City University of New York (CUNY), USA;* [4]*Dept. of Electrical Engineering and Computer Science and Dept. of Materials Science and Engineering, University of Michigan, Ann Arbor, USA.* We demonstrate hybridization of organic and inorganic excitons via strong coupling to a common microcavity mode. The system consists of 3,4,7,8-napthalenetetracarboxylic dianhydride (NTCDA) and ZnO nanocrystals embedded in a dielectric microcavity held at room temperature.

QM3D.8 • 15:15

Ultrafast Exciton Dynamics in Donor-Acceptor Conjugated Polymers, San-Hui Chi[1], Chad M. Amb[2], Dinesh Patel[2], Timothy T. Steckler[2], Xuan Zhang[1], Matthew Sartin[1], Matteo Cozzuol[1], Joel M. Hales[1], Seth Marder[1], John Reynolds[1,2], Joseph W. Perry[1]; [1]*School of Chemistry and Biochemistry, Georgia Institute of Technology, USA;* [2]*Department of Chemistry, University of Florida, USA.* Aggregate-enabled ultrafast exciton dynamics in dithienopyrrole-benzothiadiazole based donor-acceptor conjugated polymers were investigated to address factors affecting the material performance in optoelectronic and photonic devices such as OPV, OLED, power limiters and polariton lasers.

15:30–16:00 Coffee Break, *Concourse Level*

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QM3E • Non-conventional Beams and Optical Vortices—Continued

QM3E.5 • 14:30
3D Accelerating Electromagnetic Waves, Miguel A. Bandres[1], Ido Kaminer[2], Miguel A. Alonso[3], Mordechai Segev[2]; *[1]Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico; [2]Physics Department and Solid State Institute, Technion, Israel; [3]The Institute of Optics, University of Rochester, USA.* We present electromagnetic 3D spatially accelerating waves whose transverse profiles propagate along semicircular trajectories while approximately preserving their shape. Our results allow the generation of accelerating waves with novel transverse distributions, broadening their application further.

QM3E.6 • 14:45
Soliton-radiation trapping in gas-filled hollow-core photonic crystal fibers, Mohammed F. Saleh[1], Fabio Biancalana[2,1]; *[1]Max-Planck-Inst Physik des Lichts, Germany; [2]School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom.* We propose an unconventional optical trapping mechanism between a strong fundamental soliton and an ultrashort weak dispersive radiation in a hollow-core photonic crystal fiber filled with a noble gas.

QM3E.7 • 15:00
Soliton dynamics in a diffracting trapping potential, Ammon Hanan Sheinfux[1], Mikael Rechtsman[1], Braxton Osting[2], Jeremy Marzuola[3], Mordechai Segev[1]; *[1]Technion Israel Institute of Technology, Israel; [2]university of california, USA; [3]3University of North Carolina, USA.* We study, experimentally and theoretically, interactions between a soliton and a transient trapping potential. The soliton can be guided by such a potential, while its motion is arrested at the potential minimum by radiation dampening.

QM3E.8 • 15:15
Tunable polarizability and self-trapping of light in colloidal suspensions of gold nanoparticles, Shima Fardad[1,2], Anna Bezryadina[2], Peng Zhang[2], Zhigang Chen[2,3], Demetrios N. Christodoulides[1]; *[1]CREOL/College of Optics, University of Central Florida, USA; [2]Department of Physics and Astronomy, San Francisco State University, USA; [3]TEDA Applied Physics School, Nankai University, China.* Aqueous suspensions containing pure gold nanoparticles and silica-gold core-shells are shown to exhibit different polarizibilities, thus allowing self-trapping of long needles of light. The different nonlinear mechanisms behind these processes are investigated.

CM3F • Nanolasers & Photodetectors—Continued

CM3F.5 • 14:30
Defect-state-absorption photocurrent in PN-diode-integrated silicon microring resonators, Yu Li[1], Andrew W. Poon[1]; *[1]The Hong Kong University of Sci.&Tech, Hong Kong.* We report defect-state-absorption photocurrent in PN-diode-integrated silicon microrings at 1550 nm. We demonstrate a cavity-enhanced responsivity of 3.1 mA/W upon 0 V, and 173 mA/W upon -10 V with a 3dB bandwidth of 10 GHz.

CM3F.6 • 14:45
Scalable Ultra-Flat Horn Plasmonic Antenna for Enhanced Detection, Shay Yosub[1], Meir Orenstein[1]; *[1]Electrical Engineering, Technion, Israel.* Novel Micro-to-Nano scalable plasmonic flat horn antenna was proposed. A 2.2μm high antenna collected $15^2\mu m^2$ to $5^2\mu m^2$ with 72% efficiency for λ=1550nm. For 1μm to 10nm collection, a resonant 50,000-fold enhancement in absorption was achieved.

CM3F.7 • 15:00
Performance enhancement in Quantum Well Infrared Photodetector utilizing the Grating Structure, Ming-Lun Lee[1], Cheng-Ju Hsieh[1], Yao-Hong You[1], Vin-Cent Su[1], Po-Hsun Chen[1], Hung-Chou Lin[1], Han-Bo Yang[1], Hung-Ming Chen[1], Chieh-Hsiung Kuan[1]; *[1]Graduate Institute of Electronics Engineering, National Taiwan University, Taiwan.* We fabricate four different size grating structure on the top of the quantum well infrared photodetectors, then etch them into four different etching depth. With suitable design, the peak responsivity of the QWIPs is about thirteen times larger than that of the conventional QWIP.

CM3F.8 • 15:15
On-chip identifying topology charges of OAM beams with multi-beam interference, Dengke Zhang[1], Xue Feng[1], Kaiyu Cui[1], Fang Liu[1], Yidong Huang[1]; *[1]Tsinghua University, China.* Through weighted multi-beam interference in silicon waveguides, identifying the topology charge of optical angular momentum (OAM) beams is experimentally demonstrated. Based on this approach, an OAM receiver can be obtained for detecting and decoding

CM3G • RF over Fiber—Continued

CM3G.5 • 14:30
Investigation of Intra/Inter-Band Cross-Modulation in Multi-Band Radio-over-Fiber Systems, Jing Wang[1], Cheng Liu[1], Ming Zhu[1], Anlin Yi[1], Gee-Kung Chang[1]; *[1]Georgia Institute of Technology, USA.* Intra/inter-band cross-modulations due to Mach-Zehnder modulator nonlinearity in multi-band radio-over-fiber systems is investigated. Signal quality degradation induced by cross-modulation for single-/multi-band scalar and vector signals is analyzed theoretically and validated by experiments.

CM3G.6 • 14:45
Withdrawn

CM3G.7 • 15:00
SFDR enhancement in analog links by simultaneous compensation for dispersion and nonlinearity, Zhiyu Chen[1], Lianshan Yan[1], ying H. guo[1], Wei Pan[1], Bin Luo[1], Xihua Zou[1], Tao Zhou[2]; *[1]Center for Information Photonics & Communications, Southwest Jiaotong University, China; [2]State Key Lab of Electronic Information Control, Southwest China Research Institute of Electronic Equipment, China.* We proposed a linearized analog link based on single sideband phase modulator. Results show that the nonlinearity of modulator and dispersion are simultaneously compensated, and the improvement of ~21-dB in spurious-free dynamic range are obtained.

CM3G.8 • 15:15
Wideband Photonic Radiofrequency Beamforming Network Employing a Broadband Optical Source Sliced by a Wavelength Selective Switch, Xiaoxiao Xue[1], Xiaoping Zheng[1], Hanyi Zhang[1], Bingkun Zhou[1]; *[1]State Key Laboratory on Integrated Optoelectronics, Tsinghua University, China.* We propose a novel low-cost photonic radiofrequency (RF) beamforming network which eliminates the dispersion induced RF power degradation. A RF bandwidth of 40 GHz and a tunable delay range of 750 ps were demonstrated.

CM3H • Laser Materials Processing with Shaped Beams—Continued

CM3H.5 • 14:30
Kerr effect induced transient group-velocity dispersion of fused silica measured via real-time MIIPS and spectral interferometry, Gennady Rasskazov[1], Anton Ryabtsev[1], Dmitry Pestov[2], Vadim V. Lozovoy[1], Marcos Dantus[1,2]; *[1]Michigan State University, USA; [2]Biophotonic Solutions Inc., USA.* We demonstrate the measurement of transient dispersion in fused silica by RT-MIIPS. The results are validated via Fourier Transform Spectral Interferometry. The observed dispersion modulation is explained within a theoretical model.

CM3H.6 • 14:45
Chiral structure control of metal nano-needles fabrictaed by optical vortex laser ablation, Fuyuto Takahashi[1], Kohei Toyoda[1], Shun Takizawa[1], Katsuhiko Miyamoto[1], Ryuji Morita[2], Takashige Omatsu[1,3]; *[1]Chiba University, Japan; [2]Hokkaido University, Japan; [3]CREST, Japan.* We discovered that chiral-structure of nano-needles fabricated by optical vortex laser ablation can be controlled by changing the magnitude of orbital angular momentum. We also demonstrated the formation of a chiral Si-bump.

CM3H.7 • 15:00
Coherent Stitching of Light in Femtosecond Laser Formed Multi-Layered Volume Gratings, Mi Li Ng[1], Prof. Debashis Chanda[1], Peter R. Herman[1]; *[1]University of Toronto, Canada.* We propose and demonstrate a novel method for improving diffraction efficiency through strategic arrangement of multilayered weak phase gratings to coincide with Talbot planes. Multilayered volume gratings were written inside fused silica with femtosecond lasers.

CM3H.8 • 15:15
Materials processing using abruptly autofocusing beams, Dimitris Papazoglou[1,2], Paris Panagiotopoulos[1], Arnaud Couairon[3], Stelios Tzortzakis[1,2]; *[1]Institute of Electronic Structure and Laser, Foundation for Research and Technology Hellas, Greece; [2]Materials Science and Technology Department, University of Crete, Greece; [3]Centre de Physique Théorique, CNRS, Ecole Polytechnique, France.* Radially symmetric Airy optical beams exhibit a focus area that is strongly non-symmetric and abrupt. We use this unique feature to precisely deliver energy in the bulk of fused silica without affecting the preceding material.

15:30–16:00 Coffee Break, *Concourse Level*

CLEO: Science & Innovations

CM3I • Special Fiber Design & Fabrication—Continued

CM3I.5 • 14:30
Low Mode Asymmetry Highly Birefringent Microstructured Fibers, Alexander N. Denisov[1], Andrei E. Levchenko[1], Sergei L. Semjonov[1], E. M. Dianov[1]; [1]*FORC RAS, Russian Federation.* We present numerical and experimental investigations of microstructured fibers with high birefringence and low mode asymmetry. Fibers with approximately equal mode sizes along the two orthogonal axes and birefringence up to 2.7*10-3 were fabricated.

CM3I.6 • 14:45
Strong and Robust Bragg Gratings in Photo-Thermo-Refractive Glass Fiber, Peter Hofmann[1], Clemence Jollivet[1], Rodrigo Amezcua-Correa[1], Enrique Antonio-Lopez[1], Daniel Ott[1], Marc Se-Gall[1], Ivan Divliansky[1], Larissa Glebova[1], Leonid Glebov[1], Axel Schulzgen[1]; [1]*CREOL, The College of Optics and Photonics, University of Central Florida, USA.* We demonstrate strong and robust fiber Bragg gratings in the first low-loss optical fiber made from photo-thermo-refractive (PTR) glass. A high grating strength of 20 dB is maintained even at 12 hour exposure to temperatures above 400 °C.

CM3I.7 • 15:00
All-fiber Mode-locked Dissipative Thulium-doped Fiber Laser by Optically Deposited SWCNTs, Qing Qing Wang[1], Tong Chen[1], Mingshan Li[1], Botao Zhang[1], Yongfeng Lu[2], Kevin Chen[1]; [1]*University of Pittsburgh, USA;* [2]*University of Nebraska-Lincoln, USA.* Dissipative solitons from an all-fiber Thulium-doped fiber ring oscillator are generated by using optically deposited SWCNTs as the saturable absorber and high numerical aperture fiber of measured normal dispersion is introduced to produce large net normal dispersion at 1.9μm.

CM3I.8 • 15:15
Atomic polarization relaxation time measurement of Rb filled hypocycloidal core shape Kagome HC-PCF, Thomas Bradley[1,2], John J. McFerran[1], Jenny Jouin[3], Fetah Benabid[1,2], Philippe Thomas[3], Ekaterina Ilinova[1]; [1]*GPPMM, Xlim Research Institute, France;* [2]*CPPM, University of Bath, United Kingdom;* [3]*SPCTS UMR CNRS 7315, Centre Européen de la Céramique, 12 rue Atlantis, France.* We measured atomic polarization relaxation-time in PDMS coated and uncoated rubidium-loaded hypocycloidal-core Kagome HC-PCF. The measured relaxation-times of 32μs and 24μs in PDMS coated and uncoated fibers are longer two-orders-of-magnitude than the wall-collision-limited relaxation time.

CM3J • THz Spectroscopy and Sensing—Continued

CM3J.5 • 14:30
Terahertz gas sensing utilizing multilayer-stacked micro-porous polymer structure, Ho Cheng-Han[1], Borwen You[1], Ming-Che Chan[2], Ja-Yu Lu[1]; [1]*Department of Photonics, National Cheng Kung University, Taiwan;* [2]*College of Photonics, National Chiao-Tung University, Taiwan.* A simple multilayer micro-porous structure has been successfully demonstrated for identifying different types and concentrations of vapor molecules. The measured minimum concentration is achieved 9 ppm, corresponding to molecular density variation of 0.16 nano-mole/mm3.

CM3J.6 • 14:45
Coupling and cm propagation of long-range guided THz radiation in thin layers of water, Robert Sczech[1], Jaime Gomez Rivas[2,3], Audrey Berrier[2], Vincenzo Giannini[2], Giuseppe Pirruccio[2], Christian Debus[1], Heiko Schaefer-Eberwein[1], Peter Haring Bolivar[1]; [1]*Institute of High Frequency & Quantum Electronics, University of Siegen, Germany;* [2]*Centre for Nanophotonics, FOM Institute-AMOLF, Netherlands;* [3]*COBRA Research Institute, Eindhoven University of Technology, Netherlands.* We demonstrate the coupling of THz radiation in thin layers of water by means of attenuated total reflection measurements. Moreover, we excite this mode by end-fire coupling and experimentally show propagation lengths of 2 cm.

CM3J.7 • 15:00
Frequency-Swept Asynchronous-Optical-Sampling Terahertz Time-Domain Spectroscopy, Takeshi Yasui[1,2], Yuki Iyonaga[1], Yi-Da Hsieh[1], Hajime Inaba[3], Kaoru Minoshima[3], Shuko Yokoyama[1], Tsutomu Araki[1], Mamoru Hashimoto[1]; [1]*Graduate School of Engineering Science, Osaka University, Japan;* [2]*Institute of Technology and Science, University of Tokushima, Japan;* [3]*National Institute of Advanced Industrial Science and Technology, Japan.* We proposed frequency-swept asynchronous-optical-sampling terahertz time-domain spectroscopy to further improve the spectral resolution. The spectral resolution achieved here was 2.2 MHz, which is two orders of magnitude smaller than the mode-locked frequency.

CM3J.8 • 15:15
Near-Infrared Time-Domain Spectroscopy using Broadband Phase-locked Electromagnetic Pulses, Ikufumi Katayama[1], Michitaka Bito[2], Eiichi Matsubara[2], Masaaki Ashida[2]; [1]*Graduate School of Engineering, Yokohama National University, Japan;* [2]*Graduate School of Engineering Science, Osaka University, Japan.* We demonstrated the near-infrared time-domain spectroscopy using phase-locked electromagnetic pulses generated and detected with a sub-5fs laser and a DAST crystal. Transmission spectra of polystyrene and glass were measured up to 180 THz.

JOINT

JM3K • Symposium on Mid-infrared Lasers: Mid-infrared Laser Sources I—Continued

JM3K.4 • 14:30
Asynchronous Mid-infrared optical parametric oscillator frequency combs, Zhaowei Zhang[1,3], Xiaohui Fang[1,2], Tom Gardiner[3], Derryck Reid[1]; [1]*EPS, Heriot-Watt University, United Kingdom;* [2]*Tianjin University, China;* [3]*National Physical Laboratory, United Kingdom.* We report high-power, carrier-envelope-offset (CEO) frequency stabilized, asynchronous dual frequency combs at 3.3-μm. The two channels, each with 100 mW average power, share all the components for Mid-infrared generation and CEO-frequency detection.

JM3K.5 • 14:45
Octave-spanning Coherent Mid-IR Generation via a Single Adiabatically Chirped Grating, Haim Suchowski[1], Peter R. Krogen[2], Shu-Wei Huang[2], Franz X. Kärtner[2,3], Jeffrey Moses[2]; [1]*University of California, Berkeley, USA;* [2]*MIT, USA;* [3]*DESY and University of Hamburg, Germany.* A prototype single-crystal device efficiently converts a μJ-energy near-IR OPA pulse to the mid-IR by adiabatic frequency conversion, generating an octave-spanning pulse covering the 2-5-μm range and suggesting wide applicability to existing laser systems.

JM3K.6 • 15:00 Invited
Spatial-temporal Imaging in the Strong-field Limit, Louis F. DiMauro[1]; [1]*The Ohio State Univ., USA.* An approach is discussed for producing molecular images with sub-Angstrom atomic precision with few femtosecond exposures. The laser-induced electron diffraction procedure extracts a diffraction pattern from the photoelectron momentum distribution produced by strong-field Mid-infrared ionization.

CLEO: Science & Innovations

CM3L • Solitons and Nonlinear Propagation—Continued

CM3L.5 • 14:30 Tutorial
Dissipative Solitons, A Novel Paradigm for Mode-locked Lasers, Philippe Grelu[1]; [1]*Lab ICB UMR 6303 CNRS, Universite de Bourgogne, France.* The "dissipative soliton" concept brings a framework for understanding complex mode-locked laser dynamics from a unified picture. This tutorial provides conceptual pictures illustrated with universal dynamics, highlights recent achievements and prospects for mode-locked laser development.

Philippe Grelu is Professor of Physics at University of Bourgogne, in Dijon, France, since 2005. After graduating from Ecole Centrale de Paris and a master degree in theoretical physics at University Paris VI, he obtained his PhD at University of Orsay in quantum optics. His research interests then moved to ultrafast nonlinear optics and mode-locked fiber lasers. He is now among the key experts in nonlinear optical cavity dynamics, with major contributions in the field of dissipative solitons, and has authored over 150 scientific publications in journals and conference proceedings. His current research also includes spatio-temporal soliton dynamics and nonlinear microfiber optics.

Monday, 10 June

15:30–16:00 Coffee Break, *Concourse Level*

Marriott San Jose Salon III

CLEO: Applications & Technology

AM3M • Symposium on Lab-on-a-Chip Applications: Lab on Chip I—Continued

AM3M.3 • 14:30 Invited

SMART (Shrink Manufacturing Advanced Research Tools), Michelle Khine[1]; [1]*University of California, Irvine, USA.* Leveraging the inherent heat-induced relaxation of pre-stressed thermoplastic sheets, we pattern in a variety of ways at the large scale and achieve micro and nanostructures by controlled shrinking down to 5% of the original patterns.

AM3M.4 • 15:00 Invited

Microfluidics Facilitated Genome Sequencing for Limited Number of Cells, Liang Zhao[1], Xiannian Zhang[1], Aaron M. Streets[1], Yuhong Pang[1], Fuchou Tang[1], Yanyi Huang[1]; [1]*Biodynamic Optical Imaging Center (BIOPIC), Peking University, China.* We develop a microfluidics-based single cell RNA-Seq transcriptome analysis technology to perform the library-prep reaction steps at nanoliter range within sealed chambers on-chip, eliminating potential contaminations and sophisticated manual handlings.

Marriott San Jose Salon IV

CLEO: Science & Innovations

CM3N • Attosecond & XUV Metrology—Continued

CM3N.2 • 14:30

Cavity-enhanced high harmonic generation with high power Yb-fiber laser at 10MHz repetition rate, Akira Ozawa[1,2], Makoto Kuwata-Gonokami[3,4], Yohei Kobayashi[1,2]; [1]*The Institute for Solid State Physics, The University of Tokyo, Japan;* [2]*Core Research for Evolutional Science and Technology (CREST), JST, Japan;* [3]*Department of Physics, The University of Tokyo, Japan;* [4]*Photon Science Center, The University of Tokyo, Japan.* Cavity-enhanced high harmonic generation is demonstrated at 10 MHz repetition rate with Yb-fiber laser. 0.1 mJ of pulse energy is obtained for intracavity fundamental pulses and up to 31st order high harmonic radiation is observed.

CM3N.3 • 14:45

Keyhole Coherent Diffraction Imaging of an Extended Transparent Sample Using Curved Multilayer Mirrors, Matthew Seaberg[1], Bosheng Zhang[1], Justin Shaw[2], Dennis F. Gardner[1], daniel adams[1], Margaret M. Murnane[1], Henry Kapteyn[1]; [1]*Department of Physics and JILA, University of Colorado at Boulder, USA;* [2]*NIST, USA.* We use keyhole coherent diffraction imaging to gain ~20x increase in flux and fully characterize the illumination, allowing us to image a semi-transparent sample in amplitude and phase. This capability is important for x-ray microscopes.

CM3N.4 • 15:00

Imaging by Integrating Stitched Spectrograms, daniel adams[1,3], Carson Teale[1], Daniel Kane[2], Margaret M. Murnane[1], Henry Kapteyn[1]; [1]*NIST/JILA/CU, USA;* [2]*Mesa Photonics, LLC, USA;* [3]*Kapteyn-Murnane Laboratories, USA.* A new diffractive imaging technique named Imaging By Integrating Stitched Spectrograms (IBISS) is presented. The technique is successfully demonstrated using a Helium Neon laser to image a 350-μm wide sample with 12μm resolution.

CM3N.5 • 15:15

Optical Delay with a Line-by-Line Resolution Pulse Shaper, Andrew E. Hunter[1], John Willits[1], Steven T. Cundiff[1]; [1]*JILA, University of Colorado and National Institute of Standards and Technology, USA.* We demonstrate an optical delay line using a virtually imaged phased-array (VIPA) pulse shaper, producing time delays in discrete steps of 40 ps over the full repetition period of the laser.

Marriott San Jose Salon V & VI

JOINT

JM3O • Symposium on Novel Light Sources for Biomedical Applications: New Advances in Solid State and Semiconductor Lasers—Continued

JM3O.4 • 14:30

New concept of broadly tunable (440-670 nm) solid-state organic laser, Oussama Mhibik[1,2], Tatiana Leang[1,2], Alain Siove[1,2], Sébastien Forget[1,2], Sébastien Chénais[1,2]; [1]*Université Paris 13, Sorbonne Paris Cité, Laboratoire de Physique des Lasers, France;* [2]*CNRS, UMR 7538, LPL, France.* An innovative concept of organic thin-film solid-state laser is proposed, with diffraction-limited output and a broad tuning range covering the visible spectrum (from 440 to 670 nm) under UV optical pumping.

JM3O.5 • 14:45

Pseudomorphic Mid-Ultraviolet Light-Emitting Diodes for Water Purification, Craig Moe[1], Jianfeng Chen[1], James R. Grandusky[1], Mark C. Mendrick[1], Rajul Randive[1], Lee E. Rodak[2], Anand V. Sampath[2], Michael Wraback[2], Leo Schowalter[1]; [1]*Crystal IS, Inc., USA;* [2]*RDRL-SEE-M, U.S. Army Research Laboratory, USA.* UVC light output of 66 mW at 300 mA CW has been achieved from LEDs on AlN substrates with extensive photon extraction. Proper vessel design allows for efficient irradiation of a water sample for purification.

JM3O.6 • 15:00 Invited

Advances in Solid State and Semiconductor Sources for Biomedicine, Peter F. Moulton[1]; [1]*Q-Peak, Inc., USA.* We review some recent developments in semiconductor and solid state lasers that facilitate major improvements in biomedical imaging systems. Examples include fiber-laser based ultrafast systems, and swept-frequency sources.

15:30–16:00 Coffee Break, *Concourse Level*

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

16:00–18:00
QM4A • Optics of Metasurfaces
Presider: Evgenii Narimanov; Purdue University, United States

QM4A.1 • 16:00
Metamaterial Polarization Multiplexed Gratings, Yu-Ju Tsai[1], Talmage Tyler[1], Stéphane Larouche[1], Antonio Llopis[1], Matthew Royal[1], Nan M. Jokerst[1], David R. Smith[1]; [1]*Department of Electrical and Computer Engineering, Duke University, USA.* We demonstrate a metamaterial grating that has two diffraction periods for two orthogonal linear polarization states of illuminations. The proposed method will be useful in free space optical communications and novel optical imaging systems.

QM4A.2 • 16:15
Dynamic Inductive Tuning of Fano-Resonant Meta-Surfaces Using Plasmonic Response of Graphene in Mid-infrared, nima dabidian[1], S. Hossein Mousavi[1], Gennady Shvets[1]; [1]*physics, University of Texas at Austin, USA.* We demonstrate theoretically and experimentally that electrically gated single-layer graphene can be used to inductively tune the infrared optical response of Fano-resonant meta-surfaces. The induced spectral shifts are used to extract graphene's electronic properties.

QM4A.3 • 16:30
Meta-Gratings for Highly-Compact Holographic Imaging Systems, Sandeep Inampudi[1], Viktor A. Podolskiy[1]; [1]*Physics and Applied Physics, University of Massachusetts Lowell, USA.* We present a diffraction-based computational imaging paradigm and illustrate its applications for a highly-compact imaging systems capable of 3D imaging with 2D sensors.

16:00–18:00
QM4B • Quantum Dots, Nanocrystals, & Impurities
Presider: Kimberley Hall; Dalhousie University, Canada

QM4B.1 • 16:00
Observation of Optically Stimulated Depletion of Carbon Acceptor Bound Excitons in GaAs, Todd Karin[1], Russell Barbour[1], Kai-Mei Fu[1]; [1]*Department of Physics, University of Washington, USA.* We observe stimulated emission of acceptor bound excitons into an excited acceptor state. This technique is used to estimate spin coherence parameters for acceptors and may pave a path toward single acceptor isolation.

QM4B.2 • 16:15
Confinement Effects on Biexciton Binding in Semiconductor Quantum Dots Measured with 2D Coherent Spectroscopy, Galan Moody[1,2], Rohan Singh[1,2], Hebin Li[1], Ilya A. Akimov[3,4], Manfred Bayer[3], Dirk Reuter[5], Andreas D. Wieck[5], Allan Bracker[6], Daniel Gammon[6], Steven T. Cundiff[1,2]; [1]*JILA, University of Colorado & NIST, USA;* [2]*Physics, University of Colorado, USA;* [3]*Experimentelle Physik 2, Technische Universität Dortmund, Germany;* [4]*A. F. Ioffe Physical-Technical Institute, Russian Academy of Sciences, Russian Federation;* [5]*Lehrstuhl fuer Angewandte Festkoerperphysik, Ruhr-Universitaet Bochum, Germany;* [6]*Naval Research Laboratory, USA.* Two-dimensional coherent spectroscopy on a series of quantum dot samples with different morphology reveals that biexciton binding is independent of the details of confinement in InAs dots, in contrast to the behavior in GaAs dots.

QM4B.3 • 16:30
Ultrafast red-shift of biexciton binding energy by multiple exciton generation in PbS quantum dots, Younghwan Choi[1], Seongchu Lim[2], Young Hee Lee[2], Hyunyong Choi[1]; [1]*School of Electrical and Electronic Engineering, Yonsei University, Republic of Korea;* [2]*Institute of Basic Science, Center for Integrated Nanostructure Physics, Department of Physics, Department of Energy Science, Sungkyunkwan University, Republic of Korea.* Using ultrafast pump-probe spectroscopy, we investigate the exciton-exciton interaction in PbS quantum dot, and show that the biexciton binding energy is strongly altered by the extra single-exciton generated by the carrier multiplication process.

16:00–18:00
QM4C • Hybrid Plasmonics & Novel Effects
Presider: Jennifer Dionne; Stanford Univ., United States

QM4C.1 • 16:00
Plasmonically Enhanced Transverse Magneto-Optical Kerr Effect, Jessie Y. Chin[1], Lars Kreilkamp[2], Vladimir Belotelov[3], Stefanie Neutzner[1], Daniel Dregely[1], Thomas Wehlus[4], Ilya A. Akimov[2], Bernd Stritzker[4], Manfred Bayer[2], Harald W. Giessen[1]; [1]*4th Physics Institute and Research Center SCOPE, University of Stuttgart, Germany;* [2]*Experimentelle Physik 2, Technische Universität Dortmund, Germany;* [3]*Faculty of Physics, Lomonosov Moscow State University, Russian Federation;* [4]*Institute of Physics, University of Augsburg, Germany.* We demonstrate experimentally a plasmonic enhancement of the transverse magneto-optical Kerr effect. The enhanced Kerr effect modulates the transmitted light intensity by a large value of 1.5%, while high transparency of the system is maintained.

QM4C.2 • 16:15
Extraordinary magnetoplasmonic effect in SPP-MOKE configuration, Rémi Vincent[1], Hugues Marinchio[2], Juan Jose Saenz[3], Rémi Carminati[2]; [1]*Université de Technologie de Troyes, France;* [2]*Institut Langevin, ESPCI ParisTech, CNRS, France;* [3]*Universidad Autónoma de Madrid, Spain.* An as yet unexploited Magneto Optical Kerr Effect (MOKE) at evanescent distance from a surface is introduced. In the case of a magnetic particle-metallic surface system, an extraordinary intensity is discovered and fully explained by the excitation of Surface Plasmon Polariton.

QM4C.3 • 16:30
Polarization-Dependent Phase-Changing Nanoswitch, Kannatassen Appavoo[1], Richard F. Haglund[1]; [1]*Physics and Astronomy, Vanderbilt University, USA.* We fabricate a hybrid nanoswitch with polarization-dependent properties by tailoring the near-field nanoenvironment of a plasmonic nanoantenna. Positioning a phase-transforming na-noparticle at the nanoantenna's optical focus allows modulation of nanoscale light fields with specific polarizations.

16:00–18:00
CM4D • All Optical and Quantum Signal Processing
Presider: Paulina Kuo; National Inst of Standards & Technology, United States

CM4D.1 • 16:00 Invited
Quantum Frequency Conversion of Single-Photon States by Three and Four-Wave Mixing, Michael G. Raymer[1], Dileep V. Reddy[1], Lasse Mejling[2], Karsten Rottwitt[2]; [1]*Department of Physics, University of Oregon, USA;* [2]*Department of Photonics, Technical University of Denmark, Denmark.* Three- or four-wave mixing can convert a single-photon wave packet to a new frequency. By tailoring the shapes of the pump(s), one can achieve add/drop functionality for different temporally orthogonal wave packets.

CM4D.2 • 16:30
Long-wavelength-pumped single-photon detector based on frequency up-conversion in MgO-doped periodically-poled LiNbO3 waveguide reaching ultralow dark count rates, Da Li[1], Guan Sun[1], Yujie J. Ding[1], Narasimha S. Prasad[2]; [1]*Lehigh University, USA;* [2]*NASA Langley Research Center, USA.* We implemented single-photon detector in 1500-nm band based on frequency up-conversion in nonlinear waveguide at pump wavelength of 1920 nm. Ultralow dark count rate and signal photon detection rate are 20 /s and 56.8 /s.

Monday, 10 June

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

16:00–18:00
QM4E • Nonlinear Imaging and Spatial and Temporal Effects
Presider: Marco Peccianti; Institute for Complex Systems, Italy

QM4E.1 • 16:00
Dispersion of the Electronic Third-Order Nonlinearity of Symmetric Molecules, Honghua Hu[1], Trenton R. Ensley[1], Marcus Seidel[1], Manuel Ferdinandus[1], Matthew Reichert[1], Olga Przhonska[1,2], Eric W. Van Stryland[1,3], David J. Hagan[1,3]; [1]*CREOL & FPCE, The College of Optics and Photonics, University of Central Florida, USA;* [2]*Institute of Physics, National Academy of Sciences, Ukraine;* [3]*Department of Physics, University of Central Florida, USA.* Using a dual-arm Z-scan to increase the signal-to-noise, we measure the dispersion of the electronic third-order nonlinearity of symmetric polymethines and squaraines and find good agreement with the essential-state model including CS2.

QM4E.2 • 16:15
Experimental Observation of Discrete Solitons in a Temporal Photonic Lattice, Martin Wimmer[1], Alois Regensburger[1], Christoph Bersch[1], Mohammad-Ali Miri[2], Georgy Onishchukov[3], Demetrios N. Christodoulides[2], Ulf Peschel[1]; [1]*Institute of Optics, Information and Photonics, University of Erlangen-Nürnberg, Germany;* [2]*CREOL, College of Optics and Photonics, University of Central Florida, USA;* [3]*Max Planck Institute for the Science of Light, Germany.* We report the first experimental observation of solitons propagating in discrete steps through a temporal photonic lattice, which is implemented in a fiber-loop setup. Stable propagation over fifty coupling lengths is achieved.

QM4E.3 • 16:30
Amplitude-invariant Fast Light in a Semiconductor Optical Amplifier for Microwave Photonics, Matthew Chang[1], Paul R. Prucnal[1]; [1]*Electrical Engineering, Princeton University, USA.* We experimentally demonstrate tunable fast light in a semiconductor optical amplifier based on cross-gain modulation. Up to 60 ps amplitude-invariant time delay is achieved on a 500 MHz microwave signal.

16:00–18:00
CM4F • Photonic Crystals
Presider: Hong Nguyen; Yokohama National University, Japan

CM4F.1 • 16:00
25-channel all-optical switches by integrated silicon photonic crystal nanocavities, Kengo Nozaki[1,2], Eiichi Kuramochi[1,2], Akihiko Shinya[1,2], Masaya Notomi[1,2]; [1]*NTT Nanophotonics Center, Japan;* [2]*NTT Basic resarch laboratories, Japan.* Silicon photonic crystal nanocavities were monolithically integrated to construct multi-channel all-optical switches. Successful operation of 25 resonant channels was demonstrated with a length of only 200 μm and an energy consumption in the femtojoule regime.

CM4F.2 • 16:15
Wavelength-Addressable Multi-Bit Optical Memory Based on a Large-Scale Array of Photonic Crystal Nanocavities, Eiichi Kuramochi[1,2], Akihiko Shinya[1,2], Kengo Nozaki[1,2], Hideaki Taniyama[1,2], Koji Takeda[1,3], Hisashi Sumikura[1,2], Tomonari Sato[1,3], Shinji Matsuo[1,3], Masaya Notomi[1,2]; [1]*NTT Nanophotonics Center, NTT Corporation, Japan;* [2]*NTT Basic Research Laboratories, NTT Corporation, Japan;* [3]*NTT Photonics Laboratories, NTT Corporation, Japan.* Multi-bit optical memories based on a monolithic 128-channel array of photonic crystal nanocavities on a Si chip and a 32-channel array of nanocavities with a built-in buried heterostructure on an InP chip are demonstrated.

CM4F.3 • 16:30
Phase-resolved soliton dynamics in silicon photonic crystals, Chad A. Husko[1], Daniel Eades[1], Andrea B. Redondo[1,3,4], Yanbing Zhang[1], Juntao Li[2], Thomas Krauss[2], Benjamin J. Eggleton[1]; [1]*Physics, University of Sydney, Australia;* [2]*Physics, University of St. Andrews, United Kingdom;* [3]*ICT-European Software Institute Division, Tecnalia, Parque Tecnologico de Bizkaia, Spain;* [4]*Dpto. Electronica y Telecom, E.T.S. Ingenieria de Bilbao, Spain.* We report the first phase-resolved measurements of nonlinear pulse propagation in silicon photonic devices. These demonstrations indicate soliton-like behavior, despite the presence of two-photon absorption (TPA) and free-carriers impacting the dynamics at 1.55 microns.

16:00–17:45
CM4G • OTDM Technologies
Presider: Michael Dennis; Johns Hopkins University, United States

CM4G.1 • 16:00 Invited
Rapid Eye Diagram Generation of a 640 Gb/s OTDM Signal Using a Time Lens, Reza Salem[1], Noam Ophir[2], Xiaoliang Zhu[2], Keren Bergman[2]; [1]*Picoluz, USA;* [2]*Department of Electrical Engineering, Columbia University, USA.* We demonstrate for the first time, the application of a time-lens based temporal magnifier for the generation of 640-Gbaud time-division multiplexed eye diagrams. The experiments use a standard digital communication analyzer with a 10.7-GHz receiver.

CM4G.2 • 16:30
40-Gbit/s RZ-BPSK and reused RZ-OOK bi-directional transmission with a self-pulsated modulator, Huai-Yung Wang[1], Yu-Chieh Chi[1], Gong-Ru Lin[1]; [1]*National Taiwan University, Taiwan.* 40-Gbit/s down-stream RZ-BPSK and up-stream reused RZ-OOK bi-directional transmission is demonstrated by a self-started RZ pulsed carrier with 10-ps pulsewidth and 7-dB extinction ratio from a nonlinearly biased intensity modulator based self-feedback loop.

16:00–18:00
CM4H • Applications of Laser Processing
Presider: Craig Arnold; Princeton University, United States

CM4H.1 • 16:00
The Role of Surface Plasmon Polariton Excitation in Laser Induced Periodic Structure Formation After Single-Shot Ultrafast Irradiation of Au Microstructures, Ryan Murphy[1], Ben Torralva[2], David Adams[3], Steven M. Yalisove[4]; [1]*Applied Physics Program, University of Michigan, USA;* [2]*Atmospheric, Oceanic & Space Sciences, University of Michigan, USA;* [3]*Sandia National Laboratories, USA;* [4]*Materials Science and Engineering, University of Michigan, USA.* Single-shot ultrafast irradiation of Au microstructures on Si substrates forms Laser Induced Periodic Structures (LIPS) on Si surfaces near features. Surface plasmon polariton excitation influences LIPS formation for certain polarization vector orientations with edges.

CM4H.2 • 16:15
In-Situ Local Temperature Measurement During Three-Dimensional Direct Laser Writing, Jonathan Mueller[1], Joachim Fischer[2], Yatin J. Mange[3], Thomas Nann[3], Martin Wegener[1,2]; [1]*Institute of Applied Physics and DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology, Germany;* [2]*Institute of Nanotechnology (INT), Karlsruhe Institute of Technology, Germany;* [3]*Ian Wark Research Institute, University of South Australia, Australia.* We present an approach to measure *in situ* the local temperature increase in the exposed volume during three-dimensional direct laser writing. The method is based on the detection of the luminescence of $NaYF_4$:Yb^{3+}/Er^{3+} codoped nanocrystals.

CM4H.3 • 16:30 Invited
Image-guided ultrafast laser scalpel for precise and minimally invasive surgery, Adela Ben-Yakar[1]; [1]*University of Texas at Austin, USA.* Ultrafast laser microsurgery will be the preferred laser scalpel of surgeons in the future as they enable the most precise cutting tool. Towards enabling its clinical use, we are developing flexible fiber-coupled, MEMS-based microscopes with nonlinear imaging.

Meeting Room 211D-B

CLEO: Science & Innovations

16:00–18:00
CM4I • Short Wavelength Fiber Lasers and Effects
Presider: John Minelly; Coherent Inc, United States

CM4I.1 • 16:00
20 W cladding-pumped Nd3+-doped fiber laser at 910nm, Mathieu Laroche[1], Benoit Cadier[2], Hervé Gilles[1], Sylvain Girard[1], Laurent Lablonde[2], Thierry Robin[2]; [1]*CIMAP, France;* [2]*IXFIBER, France.* We report a Nd3+-doped double-clad fiber laser with a record output power of 20 W at 910nm. A laser conversion efficiency as high as 44% was achieved in CW operating mode.

CM4I.2 • 16:15
Generation of 55 W infrared and 35 W green power from a picosecond rod fiber amplifier, Zhi Zhao[1], Bruce Dunham[1], Frank W. Wise[1]; [1]*Cornell University, USA.* A Yb rod amplifier that generates 2.7 ps pulses with 55 W power at 50 MHz repetition rate is reported. Amplified pulses exhibit minimal spectral distortion and high beam quality. Frequency-doubling yields 35 W green power.

CM4I.3 • 16:30
Ultraviolet frequency comb generation by frequency quadrupling a high-power fiber amplifier, Kangwen Yang[1], Wenxue Li[1], Shen Xuling[1], Dongbi Bai[1], Jian Zhao[1], Min Yan[1], Zeng Heping[1]; [1]*East China Normal University, China.* We obtained an ultraviolet frequency comb of 1.58 W in average power by frequency quadrupling a high-power large-mode-area fiber chirped-pulse amplifier at 1032 nm, whose carrier envelope phase was stabilized down to a linewidth of 2.42 mHz via feedback control on the Ti:S seed oscillator.

Meeting Room 212A-C

16:00–18:00
CM4J • Nonlinear THz Technology
Presider: TBA

CM4J.1 • 16:00
Terahertz Energy Scaling and Saturation in Two-Color Laser Filamentation, Taek Il Oh[1], Yongsing You[1], Nihal Jhajj[1], Eric Rosenthal[1], Howard Milchberg[1], Ki-Yong Kim[1]; [1]*Institute for Research in Electronics and Applied Physics, University of Maryland, USA.* We study broadband terahertz generation via two-color femtosecond laser filamentation with laser input energy up to 60 mJ. We find that the output THz energy strongly saturates due to ionization-induced laser defocusing in filamentation.

CM4J.2 • 16:15
Elliptically Polarized Terahertz Generation in Two-color Laser Filamentation, Yongsing You[1], Taek Il Oh[1], Ki-Yong Kim[1]; [1]*University of Maryland, USA.* We observe terahertz polarization evolves from linear to elliptical with increasing plasma length. This ellipticity arises from successive polarization rotation of local THz plasma sources and the velocity mismatch between laser and terahertz pulse.

CM4J.3 • 16:30
Broadband THz detection in the counter-propagating configuration using THz-enhanced plasma fluorescence, Khan Lim[1], Magali Durand[1], Xuan Sun[2], Fabrizio Buccheri[2], Matthew Weidman[1], Bruno Bousquet[3,4], Matthieu Baudelet[1], Xi-Cheng Zhang[2], Martin Richardson[1]; [1]*Townes Laser Institute, CREOL - The College of Optics and Photonics, University of Central Florida, USA;* [2]*Institute of Optics, University of Rochester, USA;* [3]*LOMA, University of Bordeaux 1, UMR5798, France;* [4]*LOMA, CNRS, UMR5798, France.* Terahertz-Radiation Enhanced Emission of Fluorescence (THz-REEF) was studied in the counter-propagating configuration as a more accurate representation of stand-off THz sensing scenarios. Determination of the THz amplitude and phase using this technique was successfully demonstrated.

Meeting Room 212D-B

JOINT

16:00–18:00
JM4K • Symposium on Mid-infrared Lasers: Mid-infrared Laser Sources II
Presider: Jens Biegert; ICFO -The Institute of Photonic Sciences, Spain

JM4K.1 • 16:00
Multi-Wavelength QCL Based MIR Spectroscopy for Fluids and Gases, Pierre Jouy[1], Yargo Bonetti[2], Kerstin Hans[1], Michele Gianella[1], Markus Sigrist[1], Markus Mangold[3], Bela Tuzson[3], Lukas Emmenegger[3], Philip Waegli[4], Alexandra Homsy[4], Yu-Chi Chang[5], Joab Difrancesco[5], Lubos Hvozdara[5], Hans-Peter Herzig[5], Herbert Looser[6], Daniel Hofstetter[7], Jérôme Faist[1]; [1]*ETH Zurich, IQE, Switzerland;* [2]*ETH Zurich, FIRST-lab, Switzerland;* [3]*EMPA, Switzerland;* [4]*EPFL, Samlab, Switzerland;* [5]*EPFL, OPT laboratory, Switzerland;* [6]*FHNW, Switzerland;* [7]*UniNE, Laboratoire temps-fréquence, Switzerland.* We demonstrate multi-color DFB QCLs with separated electrical pumping for independent single-mode emission of several wavelengths from the same ridge. This will be implemented in our Mid-infrared spectroscopy sensors for gases (CO2) and liquids (cocaine).

JM4K.2 • 16:15 Invited
Fe-doped II-VI Mid-infrared Laser Materials for the 3 to 8 μm Region, Vladimir Fedorov[1,2], Dmitri Martyshkin[1,2], Mikhail Mirov[2], Igor S. Moskalev[2], Sergey Vasilyev[2], Jeremy Peppers[1], Sergey B. Mirov[1,2], Valentin P. Gapontsev[1,2]; [1]*Physics, Univ. of Alabama at Birmingham, USA;* [2]*Mid-IR Lasers, IPG Photonics Corp, USA.* We report on recent progress in development of new gain media for tunable (3-8 μm) mid-IR lasers as well as Fe:ZnS/Se lasers operating in CW (>1.5W), gain-switched (>1 mJ@7ns@1kHz) and long-pulse (>0.5 J@200μs) regimes

Marriott San Jose Salon I & II

CLEO: QELS-Fundamental Science

16:00–18:00
QM4L • Quantum Detectors
Presider: Hiroki Takesue; NTT Basic Research Laboratories, Japan

QM4L.1 • 16:00
High quantum efficiency photon-number-resolving detector for photonic on-chip information processing, Brice Calkins[1], Paolo L. Mennea[3], Adriana E. Lita[1], Benjamin J. Metcalf[2], W. Steven Kolthammer[2], Antia Lamas-Linares[1], Justin B. Spring[2], Peter C. Humphreys[2], Richard P. Mirin[1], James C. Gates[3], Peter Smith[3], Ian A. Walmsley[2], Gerrits Thomas[1], Sae Woo Nam[1]; [1]*National Inst of Standards & Technology, USA;* [2]*Clarendon Laboratory, University of Oxford, United Kingdom;* [3]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* We demonstrate a high-efficiency, photon-number resolving transition edge sensor, integrated on an optical waveguide structure. The detector provides a system detection efficiency of up to 93% for single photons at a wavelength of 1551.9 nm.

QM4L.2 • 16:15
Near-Infrared Characterization of ENABLE Grown Superconducting Nanowire Single Photon Detectors, Richard L. Sandberg[1], Nina R. Weisse-Bernstein[1], Mark P. Croce[1], Todd L. Williamson[1], Mark A. Hoffbauer[1], Terry G. Holesinger[1], Michael W. Rabin[1]; [1]*Los Alamos National Laboratory, USA.* We characterize the near-infrared response of superconducting nanowire single photon detectors grown with the Energetic Neutral Atom Beam Lithography&Epitaxy technique. These SNSPDs show single photon sensitivity, MHz count rate, low timing-jitter, and detection efficiency ~10-3.

QM4L.3 • 16:30
High-speed photon-number-resolved detection with sinusoidally gated multipixel photon counters, Yan Liang[1], Min Ren[1], E. Wu[1], Guang Wu[1], Zeng Heping[1,2]; [1]*State Key Laboratory of Precision Spectroscopy, East China Normal University, China;* [2]*School of Optical-Electrical and Computer Engineering, University of Shanghai for Science and Technology, China.* We demonstrated photon-number resolved detection with sinusoidally gated multipixel photon counter operated at room temperature. Sinusoidal gating minimized the capacitive response noise and improved the photon-number-resolving performance at high repetition rate up to 200 MHz.

CLEO: Applications & Technology

16:00–18:00
AM4M • Symposium on Lab-on-a-Chip Applications: Lab on Chip II

Presider: Chris Myatt; Mbio Diagnostics, USA

AM4M.1 • 16:00 Invited

From Lab-on-a-Chip to Lab-in-the Body: Miniaturization of Diagnostic Tools, Axel Scherer[1]; [1]*California Institute of Technology, USA.* Optical molecular-diagnostic tools are rapidly shrinking, enabling miniature systems that can be used to continuously monitor health in the body. We describe our work on integrated photonic systems for this purpose.

AM4M.2 • 16:30 Invited

Where the Rubber Meets the Road - Clinical Diagnostic Testing and New Technology, Valerie Ng[1]; [1]*Alameda County Medical Center/HGH, USA.* Diagnostic test devices using new and emerging technologies must meet regulatory standards for clinical use. I will discuss these regulatory requirements emphasizing how test device manufacturers can meet the needs of the clinical laboratory.

CLEO: Science & Innovations

16:00–18:00
CM4N • Long Distance Ranging and Frequency Transfer

Presider: Ian Coddington, NIST, USA

CM4N.1 • 16:00 Invited

Optical Frequency Transfer over a single-span 1840 km Fiber Link, Stefan Droste[1], Katharina Predehl[1], Theodor W. Hänsch[1], Thomas Udem[1], Ronald Holzwarth[1], Sebastian Raupach[2], Filip Ozimek[2], Harald Schnatz[2], Gesine Grosche[2]; [1]*Max-Planck-Institut fur Quantenoptik, Germany;* [2]*Physikalisch-Technische Bundesanstalt, Germany.* Optical frequency transfer via a 1840 km fiber link has been investigated. Twenty fiber amplifiers and two fiber Brillouin amplifiers are needed to compensate for 420 dB of loss. Active noise compensation reduces the instability to 2.7 x 10^-15 at 1 s with 4 x 10^-19 after 100 s.

CM4N.2 • 16:30

1.2-km Timing-Stabilized, Polarization-Maintaining Fiber Link with Sub-Femtosecond Residual Timing Jitter, Michael Y. Peng[1], Patrick T. Callahan[1], Amir H. Nejadmalayeri[1], Ming Xin[2], E. Monberg[3], Man Yan[3], Lars Grüner-Nielsen[4], John M. Fini[3], Franz X. Kärtner[1,2]; [1]*Massachusetts Institute of Technology, USA;* [2]*Deutsches Elektronen-Synchrotron and University of Hamburg, Germany;* [3]*OFS Laboratories, USA;* [4]*OFS, Denmark.* A 1.2-km timing-stabilized, polarization-maintaining fiber link based on balanced optical cross-correlation was demonstrated with ~0.9 fs RMS timing jitter over 16 days and ~0.2 fs RMS timing jitter over 3 days.

16:00–18:00
CM4O • Micro-sensors

Presider: Christian Pflügl; EOS Photonics, United States

CM4O.1 • 16:00

Photonic temperature sensor based on microring resonators, Haitan Xu[1,2], Mohammad Hafezi[1,2], Jingyun Fan[1,2], Alan Migdall[2,1], Gregory Strouse[2], Zeeshan Ahmed[2], Jacob Taylor[2,1]; [1]*JQI, University of Maryland-College Park, USA;* [2]*National Institute of Standards and Technology, USA.* We present an experimental analysis on photonic temperature sensor based on microring resonators, and we show that the sensitivity can be better than 40μK, which is limited by the noise of instrument in use.

CM4O.2 • 16:15

Torsion-Free Photonic Crystal Pressure Sensor Array Using Novel Piston-type Resonator Array, Daquan Yang[1,2], Huiping Tian[1,3], Nannan Wu[1], Yi Yang[1], Yuefeng Ji[1]; [1]*School of information and communication Engineering, Beijing University of Posts and Telecommunications, China;* [2]*School of Engineering and Applied Sciences, Harvard University, USA;* [3]*Key Laboratory of Micro and Nano Photonic Structures (Ministry of Education), and State Key Laboratory of Surface Physics, Fudan University, China.* We demonstrate a novel nanoscale torsion-free photonic crystal pressure sensor array. The proposed sensor array consists of piston-type resonator array side-coupled to photonic crystal waveguide. The pressure sensitivity as high as 0.50nm/nN is observed.

CM4O.3 • 16:30

Enhanced fluorescence emission using a photonic crystal coupled to an optical cavity, Anusha Pokhriyal[1], Meng Lu[2], Vikram Chaudhery[2], Sherine George[3], Brian T. Cunningham[2,3]; [1]*Physics, University of Illinois at Urbana Champaign, USA;* [2]*Electrical and Computer Engineering, University of Illinois at Urbana Champaign, USA;* [3]*Bioengineering, University of Illinois at Urbana Champaign, USA.* Fluorophores are excited on PC surface that is coupled to underlying Fabry-Perot cavity through a reflector beneath the PC leading to 6× increase in SNR of a dye labeled polypeptide compared to ordinary PCEF.

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QM4A • Optics of Metasurfaces—Continued

QM4A.4 • 16:45
Plasmonic Metasurface Based Ultra-thin Phase Holograms and Planar Micro-lenses, Xingjie Ni[1], Alexander Kildishev[1], Satoshi Ishii[1], Vladimir M. Shalaev[1]; [1]*School of Electrical and Computer Engineering and Birck Nanotechnology Center, Purdue University, USA.* We experimentally demonstrate a phase hologram generated at a visible wavelength by a plasmonic metasurface consisting of Babinet-inverted nano-antennas perforated on a 30-nm-thick gold film. Micrometer-sized planar lenses are made with the same technique.

QM4A.5 • 17:00
Broadband Optical Chirality Using Ultrathin Metasurface, Amr Shaltout[1], Jingjing Liu[1], Alexander Kildishev[1], Vladimir M. Shalaev[1]; [1]*Electrical and Computer Engineering, Purdue University, USA.* A metasurface layer of λ/50 thickness is developed to produce the optical rotation effect of chiral media through the use of a plasmonic nano-antenna array that generates a phase-shift between helical components of incident light.

QM4A.6 • 17:15
Spinoptical Metamaterials: Symmetry Violation Route to Spin-Based Photonics, Nir Shitrit[1], Igor Yulevich[1], Elhanan Maguid[1], Dror Ozeri[1], Dekel Veksler[1], Vladimir Kleiner[1], Erez Hasman[1]; [1]*Technion Israel Institute of Technology, Israel.* We report on spinoptical metamaterials manifested by spin-controlled optical modes, where the inversion symmetry is violated. The metasurface symmetry properties design via nanoantennas is a starting point for spin-based nanophotonic applications.

QM4A.7 • 17:30
Selective Broadband Generation of Orbital Angular Momentum Carrying Vector Beams Using Metamaterials, Zhe Zhao[1], Jian Wang[1], Shuhui Li[1], Alan E. Willner[2]; [1]*Wuhan National Laboratory for Optoelectronics, Huazhong Uni of Sci & Tech, China;* [2]*Department of Electrical Engineering, University of Southern California, Los Angeles, USA.* We design metamaterials to generate orbital angular momentum (OAM) carrying vector beams. Using a 11.2×11.2 μm device, we selectively generate broadband OAM-carrying vector beams from 1000 to 1550 nm. The device shows good fabrication tolerance.

QM4B • Quantum Dots, Nanocrystals, & Impurities—Continued

QM4B.4 • 16:45
Type-tuning of quasi-type-II CdSe/CdS seeded core/shell nanorods: type-I vs. type-II, Ahmet Fatih Cihan[1,2], Yusuf Kelestemur[2], Burak Guzelturk[1,2], Hilmi Volkan Demir[1,3]; [1]*Electrical and Electronics Engineering, Bilkent University, Turkey;* [2]*UNAM Institute of Materials Science and Nanotechnology, Bilkent University, Turkey;* [3]*School of Electrical and Electronics Engineering, School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore.* We present tuning of quasi-type-II CdSe/CdS core/shell nanorods between type-I-like and type-II-like behavior in their amplified spontaneous emission pumped by 2-photon excitation, with the type attributions verified by time-resolved emission kinetics.

QM4B.5 • 17:00
Enhanced exciton transfer from the cascaded bilayer of green- and red-emitting CdTe quantum dots into bulk silicon, Aydan Yeltik[1], Burak Guzelturk[1], Hilmi Volkan Demir[1,2]; [1]*Bilkent University, Turkey;* [2]*Nanyang Technological University, Singapore.* We show enhanced transfer of excitons from the energy-gradient of bilayered green-/red-emitting quantum dots into silicon using cascaded nonradiative energy with an overall enhancement factor of 1.3 at room temperature for solar cell sensitization.

QM4B.6 • 17:15
Lifetime measurements and blinking statistics of nonradiative energy transfer from single halide-terminated nanocrystals onto graphene, Obafunso Ajayi[1], Chee Wei Wong[1], Nicholas C. Anderson[2], Mircea Cotlet[3], Jonathan S. Owen[2], Nicholas Petrone[1], James Hone[1]; [1]*Mechanical Engineering, Columbia University, USA;* [2]*Chemistry, Columbia University, USA;* [3]*Center for Functional Nanomaterials, Brookhaven National Laboratory, USA.* Time-resolved Förster energy transfer from single halide-terminated nanocrystals with n-butylamine ligands (0.6 nm) onto two-dimensional graphene is measured with time-correlated single-photon counting. Remarkable 4× reduction in spontaneous emission is observed (237 MHz) and modified LDOS.

QM4B.7 • 17:30
Pulse Shaping and Break-Up by Quantum-Coherent Effects in Quantum-Dot Amplifiers at Room Temperature, Benjamin Lingnau[1], Julian Korn[1], Eckehard Schöll[1], Kathy Lüdge[1], Mirco Kolarczik[2], Nina Owschimikow[2], Yücel I. Kaptan[2], Ulrike Woggon[2]; [1]*Institut f. Theor. Physik, Technische Universität Berlin, Germany;* [2]*Institut f. Optik u. Atomare Physik, Technische Universität Berlin, Germany.* We show the occurrence of Rabi oscillation induced pulse shaping and break-up in a 1.3μm wavelength semiconductor quantum-dot optical amplifiers at room temperature in numerical simulations and experimental results.

QM4C • Hybrid Plasmonics & Novel Effects—Continued

QM4C.4 • 16:45
Plasmon Drag Effect in Metal Nanostructures, Natalia Noginova[1], Vincent Rono[1], Brittany Bates[1], Joshua D. Caldwell[2]; [1]*Norfolk State University, USA;* [2]*Naval Research Lab, USA.* A dramatic enhancement of the photon drag effect was observed in nanostructured gold and silver at localized plasmon resonance conditions. We demonstrated a possibility to control the effect with nanoscale geometry

QM4C.5 • 17:00
Weak measurement of the Goos-Hänchen shift, Gaurav Jayaswal[1], Giampaolo Mistura[1], Michele Merano[1]; [1]*Department of Physics and Astronomy "G. Galilei", University of Padova, Italy.* It is well known from quantum physics that weak measurements offers a platform of amplifying and detecting very small signals. In this letter, we present the first experimental observation of the Goos-Hänchen shift.

QM4C.6 • 17:15
Plasmonic Silver Nanorod Sensitivity: Experiment and Simple Theoretical Treatment, Arpad Jakab[1], Carsten Soennichsen[1]; [1]*Institute of Physical Chemistry, University of Mainz, Germany.* Comparing single-particle plasmonic sensitivity of silver and gold nanorods by monitoring the plasmon resonance shift upon changing the environment we report that silver nanoparticles have 1.2 to 2 times higher sensitivity than gold.

QM4C.7 • 17:30
Integrated SPP-Dielectric Hybrid Coupler Based Sensor For Ultra-thin Layer Detection, Boyu Fan[1], Fang Liu[1], Xiaoyan Wang[1], yunxiang Li[1], Yidong Huang[1]; [1]*electronic engineering, Tsinghua University, China.* An integrated sensor utilizing short range surface plasmon polariton mode is proposed and realized, which demonstrates the sensitivity as high as 0.67dB/nm for ultra-thin layer detection.

CM4D • All Optical and Quantum Signal Processing—Continued

CM4D.3 • 16:45
Efficient Mid-infrared Imaging at Few-photon Level by Frequency Up-conversion, Qian Zhou[1], Kun Huang[1], Haifeng Pan[1], E. Wu[1], Zeng Heping[1]; [1]*State Key Laboratory of Precision Spectroscopy, East China Normal University, China.* We demonstrated few-photon-level Mid-infrared imaging at 3.39 μm by frequency up-conversion with conversion efficiency of 78.5%. The Mid-infrared image was spectrally up-converted into the near-infrared regime captured by a silicon electron multiplying charged coupled device.

CM4D.4 • 17:00
Compact 2D Nonlinear Photonic Crystal source of Beamlike Path Entangled Photons, Eli Megidish[1], Assaf Halevy[1], Hagai Eisenberg[1], Ayelet Ganany-Padowicz[2], Nili Habshoosh[2], Ady Arie[2]; [1]*Racah Inst. of Physics, Hebrew University, Israel;* [2]*School of Electrical Engineering, Tel Aviv University, Israel.* We experimentally demonstrate a compact two-photon path entanglement source based on 2D nonlinear quasi phase matching technique. Photon pairs are directly generated into well defined and easy to collect non-collinear beamlike modes.

CM4D.5 • 17:15
Two-color switching and wavelength conversion at 10 GHz using a Photonic Crystal molecule, Sylvain Combrié[1], Gaëlle Lehoucq[1], Stefania Malaguti[2], Gaetano Bellanca[2], Johann-Peter Reithmaier[3], Stefano Trillo[2], Alfredo De Rossi[1]; [1]*Thales Research and Technology, France;* [2]*Università di Ferrara, Italy;* [3]*Universitat Kassel, Germany.* We propose a two-colors all-optical gate based on two coupled single-mode Photonic Crystals. Real-time switching and wavelength conversion at a rate up to 10 GHz have been demonstrated.

CM4D.6 • 17:30
Phase-sensitive amplifier using a PPLN waveguide integrated with a high-power-tolerant phase locking modulator, Koji Enbutsu[1], Takeshi Umeki[1], Masaki Asobe[1], Hirokazu Takenouchi[1]; [1]*Photonics Labs., NTT, Japan.* We demonstrated a phase-sensitive amplifier by using a PPLN waveguide for pump generation and a monolithically-integrated phase modulator for a phase-locked loop. The high-power-resistance of the modulator enabled us to achieve an improved noise figure.

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QM4E • Nonlinear Imaging and Spatial and Temporal Effects—Continued

QM4E.4 • 16:45
A Telecom-Based Temporal Cloak, Joseph M. Lukens[1], Daniel E. Leaird[1], Andrew M. Weiner[1]; [1]*Electrical and Computer Engineering, Purdue University, USA.* We demonstrate a new temporal cloak capable of hiding 46% of the entire time axis at a repetition rate of 12.7 GHz. Our results introduce temporal cloaking into the practical domain of secure optical communication.

QM4E.5 • 17:00
Restoration of Blurred Images Due to Phase Distortion Based on Polarization-Insensitive Phase Conjugation in Second-Order Nonlinear Medium: Novel Scheme, Xingquan Zou[1], Xiaomu Lin[1], Pu Zhao[1], Pengda Hong[1], Yujie J. Ding[1], Xiaodong Mu[2], Huai-Chuan Lee[2], Stephanie K. Meissner[2], Helmuth Meissner[2]; [1]*Lehigh University, USA;* [2]*Onyx Optics Inc., USA.* Polarization-insensitive phase conjugation, achieved based on difference-frequency generation in a second-order nonlinear composite consisting of stacked KTP plates, was exploited to restore blurred images due to phase distortion as a novel scheme.

QM4E.6 • 17:15
Imaging cross-correlation FROG: retrieval of ultrashort, complex, spatiotemporal fields, Falk Eilenberger[1], Alexander Brown[2], Stefano Minardi[1], Thomas Kaiser[1], Thomas Pertsch[1]; [1]*Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Germany;* [2]*Institute of Photonics Technologies, Germany.* We present an analysis method for the phase retrieval of ultrashort, spatiotemporal pulses. We combine the FROG concept with an imaging cross correlator and reach sub 10 fs temporal and sub 5 micron spatial resolution.

QM4E.7 • 17:30
Second harmonic generation for PW class lasers, Sergey Mironov[1], Efim A. Khazanov[1], Andrey Shaykin[1], Vladimir Lozhkarev[1], Vadim Tcheremiskine[2], Olivier Uteza[2], Marc Sentis[2], Vladislav Ginzburg[1]; [1]*Nonlinear dynamics and optics, Institute of Applied Physics RAS, Russian Federation;* [2]*LP3, Aix Marseille Université, France.* Energy conversion efficiency of the second harmonic generation in KDP under fs pulses with peak intensities of 1-5TW/cm2 is studied. Efficiency as high as 73% at 910nm and 50% at 800nm fundamental wavelength is demonstrated.

CM4F • Photonic Crystals—Continued

CM4F.4 • 16:45
Wide range Q-factor control in a photonic crystal nanobeam cavity incorporating quantum dots, Ryuichi Ohta[1], Yasutomo Ota[1], Naoto Kumagai[1], Satomi Ishida[1], Satoshi Iwamoto[1], Yasuhiko Arakawa[1]; [1]*Institute of Industrial Science, Institute of Nano Quantum Information Electronics, University of Tokyo, Japan.* We develop a Q-factor controllable photonic crystal nanobeam cavity incorporating quantum dots. Wide Q-factor control from 3,500 to 14,000 is demonstrated by means of MEMS, supplying bias from 0 to 18 V.

CM4F.5 • 17:00
Nonlinear Optics in (111)-GaAs Photonic Crystal Cavities, Marina Radulaski[1], Sonia Buckley[1], Klaus Biermann[2], Jelena Vuckovic[1]; [1]*Ginzton Laboratory, Stanford University, USA;* [2]*Paul-Drude-Institut für Festkörperelektronik, Germany.* We successfully perform second harmonic and sum frequency generation in L3 and crossbeam photonic crystal cavities fabricated in (111)-GaAs.

CM4F.6 • 17:15
Reducing disorder-induced losses for slow-light photonic crystal waveguides through Bloch mode engineering, Nishan S. Mann[1], Sylvain Combrié[2], Alfredo De Rossi[2], Pierre Colman[2], Mark Patterson[1], Stephen Hughes[1]; [1]*Physics, Queens University, Canada;* [2]*Thales Research and Technology, France.* We present theory and measurements of disorder-induced losses for slow-light photonic crystal waveguides. Our calculations and measurements explain how Bloch mode engineering can substantially reduce losses for the same slow-light group velocity regime.

CM4F.7 • 17:30
Photonic Crystal Coupled Cavity Arrays for Quantum Simulation, Armand Rundquist[1], Arka Majumdar[2], Michal Bajcsy[1], Vaishno D. Dasika[3], Seth Bank[3], Jelena Vuckovic[1]; [1]*E. L. Ginzton Laboratory, Stanford University, USA;* [2]*Department of Physics, University of California, Berkeley, USA;* [3]*Microelectronics Research Center, University of Texas, Austin, USA.* Through experimental study of an array of coupled photonic crystal cavities, we find that the intercavity coupling is significantly larger than the fabrication-induced disorder, a necessary condition for the generation of strongly correlated photons.

CM4G • OTDM Technologies—Continued

CM4G.3 • 16:45
Generation of Nyquist sinc pulses using intensity modulators, Marcelo A. Soto[1], Mehdi Alem[1], Mohammad Amin Shoaie[2], Armand Vedadi[2], Camille S. Brès[2], Luc Thévenaz[1], Thomas Schneider[3]; [1]*Group for Fibre Optics (GFO), SCI-STI-LT, EPFL Swiss Federal Institute of Technology, Switzerland;* [2]*Photonic Systems Laboratory (PHOSL), SCI-IEL, EPFL Swiss Federal Institute of Technology, Switzerland;* [3]*Institut für Hochfrequenztechnik, Hochschule für Telekommunikation, Germany.* Optical sinc-shaped Nyquist pulses are produced based on the generation of an ideal frequency comb using cascaded intensity modulators. Nyquist pulses with 9.8-ps temporal width, 82-fs jitter and more than 40 dB SNR are achieved.

CM4G.4 • 17:00
Optical Gaussian Pulse Generator Using Phase Modulator Based Spectral Slicing and Compression, Qiang Wang[1], Li Huo[1], Yanfei Xing[1], Caiyun Lou[1], Bingkun Zhou[1]; [1]*Tsinghua University, China.* A 25-GHz 3-ps optical Gaussian pulse generator using phase modulators is experimentally demonstrated with wavelength tunability over C-band. Error-free 100-km transmission of 100-Gb/s OTDM signal is achieved with it.

CM4G.5 • 17:15
Enhanced All-LiNbO3 OTDM Demultiplexing Using a Diverging Time Lens, Yanfei Xing[1], Li Huo[1], Qiang Wang[1], Dong Wang[1], Caiyun Lou[1]; [1]*Tsinghua National Laboratory for Information Science and Technology and State Key Laboratory of Integrated Optoelectronics,, Tsinghua University, China.* We propose to utilize a diverging time lens for LiNbO3 modulator based OTDM demultiplexing. Error-free detection is successfully demonstrated with 2.4-dB power penalty for all channels, 1.1 dB for the best channel.

CM4G.6 • 17:30
Full 160-Gb/s OTDM to 16x10-Gb/s WDM conversion using a single nonlinear device, Keith G. Petrillo[1], Mark A. Foster[1]; [1]*Johns Hopkins University, USA.* Using a temporal Fourier processor, we demonstrate full error-free demultiplexing of a 160-Gb/s OTDM signal with a single nonlinear interaction. Choice of the time-lens aperture is crucial to maximizing the overall system BER performance.

CM4H • Applications of Laser Processing—Continued

CM4H.4 • 17:00
Surface Plasmon Enhanced Luminescence Up-Conversion, Dawei Lu[1], Yonghao Cui[1], Suehyun Cho[1], Loic Brun[2], Chris Summers[2], Won Park[1]; [1]*University of Colorado at Boulder, USA;* [2]*Materials Science & Engineering, Georgia Institute of Technology, USA.* We report enhanced up-conversion in NaYF4:Yb3+,Er3+ nanoparticles by surface plasmon. Simple grating and MIM grating structures were investigated to target the excitation processes. Photoluminescence spectroscopy showed up to 30x enhancement in up-converted luminescence intensity.

CM4H.5 • 17:15
Direct Laser Writing With Variable Repetition Rate, Joachim Fischer[1], Jonathan Mueller[2], Johannes Kaschke[2,3], Martin Wegener[1,2]; [1]*Institute of Nanotechnology, Karlsruhe Institute of Technology, Germany;* [2]*Institute of Applied Physics, Karlsruhe Institute of Technology, Germany;* [3]*DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology, Germany.* We perform femtosecond direct laser writing at repetition rates between 1 kHz and 80 MHz. From the observed weak dependence of the threshold power on the repetition rate, we conclude that no fundamentally different structuring regimes exist.

CM4H.6 • 17:30
Indirect lift-off of thin dielectric layers from silicon by femtosecond laser 'cold' ablation at the interface, Tino Rublack[1], Markus Muchow[1], Stefan Hartnauer[1], Gerhard Seifert[1]; [1]*Martin-Luther-Universität Halle-Wittenberg, Zentr. f. Innovationskompetenz SiLi-nano, Germany.* Thin dielectric layers have been removed from silicon substrates using femtosecond laser pulses via evaporation of few nanometers Si at the interface. Slightly above threshold, this non-thermal ablation process leaves the opened area structurally undamaged.

CLEO: Science & Innovations

CM4I • Short Wavelength Fiber Lasers and Effects—Continued

CM4I.4 • 16:45
High-power yellow and near-infrared lasers from cascaded four-wave mixing in nonlinear Yb-doped fiber amplifiers, Qiang Hao[1], Zeng Heping[1]; [1]*Shanghai Key Laboratory of Modern Optical System, Engineering Research Center of Optical Instrument and System, Ministry of Education, School of Optical-Electrical and Computer Engineering, University of Shanghai for Science and Technology, China.* We demonstrated high-power yellow and near-infrared laser emissions by cascaded four-wave mixing in a nonlinear Yb-doped fiber amplifier, generating 0.3 W at 594 nm and 1.6 W at 825 nm of average power.

CM4I.5 • 17:00
Self-bleaching Phenomenon Observed in the Ce/Yb Co-doped Silica Fiber, gui chen[1], Jinyan Li[1]; [1]*Wuhan National Laboratory for Optoelectronics, hust, China.* We report on a self-bleaching phenomenon observed in the Ce Yb co-doped silica fiber. The excess loss of the Ce/Yb fiber reduces about 1.5 dB/m at 633 nm after the pump laser was turned off for an hour.

CM4I.6 • 17:15
Suppression mechanism by Ca additive of photodarkening effect in Yb-doped silica glass fiber, Yasushi Fujimoto[1], Sei-ichi Sugiyama[2], Motoichiro Murakami[1], Hitoshi Nakano[2], Tatsuhiro Sato[3], Hiroyuki Shiraga[1]; [1]*Institute of Laser Engineering, Osaka University, Japan;* [2]*Faculty of science and Engineering, Kinki University, Japan;* [3]*Research and Application Laboratory, Shin-Etsu Quartz Products Co., Ltd., Japan.* We found that Ca additive effectively suppresses the photo-darkening effect in Yb-doped silica fiber even at 6.0 wt% of high Yb2O3 concentration. Ca ion works as a stabilizer to maintain the Yb3+ valence state.

CM4I.7 • 17:30
High-Temperature-Resistant Distributed Bragg Reflector Fiber Laser Based on Thermally Regenerated Gratings, Rongzhang Chen[1], Aidong Yan[1], Mingshan Li[1], John Canning[2], Kevin Chen[1]; [1]*Electrical and Computer Engineering, University of Pittsburgh, USA;* [2]*Interdisciplinary Photonics Laboratories (iPL), University of Sydney, Australia.* We report a high-temperature-resistant distributed Bragg reflector fiber laser using thermally regenerated gratings. The laser was characterized and tested to be capable of long-term lasing in high temperature environment up to 750°C.

CM4J • Nonlinear THz Technology—Continued

CM4J.4 • 16:45
Coherent Detection of Terahertz via Laser Induced Plasma with Controlled Optical Bias, Chia-Yeh Li[1], Denis V. Seletskiy[1,2], Mansoor Sheik-Bahae[1]; [1]*Physics and Astronomy, University of New Mexico, USA;* [2]*Physics and Center for Applied Photonics, University of Konstanz, Germany.* Common air-breakdown coherent detection techniques rely on either large DC bias across plasma or second harmonic contribution from the supercontinuum to provide a local oscillator field. Here we report coherent detection by purposely injecting second harmonic.

CM4J.5 • 17:00
Counter-Propagating Difference Frequency Mixing in Diamond with Terahertz Waves, Matteo Clerici[1,2], Lucia Caspani[1], Eleonora Rubino[1,3], Marco Peccianti[4], Marco Cassataro[1,5], Alessandro Busacca[5], Tsuneyuki Ozaki[1], Daniele Faccio[2], Roberto Morandotti[1]; [1]*INRS-EMT, Canada;* [2]*School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom;* [3]*Dipartimento di Scienza e Alta Tecnologia, Università degli Studi dell'Insubria, Italy;* [4]*Institute for Complex Systems, CNR, Italy;* [5]*DIEET, Università di Palermo, Italy.* We investigate four-wave mixing between terahertz and optical pulses in diamond. We observe the occurrence of sum and difference frequency generation, with the latter being phase-matched for terahertz pulses counter-propagating to the optical field.

CM4J.6 • 17:15
Metamaterial-Enhanced Nonlinear Responses in Semiconductors as a THz Detection Platform, Harold Y. Hwang[1,2], Kebin Fan[2], Aaron Sternbach[2], Xin Zhang[2], Richard D. Averitt[2], Keith A. Nelson[1]; [1]*Massachusetts Institute of Technology, USA;* [2]*Boston University, USA.* We present recent work utilizing terahertz field enhancement in metamaterial structures to drive carrier generation in semiconductors. We implement this as a novel platform to detect terahertz radiation.

CM4J.7 • 17:30
Towards Nonlinear Terahertz Metamaterials, Ibraheem Al-Naib[1], Gargi Sharma[1], Marc M. Dignam[2], Hassan Hafez[1], Akram Ibrahim[1], David G. Cooke[3], Tsuneyuki Ozaki[1], Roberto Morandotti[1]; [1]*INRS-EMT, Canada;* [2]*Department of Physics, Queen's University, Canada;* [3]*Department of Physics, McGill University, Canada.* We demonstrate nonlinear effects induced by an intense terahertz field on the transmission response of metamaterial structures fabricated on a silicon wafer, as well as ultrafast modulation in the terahertz response of our samples.

JOINT

JM4K • Symposium on Mid-infrared Lasers: Mid-infrared Laser Sources II—Continued

JM4K.3 • 16:45
High-power, 100-Hz HgGa2S4 OPO pumped at 1064 nm, Aleksey Tyazhev[1], Georgi Marchev[1], Valeriy Badikov[2], Adolfo Esteban-Martin[1,3], Dmitrii Badikov[2], Vladimir Panyutin[1], Galina Shevyrdyaeva[2], Svetlana Sheina[2], Anna Fintisova[2], Valentin Petrov[1]; [1]*Max Born Institute, Germany;* [2]*High Technologies Laboratory, Kuban State University, Russian Federation;* [3]*ICFO, Spain.* HgGa2S4 is employed in a 1064-nm pumped optical parametric oscillator, to generate ~5-ns long idler pulses near 4 μm with energies as high as 6.1 mJ and average power of 610 mW at 100 Hz.

JM4K.4 • 17:00
Mid-infrared chirped-pulse upconversion with four-wave difference frequency generation in gases, Takao Fuji[1], Yutaka Nomura[1], Yu-Ting Wang[2], Atsushi Yabushita[2], Chih-Wei Luo[2]; [1]*National Institutes of Natural Sciences, Japan;* [2]*National Chiao Tung University, Taiwan.* Chirped-pulse upconversion of sub-single-cycle Mid-infrared pulses with gaseous media has been realized. Single-shot detection of Mid-infrared spectra from 250 to 5500 cm-1 with 5 cm-1 resolution was demonstrated.

JM4K.5 • 17:15
Recent Progress in Development Orientation-Patterned GaP for Next-Generation Frequency Conversion Devices, Vladimir Tassev[1], Michael Snure[1], Rita Petterson[1], Kenneth L. Schepler[1], Robert G. Bedford[1], James Matt Mann[1], Shiva Vangala[1,2], William Goodhue[3], Angie Lin[4], James S. Harris[4], Martin Fejer[4], Peter G. Schunemann[5]; [1]*Sensors Directorate, Air Force Research Laboratory, USA;* [2]*Solid State Scientific Corporation, USA;* [3]*Photonics Center, University of Massachusetts, USA;* [4]*Stanford University, USA;* [5]*BAE Systems, Inc., USA.* Progress in developing a cost effective technique for fabrication of orientation patterned GaP templates and a reliable technology for thick epitaxial growth on them is described. First 350 μm thick device quality OPGaP is produced.

JM4K.6 • 17:30 Invited
New Beam Engineered and Spectrally Engineered Mid-ir Quantum Cascade Lasers by Transverse and Longitudinal Mode Control, Federico Capasso[1]; [1]*Harvard University, USA.* The talk will focus on advances in high power single longitudinal/transverse mode master oscillator power amplifier (MOPA) QCls and MOPA QCL arrays capable of broadband tuning, as well as on low-divergence high brightness plasmomic QCLs.

CLEO: QELS-Fundamental Science

QM4L • Quantum Detectors—Continued

QM4L.4 • 16:45
Ultrabroadband, Direct Detection of Nonclassical Photon Statistics in Parametric Fluorescence at Telecom Wavelength, Kentaro Wakui[1], Yujiro Eto[1], Tetsufumi Yanagida[1,2], Hugo Benichi[1], Shuro Izumi[1,2], Kazuhiro Ema[2], Takayuki Numata[3], Daiji Fukuda[3], Masahide Sasaki[1]; [1]*National Institute of Information and Communications Technology, Japan;* [2]*Sophia University, Japan;* [3]*National Institute of Advanced Industrial Science and Technology, Japan.* Ultrabroadband photon-number-resolving detection is demonstrated for parametric fluorescence ranging over 150 nm in the telecom window, using a Ti transition edge sensor. Our results violate Klyshko's classical limit for even photon numbers.

QM4L.5 • 17:00
Ultra-low Noise Upconversion Single-Photon Detector in the Telecom Band, Guoliang Shentu[1], Jason S. Pelc[2], Xiao-Dong Wang[3], Martin Fejer[2], Qiang Zhang[1], Jian-Wei Pan[1]; [1]*Shanghai Branch, Hefei National Laboratory for Physical Sciences at Microscale and Department of Modern Physics, University of Science and Technology of China, China;* [2]*E. L. Ginzton Laboratory, Stanford University, USA;* [3]*College of Physics and Electronic Engineering, Northwest Normal University, China.* We demonstrate upconversion single-photon detection for the 1550-nm band using a PPLN waveguide, long-wavelength pump, and narrowband filtering. We achievetotal-system detection efficiency of 30% with noise at the dark-count level of a silicon APD.

QM4L.6 • 17:15
Operating Temperature Dependence of QDOGFET Single-Photon Detectors, Eric J. Gansen[1], Sean D. Harrington[1], John M. Nehls[1], Mary A. Rowe[2], Shelley M. Etzel[2], Sae Woo Nam[2], Richard P. Mirin[2]; [1]*Physics Department, University of Wisconsin-La Crosse, USA;* [2]*National Institute of Standards and Technology, USA.* To date, QDOGFETs (quantum dot, optically gated, field-effect transistors) have only been shown to be single-photon sensitive when cooled to 4 K. Here, we show that QDOGFETs can sense single photons at temperatures approaching 40 K.

QM4L.7 • 17:30
Tungsten Silicide Superconducting Nanowire Arrays for the Lunar Laser OCTL Terminal, Matthew Shaw[1], Jeffrey A. Stern[1], Kevin Birnbaum[1], Meera Srinivasan[1], Michael Cheng[1], Kevin Quirk[1], Abhijit Biswas[1], Francesco Marsili[2], Varun Verma[2], Richard P. Mirin[2], Sae Woo Nam[2], William Farr[1]; [1]*Jet Propulsion Laboratory, USA;* [2]*National Institute of Standards and Technology, USA.* We have developed 12-pixel arrays of fiber-coupled tungsten silicide superconducting nanowire single photon detectors and performed end-to-end tests of a 39 Mbps pulse position modulation optical communication link with a software receiver.

Monday, 10 June

CLEO: Applications & Technology

AM4M • Symposium on Lab-on-a-Chip Applications: Lab on Chip II—Continued

AM4M.3 • 17:00
Optofluidic Electrical Manipulation of Individual Biomolecules with nm-scale Precision, Mohammad Soltani[1,2], Jun Lin[1], Summer Saraf[1], Robert Forties[1], Michal Lipson[2], Michelle Wang[1]; *[1]Physics, Cornell University, USA; [2]Electrical and Computer Engineering, Cornell University, USA.* We design and demonstrate electrically controlled optical trapping of individual microparticles and manipulation of biomolecules with nm-scale precision for high throughput applications. This has been realized by integration of photonics, fluidics, and electronics, on-chip.

AM4M.4 • 17:15 Invited
Second Generation Multiplexed Diagnostics with Silicon Photonics, Cary Gunn[1]; *[1]Genalyte, USA.* Silicon photonics ring resonators are developed and applied to medical diagnostics and pharmaceutical development. This talk addresses how these devices function and why their unique optical characteristics are bringing important change to your diagnostic future.

CLEO: Science & Innovations

CM4N • Long Distance Ranging and Frequency Transfer—Continued

CM4N.3 • 16:45
Stable Radio Frequency Delivery by Phase-Conjugation-Based Error Auto-Correction, Anxu Zhang[1], Feifei Yin[1], Yitang Dai[1], Kun Xu[1], Jianqiang Li[1], Jintong Lin[1]; *[1]State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications, China.* Without phase-locking loop or any tunable parts, stable radio frequency transfer is proposed by phase-conjugation-based, rapid and endless pre-correction at center station. Time jitter suppression ratio > 250 is demonstrated experimentally after 30-km link.

CM4N.4 • 17:00
Free-Space Optical Time-Frequency Transfer Over 2 km, William C. Swann[1], Fabrizio R. Giorgetta[1], Laura C. Sinclair[1], Esther Baumann[1], Ian Coddington[1], Nathan R. Newbury[1]; *[1]National Inst of Standards & Technology, USA.* Precision free-space time-frequency transfer could advance fields where present microwave-based transfer is inadequate. We demonstrate an optical free-space link with femtosecond timing deviation and residual instability below 10-18 at 1000 seconds.

CM4N.5 • 17:15
An Optical Fiber Interferometer as a Frequency Reference for Space-based Laser Rangefinding, Terry McRae[1], Silvie Ngo[2], Daniel Shaddock[2], Magnus Hsu[1], Malcolm Gray[1]; *[1]Physical Metrology, NMIA, Australia; [2]Centre for Grravitational Physics, The Australian National University, Australia.* We demonstrate a fiber interferometer that is a viable candidate for a laser frequency reference for future space based missions requiring a stability of 30 Hz/√Hz over a 10 mHz to 1 Hz bandwidth.

CM4N.6 • 17:30 Invited
COMPASS - Towards Centimeter Positioning & Applications, Lijun Wang[1]; *[1]Tsinghua Univ., China.* We describe the design of COMPASS and several key features that potentially enable it to reach very high precision in positioning, navigation, and time dissemination.

CM4O • Micro-sensors—Continued

CM4O.4 • 16:45
Evanescent Field Absorption Spectroscopy of Trace Gases Using Functionalized Microring Resonators, Todd H. Stievater[1], Marcel W. Pruessner[1], Doewon Park[1], William S. Rabinovich[1], R. Andrew McGill[1], Scott A. Holmstrom[2], Jacob Khurgin[3]; *[1]US Naval Research Laboratory, USA; [2]University of Tulsa, USA; [3]Johns Hopkins University, USA.* We detect trace gases at ppb levels using evanescent-field absorption spectroscopy in microring resonators coated with sorbent polymers. The overtone spectra derive from Mid-infrared resonances that provide a signature of analyte toxicity.

CM4O.5 • 17:00
Observation of Brillouin Dynamic Grating Reflection with Pump-Probe-Read Time-Division Generation Scheme, Tsuyoshi Matsumoto[1], Masato Kishi[1], Kazuo Hotate[1]; *[1]The University of Tokyo, Japan.* Brillouin dynamic grating is observed by single laser diode. Laser frequency is modulated by injection current, whose waveform is synthesized so that the pump, probe, and read frequencies are appropriately generated in a time-division way.

CM4O.6 • 17:15
Purcell Enhancement of Raman Scattering from Atmospheric Gases in a High-Finesse Microcavity, Benjamin Petrak[1], Nicholas Djeu[2], Andreas Muller[1]; *[1]Physics, University of South Florida, USA; [2]MicroMaterials, Inc., USA.* We report spontaneous emission enhancement of Raman scattering from CO2 and O2 gases in a ≈30 µm-long Fabry-Perot microcavity with a mode volume of 200 µm3 and a peak finesse of 50 000.

CM4O.7 • 17:30
Demonstration of Surface Enhanced Raman Scattering in Purely Dielectric Structures via Bloch Surface Waves, Marco Liscidini[1], Stefano Pirotta[1], Xiaoji Xu[2], Aida Delfan[3], Srinivasan Mysore[2], Sudipta Maiti[4], Giacomo Dacarro[1], Maddalena Patrini[1], Matteo Galli[1], Giorgio Guizzetti[1], Daniele Bajoni[5], John E. Sipe[3], Gilbert Walker[2]; *[1]Physics, Università degli Studi di Pavia, Italy; [2]Chemistry, University of Toronto, Canada; [3]Physics, University of Toronto, Canada; [4]Chemical Science, Tata Institute of Fundamental Research, India; [5]Ingegneria Industriale, Università degli Studi di Pavia, Italy.* We experimentally demonstrate surface-enhanced Raman scattering in fully dielectric structures supporting Bloch surface waves. These results suggest an alternative to plasmonic materials for enhancing the light-matter interaction at a surface with application in optical sensing.

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QM4A • Optics of Metasurfaces—Continued

QM4A.8 • 17:45
Dynamic Coherent Backscattering Mirror, Iosif Zeylikovich[1], Min Xu[2]; *[1]Physics & Technology, Bronx Community College,City University of New York, USA; [2]Physics Department, Fairfield University, USA.* The coherent backscatering mirror (CBM) has some remarkable properties. The dynamic CBM compensates and corrects automatically static and dynamic distortions occurring on the optical path of the incident beam with response time of few picoseconds.

QM4B • Quantum Dots, Nanocrystals, & Impurities—Continued

QM4B.8 • 17:45
Optimal Two-Qubit Quantum Control in InAs Quantum Dots, Angela Gamouras[1], Reuble Mathew[1], Sabine Freisem[2], Dennis G. Deppe[2], Kimberley Hall[1]; *[1]Dalhousie University, Canada; [2]University of Central Florida, USA.* Simultaneous control of exciton qubits in two distinguishable InAs semiconductor quantum dots with emission wavelengths near 1.3 microns is demonstrated through the development and application of general femtosecond pulse shaping

QM4C • Hybrid Plasmonics & Novel Effects—Continued

QM4C.8 • 17:45
Asymmetric Ring/Disk Nanocavities on Conducting Substrates for Strong Fano-Interference, Arif E. Cetin[1], Hatice Altug[1]; *[1]Electrical and Computer Engineering, Boston University, USA.* We introduce a Fano resonant asymmetric ring/disk cavity system employing a conducting layer underneath. Our system shows stronger local fields which are highly accessible to surrounding medium and sharper spectral features resulting in more reliable biodetection platforms.

CM4D • All Optical and Quantum Signal Processing—Continued

CM4D.7 • 17:45
Experimental Demonstration of Phase Sensitive Parametric Processes in a Nano-Engineered Silicon Waveguide, Ning Kang[1], Ahmed Fadil[1], Minhao Pu[1], Hua Ji[1], Hao Hu[1], Evarist Palushani[1], Dragana Vukovic[1], Jorge Seoane[1], Haiyan Ou[1], Karsten Rottwitt[1], Christophe Peucheret[1]; *[1]Danmarks Tekniske Universitet, Denmark.* We demonstrate experimentally phase-sensitive processes in nano-engineered silicon waveguides for the first time. Furthermore, we highlight paths towards the optimization of the phase-sensitive extinction ratio under the impact of two-photon and free-carrier absorption.

18:30–20:00 Dine and Discover Event, *Off site*

NOTES

CLEO: QELS-Fundamental Science

CLEO: Science & Innovations

QM4E • Nonlinear Imaging and Spatial and Temporal Effects—Continued

QM4E.8 • 17:45
Observation of Collapse Arrest in Pure Kerr Media Sustained by a Parametric Interaction, Alessia Pasquazi[1], Marco Peccianti[2], Matteo Clerici[1], Calogero Buscemi[1,3], Alessandro Busacca[3], Roberto Morandotti[1]; *[1]INRS-EMT, Canada; [2]Istituto dei Sistemi Complessi, Consiglio Nazionale delle Ricerche, Italy; [3]Dipartimento di Ingegneria Elettrica, Elettronica e delle Telecomunicazioni (DIEET), Università di Palermo, Italy.* We demonstrate a parametric interaction based on four wave mixing that can arrest the collapse and stabilize solitary propagation in a pure Kerr material by controlling the wavelength of the interacting beams.

CM4F • Photonic Crystals—Continued

CM4F.8 • 17:45
The Analysis of Nano-Patterned Sapphire Substrates-Induced Compressive Strain to Enhance Quantum-Confined Stark Effect of InGaN-Based Light-Emitting Diodes, Po-Hsun Chen[1], Vincent Su[1], Yao-Hong You[1], Ming-Lun Lee[1], Cheng-Ju Hsieh[1], Chieh-Hsiung Kuan[1], Hung-Ming Chen[1], Han-Bo Yang[1], Hung-Chou Lin[1], Ray-Ming Lin[2], Fu-Chuan Chu[2], Gu-Yi Su[3]; *[1]National Taiwan University, Taiwan; [2]Chang Gung University, Taiwan; [3]National Chiao Tung University, Taiwan.* This paper demonstrates that the quantum-confined stark effect of InGaN-based light-emitting diodes can be enhanced by the means of using the hexagonal nano-post patterned sapphire substrates based on the increase of the post-duty cycle.

CM4G • OTDM Technologies—Continued

CM4H • Applications of Laser Processing—Continued

CM4H.7 • 17:45
Anomalous Interaction of Longitudinal Electric Field with Hydrogenated Amorphous Silicon Films, Jingyu Zhang[1], Mindaugas Gecevičius[1], Martynas Beresna[1], Andrey G. Kazanskii[2], Peter G. Kazansky[1]; *[1]Optoelectronics Research Centre, University of Southampton, United Kingdom; [2]Physics Department, M.V. Lomonosov Moscow State University, Russian Federation.* Cylindrically polarized beams produced by femtosecond laser written S-waveplate are used to modify amorphous silicon films. Paradoxically, no crystallization is observed in the maximum of longitudinal electric field despite the strongest light intensity.

18:30–20:00 Dine and Discover Event, *Off site*

NOTES

Meeting Room 211D-B	Meeting Room 212A-C	Meeting Room 212D-B	Marriott San Jose Salon I & II
CLEO: Science & Innovations		**JOINT**	**CLEO: QELS-Fundamental Science**

CM4I • Short Wavelength Fiber Lasers and Effects—Continued

CM4I.8 • 17:45
Wavelength and Pulse Width Tunable 1 µm Yb-doped Programmable Fiber Laser, Youngjae Kim[1], Andre Archambault[1], Alexandre Dupuis[1], Bryan Burgoyne[1], Guido Pena[1], Alain Villeneuve[1]; [1]*Genia Photonics Inc., Canada.* We present a wavelength and pulse width agile programmable laser in the 1 µm region using Ytterbium-doped fiber amplifiers. Wavelengths and pulse widths are tuned independently from 1020 to 1080 nm and from 26 down to 4 ps after compression.

CM4J • Nonlinear THz Technology—Continued

CM4J.8 • 17:45
Withdrawn

JM4K • Symposium on Mid-infrared Lasers: Mid-infrared Laser Sources II—Continued

QM4L • Quantum Detectors—Continued

QM4L.8 • 17:45
A three-dimensional, polarization-insensitive superconducting nanowire avalanche photodetector, Varun Verma[1], Francesco Marsili[1], Sean D. Harrington[1], Adriana E. Lita[1], Richard P. Mirin[1], Sae Woo Nam[1]; [1]*National Inst of Standards & Technology, USA.* We measure a peak system detection efficiency (SDE) of 87.7 ± 0.5 % and a polarization dependence of less than 2 % using vertically-stacked superconducting nanowire single-photon detectors connected electrically in parallel.

18:30–20:00 Dine and Discover Event, *Off site*

NOTES

CLEO: Applications & Technology

AM4M • Symposium on Lab-on-a-Chip Applications: Lab on Chip II—Continued

AM4M.5 • 17:45
High-Q Mid-infrared Chalcogenide Glass-On-Silicon Resonators for Spectroscopic Chemical Sensing, Hongtao Lin[1], Lan Li[1], Yi Zou[1], Sylvain Danto[2], J. David Musgraves[2], Kathleen Richardson[2], Juejun Hu[1]; *[1]Department of Materials Science & Engineering, University of Delaware, USA; [2]College of Optics & Photonics, University of Central Florida, USA.* We fabricated and characterized high-index-contrast As_2Se_3 micro-disk resonators on silicon with a record loaded Q-factor of 10^5 at 5.2 μm wavelength. On-chip chemical sensing using cavity-enhanced infrared spectroscopy was demonstrated using the micro-disk device.

CLEO: Science & Innovations

CM4N • Long Distance Ranging and Frequency Transfer—Continued

CM4O • Micro-sensors—Continued

CM4O.8 • 17:45
On the Performance and Sensitivity Limit of Mass Sensing with Optomechanical Oscillation, Fenfei Liu[1], Seyedhamidreza Alaie[2], Yang Deng[1], Zayd Leseman[2], Mani Hossein-Zadeh[1]; *[1]Center for High Technology Materials, University of New Mexico, USA; [2]Mechanical Engineering, University of New Mexico, USA.* We characterize the mass sensing properties of microtoroidal optomechanical oscillator (OMO). We show a record sensitivity slope of 1300 Hz/pg and study the impact of mass distribution, mode selection and noise on mass sensitivity.

18:30–20:00 Dine and Discover Event, *Off site*

NOTES