Ballroom A1 and A8 — QELS

8:00 a.m.–9:45 a.m.
QMA • Metamaterials I
Presider to Be Announced

QMA1 • 8:00 a.m. Invited
Engineering Optical Space with Metamaterials, *Vladimir M. Shalaev[1], A. V. Kildishev[1], V. P. Drachev[1], W. Cai[1], H. K. Yuan[1], U. Chettiar[1], A. V. Boltasseva[2]; [1]Purdue Univ., USA, [2]Technical Univ. of Denmark, Denmark.* Metamaterials-enabled transformation optics allows one to *engineer* space for light, with a family of new "metadevices." By designing required distributions of material parameters on can arbitrarily "curve" optical path and control light in unprecedented way.

QMA2 • 8:30 a.m.
Metal-Dielectric Layered Nanostructures as Epsilon-Near-Zero (ENZ) Circuit Boards for Optical Nanocircuits, *Nader Engheta, Andrea Alù; Univ. of Pennsylvania, USA.* Using analytical-numerical methods, we study near-zero permittivity of stacks of thin layers of noble metals and dielectric materials as circuit boards for our concept of optical nanocircuits, and discuss nanoscale light manipulations in these nanoboards.

QMA3 • 8:45 a.m.
Contribution of Electric Quadrupole Resonance in Optical Metamaterials, *David J. Cho, Feng Wang, Xiang Zhang, Y. Ron Shen; Univ. of California at Berkeley, USA.* Contribution of electric quadrupole resonance is studied in optical metamaterials through numerical simulation. For nanostructures, its radiation is often comparable to that from magnetic dipole. Their individual contributions can be determined by angle-resolved scattering spectroscopy.

Ballroom A2 and A7 — JOINT

8:00 a.m.–9:30 a.m.
JMA • Joint CLEO/QELS Symposium on Novel Resonators: Superconducting Cavities and Qubits
Markus Aspelmeyer; Austrian Acad. of Sciences, Austria, Presider

JMA1 • 8:00 a.m. Invited
Quantum Information with Superconducting Qubits and Cavities, *Raymond W. Simmonds; NIST, USA.* We have implemented cavity quantum-electro dynamics, in the strong coupling regime, using superconducting phase qubits and a resonant transmission line cavity. We have observed coherent quantum interactions with cavity decay times over 1 microsecond.

JMA2 • 8:30 a.m. Invited
Superconducting Microwave Cavities as Quantum Nanomechanical Transducers, *Gerard J. Milburn[1], M. J. Woolley[1], A. C. Doherty[1], K. C. Schwab[2]; [1]Univ. of Queensland, Australia, [2]Cornell Univ., USA.* We show how a superconducting coplanar microwave cavity can be used as a quantum limited displacement transducer for a nanomechanical resonator by demonstrating that nanomechanical squeezing can be detected in the cavity field.

Ballroom A3 and A6 — CLEO

8:00 a.m.–9:45 a.m.
CMA • High-Power Fiber Lasers
Andy Chong; Cornell Univ., USA, Presider

CMA1 • 8:00 a.m.
Cladding-Pumped Distributed Feedback Phosphate Glass Fiber Lasers, *Li Li[1], Axel Schülzgen[1], Valery L. Temyanko[1], Christine Spiegelberg[2], Dan T. Nguyen[1,2], Xiushan Zhu[1], Jerome V. Moloney[1], Jacques Albert[3], Nasser Peyghambarian[1]; [1]College of Optical Sciences, Univ. of Arizona, USA, [2]NP Photonics Inc., USA, [3]Dept. of Electronics, Carleton Univ., Canada.* Distributed feedback (DFB) phosphate glass fiber lasers that are cladding pumped with multimode diodes have been demonstrated. Single and cascaded DFB lasers with outputs up to 160 mW and 1 W, respectively, have been achieved.

CMA2 • 8:15 a.m.
Wavelength Selection in High-Power Cladding-Pumped Er,Yb and Yb Fiber Lasers Using Volume Bragg Gratings, *Ji Won Kim[1], Pär Jelger[2], Pu Wang[1], J. K. Sahu[1], Fredrik Laurell[2], W. A. Clarkson[1]; [1]Optoelectronics Res. Ctr., Univ. of Southampton, UK, [2]Dept. of Applied Physics, Royal Inst. of Technology, Sweden.* We report high-power operation of double-clad Yb-doped and Er,Yb-doped fiber lasers at 1066 nm and 1553 nm, respectively, using volume Bragg gratings for wavelength selection. Both lasers yielded output powers over 100 W limited by available pump power.

CMA3 • 8:30 a.m.
Suppression of Self-Pulsations in Dual-Clad, Ytterbium-Doped Fiber Lasers, *Weihua Guan, John R. Marciante; Inst. of Optics and Lab for Laser Energetics, Univ. of Rochester, USA.* Regimes of self-pulsing in fiber lasers have been characterized. Experiments show that the addition of a long section of passive fiber in the laser cavity can stabilize the laser and largely suppress the self-pulsations.

CMA4 • 8:45 a.m.
Spatial-Dispersion-Free Spectral Beam Combining of High-Power Pulsed Yb-Doped Fiber Lasers, *Kestutis Regelskis[1,2], Kai-Chung Hou[1], Gediminas Raciukaitis[2], Almantas Galvanauskas[1]; [1]Univ. of Michigan, USA, [2]Inst. of Physics, Lithuania.* Pulsed fiber laser spectral beam combining is demonstrated using spatial-dispersion-free approach based on 1 nm-sharp spectral-edge filters. Three beams separated spectrally by ~2 nm are combined with >90% efficiency yielding 52-W combined power and 1.9-mJ combined energy.

Ballroom A4 and A5 — CLEO

8:00 a.m.–9:45 a.m.
CMB • Large Mode Area Fibers
Liang Dong; IMRA America Inc., USA, Presider

CMB1 • 8:00 a.m. Invited
Effectively Single-Mode Large Core Passive and Active Fibers with Chirally Coupled-Core Structures, *Almantas Galvanauskas, M. Craig Swan, Chi-Hung Liu; Univ. of Michigan, USA.* Chirally coupled-core fibers with core sizes well exceeding those of conventional LMA provide robust single-mode output irrespective of mode excitation and fiber coiling, are spliceable and can preserve mode-area in tight bends and reduce nonlinear effects.

CMB2 • 8:30 a.m.
Single-Polarization Large-Mode-Area Yb-Doped Photonic Crystal Fiber, *Oliver Schmidt[1], Jan Rothhardt[1], Tino Eidam[1], Fabian Röser[1], Jens Limpert[1], Andreas Tünnermann[1], Kim P. Hansen[2], C. Jakobsen[2], Jes Broeng[2]; [1]Inst. of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany, [2]Crystal Fibre A/S, Denmark.* We report on an ytterbium-doped, single-polarization, single-mode large-mode-area rod-type PCF. The active core possesses a diameter of 70 μm and a single-polarization window ranging from 1030-1090 nm. In a laser experiment 163 W of output power are obtained.

CMB3 • 8:45 a.m.
Single-Mode Laser Emission from a Multimode Core Surrounded by a Tailored Cladding, *Laure Lavoute[1], Philippe Roy[1], Sébastien Février[1], Raphaël Jamier[1], Kay Schüster[2], Jens Kobelke[2], Stephan Grimm[2]; [1]XLIM, Unité Mixte de Recherche, Ctr. Natl. de la Recherche Scientifique, Univ. de Limoges, France, [2]IPHT, Inst. of Photonic Technology, Germany.* We report the transversally-single-mode laser emission from a large ytterbium-doped core exhibiting a normalized frequency of 7.25. Strong interaction between the core and an array of high refractive index rods leads to single-mode emission.

8:00 a.m.–9:45 a.m.
QMB • Foundations of Quantum Mechanics
John Howell; Univ. of Rochester, USA, Presider

QMB1 • 8:00 a.m.
Experimental Demonstration of Macroscopic Quantum Coherence in Gaussian States, *Christoph Marquardt[1], Ulrik L. Andersen[1,2], Gerd Leuchs[1], Yuishi Takeno[3], Mitsuyoshi Yukawa[3], Hidehiro Yonezawa[3], Akira Furusawa[3]; [1]Inst. of Optics, Information and Photonics, Germany, [2]Dept. of Physics, Technical Univ. of Denmark, Denmark, [3]Dept. of Applied Physics, Univ. of Tokyo, Japan.* We experimentally proved the existence of macroscopic coherences in Gaussian quantum states using a criterion by Cavalcanti and Reid. We show coherences with remarkable distances in phase space for squeezed, entangled and even coherent states.

QMB2 • 8:15 a.m.
The CHSH-Bell Inequality and Tsirelson's Bound with Postselection, *Dominic W. Berry[1], Hyunseok Jeong[2], Magdalena Stobińska[3], Timothy C. Ralph[2]; [1]Ctr. for Quantum Computer Technology, Macquarie Univ., Australia, [2]Ctr. for Quantum Computer Technology, Dept. of Physics, Univ. of Queensland, Australia, [3]Inst. Fizyki Teoretycznej, Poland.* We show the necessary and sufficient conditions on loss for valid CHSH-Bell experiments, and propose an experiment with loss which should violate Tsirelson's bound for entangled states.

QMB3 • 8:30 a.m. Tutorial
Entanglement, Decoherence and Quantum Information, *Luiz Davidovich; Univ. Federal do Rio de Janeiro, Brazil.* Multiphoton entangled states are important for quantum cryptography, quantum computation, precise measurements and subtle tests of quantum mechanics. I will review recent progress in this area, emphasizing some basic applications and the role of decoherence.

Luiz Davidovich got his Ph.D. at the University of Rochester, NY, USA, in 1976. He is a member of the Brazilian Academy of Sciences, the Academy of Sciences for the Developing World and foreign associate of the National Academy of Sciences (USA). He works on quantum optics and quantum information.

8:00 a.m.–9:45 a.m.
CMC • Precision Optical Metrology
Erich Ippen; MIT, USA, Presider

CMC1 • 8:00 a.m. Tutorial
Metrology with Cold Atoms, *Mark Kasevich; Stanford Univ., USA.* Abstract, biography and photo not available.

8:00 a.m.–9:45 a.m.
CMD • THz Near-Field Optics and Plasmonics
John F. O'Hara; Los Alamos Natl. Lab, USA, Presider

CMD1 • 8:00 a.m.
Spectral Effects in Terahertz Apertureless Near-Field Microscopy, *Victoria Astley, Hui Zhan, Daniel M. Mittleman; Rice Univ., USA.* We observe dramatic changes in the spectrum of radiation scattered from a near-field tip with decreasing tip-sample distance. This arises from a balance between direct tip scattering and signals associated with the near-field image dipole.

CMD2 • 8:15 a.m.
Terahertz Transmission through Rectangular Apertures: Far- and Near-Field Studies, *D. S. Kim[1], J. W. Lee[1], M. A. Seo[1], A. J. L. Adam[2], D. H. Kang[1], J. H. Kang[3], Q. H. Park[3], P. C. M. Planken[2]; [1]Seoul Natl. Univ., Republic of Korea, [2]Univ. of Technology Delft, Netherlands, [3]Korea Univ., Republic of Korea.* We report that the terahertz transparency occurs at the fundamental shape resonance of the rectangular holes regardless of the areal coverage. The funneling of energy at the fundamental resonance is also confirmed at the near-field.

CMD3 • 8:30 a.m.
Sub-Wavelength Measurements of the Near-Field of a Metal Aperture, *Aurele Adam[1], Min Ah Seo[2], Kwang Jun Ahn[2], Dai Sik Kim[2], Ji Hun Kang[3], Q-Han Park[3], Michael Nagel[4], Paul Planken[1,5]; [1]Univ. of Technology Delft, Netherlands, [2]Seoul Natl. Univ., Republic of Korea, [3]Korea Univ., Republic of Korea, [4]RWTH Aachen Univ., Germany, [5]FOM -Inst. for Plasma Physics, Netherlands.* We present results on THz near-field measurements of sub-wavelength apertures in metal films. Our results allow us to test, with unprecedented detail, the near-field predictions made by the well-known Bethe-Bouwkamp model.

CMD4 • 8:45 a.m.
Enhanced Transmission through Subwavelength Aperture Arrays with Short-Range Order, *Amit K. Agrawal[1], Tatsunosuke Matsui[2], Valy Vardeny[3], Ajay Nahata[1]; [1]Dept. of Electrical and Computer Engineering, Univ. of Utah, USA, [2]Dept. of Electrical and Electronic Engineering, Mie Univ., Japan, [3]Physics Dept., Univ. of Utah, USA.* We measure the THz transmission properties of subwavelength aperture arrays that possess short-range order (SRO), but lack long-range order (LRO). We demonstrate that transmission enhancement still occur through these structures despite the absence of LRO.

8:00 a.m.–9:45 a.m.
QMC • Nonlinear Optics and Resonators
Charles C. Harb; Univ. of New South Wales, Australia, Presider

QMC1 • 8:00 a.m. Invited
Broadband Cascaded Four-Wave Mixing in High-Q Silica Microspheres, *Imad H. Agha, Yoshitomo Okawachi, Alexander L. Gaeta; School of Applied and Engineering Physics, Cornell Univ., USA.* We demonstrate broadband, continuous-wave cascaded four-wave mixing parametric oscillation in the anomalous dispersion regime of a high-Q silica microsphere with an overall bandwidth greater than 100 nm and spectral features smaller than 10 MHz.

QMC2 • 8:30 a.m.
Surface Nonlinear Light Generation in the Whispering Gallery Modes of Spherical Microresonators, *Jorge Luis Dominguez-Juarez[1], Gregory Kozyreff[1,2], Jordi Martorell[1,3]; [1]Inst. de Ciencies Fotoniques, Spain, [2]Univ. Politecnica de Catalunya, Spain, [3]Univ. Libre de Bruxelles, Belgium.* We measured second harmonic generation in the whispering gallery modes of a microspherical cavity from a monolayer of nonlinear molecules on the sphere surface. Such monolayer is placed with the appropriate configuration for phase matching.

QMC3 • 8:45 a.m.
Transverse Patterns for All-Optical Switching, *Andrew M. C. Dawes, Daniel J. Gauthier; Duke Univ., USA.* Transverse optical patterns, generated by nonlinear interactions, rotate in the presence of a weak switch beam. Using an experimental system with increased symmetry, we observe that the switch can be actuated by ~2100 photons.

CLEO

8:00 a.m.–9:45 a.m. CME • Semiconductor Communication Devices

Jesper Mørk; Danmarks Tekniske Univ., Denmark, Presider

CME1 • 8:00 a.m.
Bandwidth Enhancement with Tunable Optical Equalizer for High-Speed Intensity Modulation, *Koichi Hasebe[1], Xiaoxue Zhao[2], Takahiro Sakaguchi[1], Fumio Koyama[1], Connie J. Chang-Hasnain[2], Nobuhiko Nishiyama[1], Catherine Caneau[3], Chung-En Zah[3]; [1]Tokyo Inst. of Technology, Japan, [2]Univ. of California at Berkeley, USA, [3]Corning Inc., USA.* We demonstrate bandwidth enhancement of external- and direct-modulated lasers using a tunable optical equalizer. Modulation bandwidth of >50 GHz for $LiNbO_3$ modulators was obtained. The equalizer permits the increased-speed and chirp-reduction simultaneously for direct-modulated VCSELs.

CME2 • 8:15 a.m.
Power and Modulation Response of Wavelength-Locked Lasers for WDM-PON Applications, *Tauhid R. Zaman, Rajeev J. Ram; MIT, USA.* The optical spectrum and modulation response of wavelength-locked lasers are analyzed. The model is verified against WDM-PON system data. A maximum data rate resulting from a trade-off of chromatic dispersion and modulation damping is predicted.

CME3 • 8:30 a.m.
Return-to-Zero Technique for Eliminating Wavelength Abnormalities in High-Power DBR Lasers, *Martin Hu, Daniel Rickets, David Loeber, Jacques Gollier, Vikram Bhatia, Dragan Pikula; Corning Inc., USA.* The characteristics of the longitudinal mode hops of 1060-nm high-power DBR lasers are studied. We demonstrate a return-to-zero technique for eliminating large mode hops and wavelength hysteresis caused by the photon-induced gain saturation effect.

CME4 • 8:45 a.m.
Analysis of an Effective Optical Filtering Technique to Enhance Microwave Phase Shifts Based on Slow and Fast Light Effects, *Yaohui Chen, Filip Öhman, Weiqi Xue, Jesper Mørk; Dept. of Communications, Optics and Materials, Technical Univ. of Denmark, Denmark.* We theoretically analyze and interpret an effective mechanism, which employs optical filtering to enhance the microwave phase shift that can be achieved in semiconductor optical amplifiers based on slow and fast light effects.

8:00 a.m.–9:45 a.m. CMF • Fundamentals of Femtosecond Laser/Material

Donald Harter; IMRA America Inc., USA, Presider

CMF1 • 8:00 a.m. Invited
Coherent Phonon Excitation and Manipulation in Bismuth Using Temporally Shaped Ultrafast Pulses, *Alexander Q. Wu, Xianfan Xu, Andrew M. Weiner; Purdue Univ., USA.* This presentation discusses generation of coherent phonons during ultrafast laser interaction with materials and its effect on materials removal. Ultrafast pulse shaping is used to produce THz pulse trains to enhance phonon generation.

CMF2 • 8:30 a.m.
Non-Reciprocal Femtosecond Laser Micromachining, *Peter G. Kazansky[1], Weijia Yang[1], Yuri Svirko[2]; [1]Optoelectronics Res. Ctr., Univ. of Southampton, UK, [2]Univ. of Joensuu, Finland.* We demonstrate both experimentally and theoretically that in a non-centrosymmetric crystal modification of the material can be different when femtosecond laser beam propagates in opposite directions. Our result presents the first evidence of non-reciprocal photosensitivity.

CMF3 • 8:45 a.m.
Plasma Properties during the Formation of "Nanograting" Structures inside Fused Silica, *Arnaud Royon[1,2], Lionel Canioni[1], Thierry Cardinal[3], Martin Richardson[2]; [1]CPMOH-CNRS Univ. Bordeaux [1], France, [2]College of Optics and Photonics, CREOL, USA, [3]ICMCB-CNRS Univ. Bordeaux 1, France.* The influence of accumulation effects on the creation of "nanograting" structures has been investigated. Furthermore, the plasma electron density has been measured with a spectral interferometry pump-probe technique.

8:00 a.m.–9:45 a.m. CMG • Optical Signal Processing

Matthew E. Grein; MIT Lincoln Lab, USA, Presider

CMG1 • 8:00 a.m.
Time Lens for Ultrafast Measurements Based on Four-Wave Mixing in Silicon, *Reza Salem, Mark A. Foster, David F. Geraghty, Alexander L. Gaeta, Amy C. Turner, Michal Lipson; Cornell Univ., USA.* We demonstrate a novel time lens based on four-wave mixing in a silicon nanowaveguide. The lens is used for 20× temporal magnification of a signal with 3-ps features, which permits measurement by a 20-GHz detector.

CMG2 • 8:15 a.m.
A Novel Optical Correlator and Its Application to Packet-Header Recognition, *David F. Geraghty, Reza Salem, Mark A. Foster, Alexander L. Gaeta; Cornell Univ., USA.* We propose a novel, fiber-based correlator for processing temporal optical signals. We demonstrate its operation by performing all-optical packet-header recognition at 100 Gb/s.

CMG3 • 8:30 a.m. Invited
Optical Signal Processing Using InP-Based Quantum-Dot Semiconductor Mode-Locked Lasers, *Guang-Hua Duan; Alcatel Thales III-V Lab, France.* This paper summarizes recent advances on optical processing using InAs/InP quantum dot semiconductor mode-locked lasers. In particular, all-optical clock recovery at 40 and 160 Gbit/s with low time jitter will be demonstrated using these lasers.

8:00 a.m.–9:45 a.m. CMH • Hyperspectral and Diode-Laser Absorption Spectroscopy

Douglas J. Bamford; Physical Sciences Inc., USA, Presider

CMH1 • 8:00 a.m.
Continuously Tunable Compact Single-Mode Quantum Cascade Laser Source for Chemical Sensing, *Benjamin G. Lee[1], Mikhail A. Belkin[1], Jim MacArthur[1], Ross M. Audet[1], Laurent Diehl[1], Christian Pflugl[1], Federico Capasso[1], David Bour[2], Scott Corzine[2], Gloria Hofler[2]; [1]Harvard Univ., USA, [2]Agilent Labs, USA.* We demonstrate a compact, single-mode quantum cascade laser source continuously tunable over 8% of its center wavelength of 9 μm. We integrate the source into a compact mid-infrared spectrometer for absorption spectroscopy of liquids and gases.

CMH2 • 8:15 a.m.
Fast Hyperspectral Imaging Using a Mid-Infrared Tunable External Cavity Quantum Cascade Laser, *Mark C. Phillips, Nicolas Ho; Pacific Northwest Natl. Lab, USA.* A hyperspectral imaging system using an external cavity quantum cascade laser and a focal plane array acquiring images at 25 Hz from 985 cm^{-1} to 1075 cm^{-1} with a resolution of 0.3 cm^{-1} is demonstrated.

CMH3 • 8:30 a.m. Invited
Frequency Combs and Hyperspectral Sources for Absorption Spectroscopy, *Scott Sanders; Univ. of Wisconsin, USA.* We continue to develop laser sources for high-speed gas absorption spectroscopy. A recent source cycles through 14 wavelengths in the 1325-1666 nm range every 33 μs for combined measurements of gas temperature, H_2O, and CH_4.

8:00 a.m.–9:45 a.m.
CMI • Gallium Nitride Lasers

Stephane Calvez; Inst. of Photonics, Univ. of Strathclyde, UK, Presider

CMI1 • 8:00 a.m.
The Lasing Action of GaN-Based Two-Dimensional Surface-Emitting Photonic Crystal Lasers, *Tien-Chang Lu, Tsung-Ting Kao, Shih-Wei Chen, Chih-Chiang Kao, Li-Fan Lin, Tzu-Wei Liu, Hao-Chung Kuo, Shing-Chung Wang; Dept. of Photonics and Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan.* We report fabrication of GaN-based two-dimensional surface-emitting photonic-crystal lasers and successful demonstration of lasing action at room temperature with the emission wavelength at 424.3 nm and low threshold pumping energy density of 3.5 mJ/cm^2.

CMI2 • 8:15 a.m.
Self-Consistent Optical Gain Analysis and Epitaxy of Strain-Compensated InGaN-AlGaN Quantum Wells for Laser Applications, *Hongping Zhao, Ronald A. Arif, G. S. Huang, Yik-Khoon Ee, Nelson Tansu; Lehigh Univ., USA.* Self-consistent optical gain analysis of strain-compensated InGaN-AlGaN quantum wells (QWs) using 6-band *k·p* formalism shows 28% improvement, which is suitable for laser active regions. MOCVD-grown strain-compensated InGaN QW exhibited 62.7% improvement in integrated luminescence intensity.

CMI3 • 8:30 a.m. Invited
GaN Photonic-Crystal Surface-Emitting Laser Operating at Blue-Violet Wavelengths, *Susumu Yoshimoto, Hideki Matsubara, Hirohisa Saito, Yue Jianglin, Yoshinori Tanaka, Susumu Noda; Kyoto Univ., Japan.* We report on a first successful operation of current-driven GaN photonic-crystal surface-emitting laser, which can operate in blue-violet wavelength regions at room temperature.

NOTES

QELS

QMA • Metamaterials I—Continued

QMA4 • 9:00 a.m.
3-D-Chiral Metamaterial with Artificial Magnetic Response, *Eric Plum[1], Jianfeng Dong[2,3], Jiangfeng Zhou[3], Vassili A. Fedotov[1], Thomas Koschny[3,4], Costas Soukoulis[3,4], Nikolay I. Zheludev[1]; [1]Univ. of Southampton, UK, [2]Ningbo Univ., China, [3]Iowa State Univ., USA, [4]Univ. of Crete, Greece.* Artificial magnetism, negative permeability and zero refractive index are demonstrated in 3-D-chiral metamaterial that shows giant polarization rotation and circular dichroism.

QMA5 • 9:15 a.m.
Dispersionless Three-Dimensional Metamaterial with a Very High Refractive Index, *Jonghwa Shin, Jung-Tsung Shen, Shanhui Fan; Stanford Univ., USA.* We present metamaterials that can possess arbitrarily high refractive indices over very broad frequency range. Nearly independent control of permittivity and permeability can be achieved by geometrical designs, without using dispersive, resonant elements.

QMA6 • 9:30 a.m.
"Effective Index Method": Is It Valid for Nano-Circuitry Based on Plasmonic Gaps? *Eyal Feigenbaum, Gal Afriat, Gal Bitan, Meir Orenstein; Technion, Israel.* The effective index concept validity is studied for plasmonic gap nano-circuitry: waveguides, resonators and self-guiding. Contrary to unique and adverse characteristics of plasmonic modes in nano-devices, the EI analysis fairly agrees with the simulation results.

JOINT

JMA • Joint CLEO/QELS Symposium on Novel Resonators: Superconducting Cavities and Qubits—Continued

JMA3 • 9:00 a.m. Invited
Coupling a Nanomechanical Resonator to a Cooper-Pair-Box Qubit, *Matthew LaHaye[1], Junho Suh[1], Pierre Echternach[2], Keith Schwab[3], Michael Roukes[1]; [1]Kavli Nanoscience Inst., Caltech, USA, [2]Ctr. for Space Microelectronics Technology, JPL, USA, [3]Dept. of Physics, Cornell Univ., USA.* We demonstrate dispersive coupling between a Cooper-pair box (CPB) qubit and a VHF NEMS (nanoelectromechanical systems) resonator. The observed interaction strength is sufficient to pursue more advanced experiments to elicit quantum behavior in NEMS.

CLEO

CMA • High-Power Fiber Lasers—Continued

CMA5 • 9:00 a.m.
All-Fiber 32x1 Pump Combiner with High Isolation for High-Power Fiber Laser, *Mathieu Faucher, Benoit Sevigny, Roger Perreault, Alexandre Wetter, Nigel Holehouse; ITF Labs, Canada.* We present an all-fiber* pump combiner with 32 ports. This device is designed to provide high isolation providing intrinsic pump protection. We demonstrated that over 200 W of pump power can be delivered in 20/400-um fiber.

CMA6 • 9:15 a.m.
Watt-Level Fluoride Fiber Laser at 1480 nm, *Martin Bernier, Guillaume Androz, Dominic Faucher, Réal Vallée; Ctr. d'Optique, Photonique et Lasers, Univ. Laval, Canada.* We report an advance in the power scaling of fluoride fiber lasers using FBGs. Watt-level output power at 1480 nm is demonstrated, which is four-fold greater than the best result obtained with external bulk mirrors.

CMA7 • 9:30 a.m.
Preparation, Joining and Packaging Concepts for High-Power Fiber Lasers, *Tina Eschrich, Christian Wirth, Steffen Böhme, Thomas Schreiber, Ramona Eberhardt, Andreas Tünnermann; Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* We report on preparation, joining and packaging of photonic crystal fibers for high-power applications. Fusion splices of air-clad fibers with losses down to 0.03 dB and a transmitted pump power of 3.2 kW are obtained.

CMB • Large Mode Area Fibers—Continued

CMB4 • 9:00 a.m.
Characterization of Higher-Order-Mode Content in Large-Mode-Area Fibers, *Jeffrey W. Nicholson, Andrew D. Yablon, Siddharth Ramachandran; OFS Labs, USA.* Higher-order modes propagating in large-mode-area fibers are characterized using spatially-resolved modal interference. The measurements provide the fraction of power contained in multiple higher-order-modes, and allow for mode identification without prior knowledge of the fiber characteristics.

CMB5 • 9:15 a.m.
Novel Approach for Polarization-Sensitive Mode Measurement and Its Application in Few-Mode Fiber Amplifier Systems, *Niklas Andermahr[1], Thomas Theeg[1], Carsten Fallnich[2]; [1]Physikalisch-Technische Bundesanstalt, Germany, [2]Inst. für Angewandte Physik, Germany.* We present a novel approach for polarization-sensitive measurement of higher-order fiber modes and use it to analyze mode behavior in a few-mode fiber amplifier, where we show that modes prefer to have orthogonal polarization states.

CMB6 • 9:30 a.m.
Pre-Compensated Resonant Higher-Order Mode Suppression in Coiled Large Mode Area Amplifier Fibers, *John M. Fini; OFS Labs, USA.* An improved strategy for resonant suppression of higher-order modes is presented. HOM suppressing structures in the cladding are pre-compensated for the bend-induced shift of coupling resonances. Simulations confirm that excellent HOM suppression is achieved.

9:45 a.m.–10:15 a.m., Coffee Break, *Concourse Level*

QMB • Foundations of Quantum Mechanics—Continued

QMB4 • 9:30 a.m.
Observation of the Entanglement Sudden Death, *Marcelo P. Almeida, Fernando de Melo, Malena Hor-Meyll, Alejo Salles, Stephen P. Walborn, Paulo H. Souto-Ribeiro, Luiz Davidovich; Univ. Federal do Rio de Janeiro, Brazil.* We demonstrate, using an all-optical setup, the difference between local and global dynamics of entangled quantum systems coupled to independent environments. Even when the decay of each system is asymptotic, quantum entanglement may suddenly disappear.

CMC • Precision Optical Metrology—Continued

CMC2 • 9:00 a.m.
Fibered Laser System for Atom Interferometers Based on Telecom Technology at 1560 nm and Frequency Doubling, *Olivier Carraz, Fabien Lienhart, Nassim Zahzam, Yannick Bidel, Alexandre Bresson; Office Natl. d'Etudes et de Recherches Aérospatiales, France.* We propose a compact and reliable laser system for onboard atom interferometers using Rubidium. Our system is based on the frequency doubling of a telecom fiber bench at 1560 nm.

CMC3 • 9:15 a.m.
Radiation Pressure Force Measurement at the Thermal Noise Limit, *Felix Mueller, Simon Heugel, Lijun Wang; Max-Planck Res. Group, Inst. of Optics, Information and Photonics, Univ. of Erlangen-Nuremberg, Germany.* We report radiation force measurements to a precision of 100 femto-Newton using a high Q torsion balance oscillator. The optomechanically coupled oscillator can be cooled down to a temperature of 300 milli-Kelvin.

CMC4 • 9:30 a.m.
Floating Micro-Structured Force Probe for 3-D Imaging and Force Microscopy on the Nanometre Scale, *Michael Towrie[1], Stanley W. Botchway[1], Andrew T. Clark[2], Edward J. Freeman[2], Robert N. J. Halsall[2], Derek W. K. Jenkins[2], Ian M. Loader[2], Peter O'Neill[3], Anthony W. Parker[1], Mark L. Prydderch[2], Robert Stevens[2], Renato Turchetta[2], Andrew D. Ward[1], Mark Pollard[1]; [1]Central Laser Facility, Photon Science Dept., Science and Technology Facilities Council, Rutherford Appleton Lab, UK, [2]Technology Dept., Science and Technology Facilities Council, Rutherford Appleton Lab, UK, [3]Radiation and Genome Stability Unit, Medical Res. Council, UK.* A nanometre scale, picoNewton force probe based on advanced optical tweezers control of transparent microstructures will be presented. The probe will be applied to dynamic bio-molecular interactions in solution.

CMD • THz Near-Field Optics and Plasmonics—Continued

CMD5 • 9:00 a.m.
Metal-Dielectric Cavities for Subwavelength Light Confinement in the THz Regions, *Yanko P. Todorov[1,2], Jean Teissier[1], Isabelle Sagnes[2], Carlo Sirtori[1]; [1]Lab de Materiax et Phenomenes Quantique, Univ. Paris 7, France, [2]Lab de Photonique et Nanostructures CNRS, France.* Experimental study of new type of plasmonic cavities is reported. We demonstrate the excitation of localised modes, with very high light confinement. The cavities are suitable for devices operating in the strong light-matter coupling regime.

CMD6 • 9:15 a.m.
Electronically Switchable Extraordinary Terahertz Transmission through Metallic Hole Arrays Fabricated on a Semiconductor Substrate, *Hou-Tong Chen[1], Hong Lu[2], Abul K. Azad[1], John F. O'Hara[1], Arthur C. Gossard[2], Richard D. Averitt[3], Antoinette J. Taylor[1]; [1]Los Alamos Natl. Lab, USA, [2]Univ. of California at Santa Barbara, USA, [3]Boston Univ., USA.* We demonstrated electronically switchable extraordinary terahertz transmission through sub-wavelength metallic hole arrays fabricated on doped semiconductor substrates. A reverse voltage bias results in a controllable depletion, thus tuning the substrate loss and switching the transmission.

CMD7 • 9:30 a.m.
Measurement of the Gouy Phase Shift for Surface Plasmon Polaritons, *Wenqi Zhu, Amit K. Agrawal, Ajay Nahata; Dept. of Electrical and Computer Engineering, Univ. of Utah, USA.* We measure the Gouy phase-shift of converging surface-plasmons as they evolve through the focus using terahertz time-domain spectroscopy. We perform numerical simulations to determine the surface field distribution and associate it with the Gouy phase-shift.

QMC • Nonlinear Optics and Resonators—Continued

QMC4 • 9:00 a.m.
Instability-Induced All-Optical Switching in Planar Semiconductor Microcavities, *Stefan Schumacher[1], Nai H. Kwong[1], Rolf Binder[1], Arthur L. Smirl[2]; [1]College of Optical Sciences, Univ. of Arizona, USA, [2]Lab for Photonics and Quantum Electronics, Univ. of Iowa, USA.* Using a microscopic theory, we predict all-optical switching in semiconductor microcavities where a weak beam switches a stronger signal. The scheme is similar to that recently demonstrated in atomic vapors [Dawes et al., Science 308,672(2005)].

QMC5 • 9:15 a.m.
Orbital Angular Momentum Hall Effect via Multiple Filamentation in Nonlinear Kerr Media, *Luat T. Vuong, Alexander L. Gaeta; School of Applied and Engineering Physics, Cornell Univ., USA.* We demonstrate that the orbital angular momentum Hall effect occurs during multiple filamentation in Kerr media. Counter-rotating instabilities accumulate different phases and result in the spatial separation of copropagating orthogonal-polarization optical vortices of different helicity.

QMC6 • 9:30 a.m.
Demonstration of Two-Pump Photorefractive Gain in a $BaTiO_3$ Crystal for Realizing a Whitelight Cavity, *Gour S. Pati, M. Salit, M. S. Shahriar; Northwestern Univ., USA.* We demonstrated double-peaked gain in a $BaTiO_3$ crystal using two non-degenerate pump beams. This shows that the negative dispersion necessary for a whitelight cavity for gravitational wave detection can be produced with photorefractive crystals.

9:45 a.m.–10:15 a.m., Coffee Break, *Concourse Level*

CME • Semiconductor Communication Devices—Continued

CME5 • 9:00 a.m.
All-Optical Flip-Flop Operation Using 1.55-µm Polarization Bistable VCSELs, *Takeo Katayama[1,2], Toshiyuki Kitazawa[1], Hitoshi Kawaguchi[1,2]; [1]Nara Inst. of Science and Technology, Japan, [2]CREST, Japan Science and Technology Agency, Japan.* We investigated detuning and repetition-frequency dependencies of minimum polarization switching optical power for all-optical flip-flop operation using 1.55-µm polarization bistable VCSELs. We demonstrated it up to 3.1-GHz switching frequency by 10-fJ optical pulses.

CME6 • 9:15 a.m.
Uncooled 2x2 Quantum Dot Semiconductor Optical Amplifier-Based Switch, *Eng Tin Aw[1], Haibo Wang[1], Mark Thompson[1], Adrian Wonfor[1], Richard Penty[1], Ian H. White[1], A. R. Kovsh[2]; [1]Cambridge Univ., Electrical Div., UK, [2]Innolume GmbH, Germany.* This paper highlights the potential of an integrated 2x2 quantum dot switch for uncooled switching applications. High gain of 11.6 dB and <0.6 dB power penalty over 11 dB dynamic range is demonstrated at temperatures up to 70°C.

CME7 • 9:30 a.m.
The Higher Mode Lasing Scheme of 1.56-µm Si-InGaAsP Hybrid Laser Diode, *Young Ahn Leem, Kisoo Kim, Jung Ho Song, O-Kyun Kwon, Gyungock Kim; Electronics and Telecommunications Res. Inst., Republic of Korea.* A hybrid laser diode consisted of Si slab waveguide and III-V ridge waveguide has been investigated. This structure is efficient for enhancing the confinement factors in the silicon region and the III-V active region simultaneously.

CMF • Fundamentals of Femtosecond Laser/Material—Continued

CMF4 • 9:00 a.m.
Ultrashort-Pulse Laser Calligraphy, *Weijia Yang[1], Peter G. Kazansky[1], Yasuhiko Shimotsuma[2], Kazuyuki Hirao[2]; [1]Optoelectronics Res. Ctr., Univ. of Southampton, UK, [2]Kyoto Univ., Japan.* Control of structural modifications inside silica glass by varying the direction of pulse front tilt is demonstrated, achieving a calligraphic style of writing. Anisotropic cavitation is observed in the vicinity of the irradiated region.

CMF5 • 9:15 a.m.
Material Dynamics from Laser Pulse Filamentation to Permanent Structural Modifications in Fused Silica, *Dimitris Papazoglou[1,2], Stelios Tzortzakis[1]; [1]Inst. of Electronic Structure and Laser, Foundation of Res. and Technology, Greece, [2]Univ. of Crete, Greece.* Using pump-probe imaging techniques we monitor the formation of plasma strings, the subsequent emergence of transient electronic defects, and their transformation to permanent refractive index modifications in fused silica following sub-picosecond ultraviolet laser pulse filamentation.

CMF6 • 9:30 a.m.
High-Speed Observation of Ultrafast Machining Dynamics, *Paul J. L. Webster, James M. Fraser; Queen's Univ. at Kingston, Canada.* We demonstrate simultaneous drilling and coaxial depth imaging of holes in stainless steel at axial rates of 46 kHz. Depth measurement with 6-µm resolution is performed using the machining beam via Fourier-domain interferometry.

CMG • Optical Signal Processing—Continued

CMG4 • 9:00 a.m.
Terabit Capacity Passive Polymer Optical Backplane, *Joseph Beals IV[1], Nikolaos Bamiedakis[1], Adrian Wonfor[1], Richard V. Penty[1], Ian H. White[1], Jon V. DeGroot Jr.[2], Terry V. Clapp[2], Madeleine Glick[3]; [1]Univ. of Cambridge, UK, [2]Dow Corning Corp., USA, [3]Intel Res., USA.* A novel, low-loss, low-crosstalk optical backplane with scalable architecture using a planar array of multimode polymer waveguides is presented. Passive strict non-blocking interconnection of 10-cards is enabled via 100 waveguides each capable of 10 Gb/s operation.

CMG5 • 9:15 a.m.
Widely Tunable Mirror Based on 3-D Hollow Waveguide for Tunable Photonic Integrated Circuits, *Mukesh Kumar, Takahiro Sakaguchi, Fumio Koyama; Microsystem Res. Ctr., Tokyo Institue of Technology, Japan.* A 3-D hollow-waveguide based tunable-mirror is proposed to realize widely tunable and temperature insensitive photonic devices. The giant tuning in wavelength of 150 nm is reported, exhibiting much larger tuning efficiency than that of slab hollow-waveguide-mirrors.

CMG6 • 9:30 a.m.
Adaptive Spectral Selection of a Super Continuum Source Using Optical MEMS for Biomedical Diagnosis, *David Bouyge, Christelle Lesvignes-Buy, Vincent Couderc, Aurelian Crunteanu, Philippe Leproux, Laurent Lefort, Pierre Blondy; XLIM, Ctr. Natl. de la Recherche Scientifique, Univ. of Limoges, France.* We present an innovative approach for digital selection of precise spectral regions from a super-continuum beam using an array of electrostatically-actuated micro-mirrors. The device allows spectral and temporal encoding of selected spectral bands.

CMH • Hyperspectral and Diode-Laser Absorption Spectroscopy—Continued

CMH4 • 9:00 a.m.
High-Bandwidth H_2O Absorption Spectroscopy in a Flame Using a Dispersed Supercontinuum Source, *Rosalynne S. Watt, Clemens F. Kaminski, Johan Hult; Univ. of Cambridge, UK.* A dispersed near-IR supercontinuum source has been developed, which is capable of acquiring 120 nm wide line-of-sight absorption spectra of H_2O, in combustion gases, at 5 kHz repetition rate.

CMH5 • 9:15 a.m.
Ultra-Sensitive Detection of Nitric Oxide at 5.33 µm Using an External Cavity QCL-Based Faraday Rotation Spectroscopic Sensor Platform, *Rafal Lewicki, Gerard Wysocki, Jim Doty, Robert F. Curl Jr., Frank K. Tittel; Rice Quantum Inst., Rice Univ., USA.* Magnetic rotation spectroscopy of nitric oxide at most favorable Q(3/2) transition at 1875.8 cm^{-1} is reported. Detection limit (1σ) at 5 ppb level was obtained for ~44 cm long active optical path with 1s lock-in time constant.

CMH6 • 9:30 a.m.
Nitrous Oxide Isotope Ratio Determination by Mid-Infrared Laser Spectroscopy, *Helen Waechter, Markus W. Sigrist; ETH Zurich, Switzerland.* A fiber-coupled difference frequency generation laser spectrometer for measuring isotopic compositions of N_2O at trace concentrations is presented. Using wavelength modulation 9‰ precision at 100 ppm is achieved. The accuracy is demonstrated with enriched samples.

9:45 a.m.–10:15 a.m., Coffee Break, *Concourse Level*

CMI • Gallium Nitride Lasers—Continued

CMI4 • 9:00 a.m.
InGaN-GaNAs Type-II "W" Quantum Well Lasers for Emission at 450 nm, *Ronald A. Arif, Hongping Zhao, Nelson Tansu; Lehigh Univ., USA.* Type-II InGaN-GaNAs quantum well gain media is analyzed for lasers emitting at 450 nm. Optical gain analysis, using 6-band *k.p* formalism, show 3-times improvement and 40% reduction in threshold current.

CMI5 • 9:15 a.m.
CW Lasing of Current Injection Blue GaN-Based Vertical Cavity Surface-Emitting Lasers, *Tien-Chang Lu, Tsung-Ting Kao, Shih-Wei Chen, Chih-Chiang Kao, Hao-Chung Kuo, Shing-Chung Wang; Inst. of Electro-Optical Engineering, Natl. Chiao Tung Univ., Taiwan.* We demonstrated CW laser operation of GaN-based VCSELs under current injection at 77 K. CW laser action was achieved at a threshold current of 1.4 mA, emitting at 462 nm with a narrow linewidth of about 0.15 nm.

CMI6 • 9:30 a.m.
142 mW Tunable Blue Light Generation at 488 nm by Single-Pass SHG of an External Cavity Enhanced Broad-Area Laser Diode, *Andreas Jechow, Ralf Menzel; Univ. of Potsdam, Germany.* 142 mW visible light with a tuning range of 5 nm were generated by frequency doubling of an external cavity broad-area laser diode using a PPLN waveguide crystal. A wall-plug efficiency of 5.9% was obtained.

9:45 a.m.–10:15 a.m.
Coffee Break, *Concourse Level*

NOTES

Ballroom A1 and A8 — QELS

10:15 a.m.–12:00 p.m.
QMD • Metamaterials II
Presider to Be Announced

QMD1 • 10:15 a.m. Invited
Nanoplasmonics: Subwavelength Waveguides, Resonators and Antennas, *Sergey I. Bozhevolnyi; Aalborg Univ., Denmark.* Subwavelength waveguides, resonators and antennas utilizing surface plasmon polariton modes are considered, reviewing recent experimental investigations and demonstrating first examples of ultracompact plasmonic components.

QMD2 • 10:45 a.m.
Refracting Surface Plasmons with Nanoparticle Arrays, *Ilya P. Radko[1], Alexandra Boltasseva[2], Sergey I. Bozhevolnyi[1]; [1]Aalborg Univ., Denmark, [2]Technical Univ. of Denmark, Denmark.* Variously shaped structures formed with a 100-nm-period square lattice of gold nanoparticles placed on a gold film are shown to possess an effective refractive index of about 1.08 for SPPs propagating through them.

QMD3 • 11:00 a.m.
Photonic Metamaterials by Direct Laser Writing and Silver Chemical Vapor Deposition, *Michael Rill[1], Christine Plet[1], Michael Thiel[1], Martin Wegener[1], Georg von Freymann[2], Stefan Linden[2]; [1]Inst. für Angewandte Physik, Univ. Karlsruhe (TH), Germany, [2]Inst. für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Germany.* We fabricate planar magnetic photonic metamaterials via direct laser writing and silver chemical vapor deposition, an approach, which is also suitable for three-dimensional structures. Retrieval of the effective metamaterial parameters reveals the importance of bi-anisotropy.

Ballroom A2 and A7 — JOINT

10:15 a.m.–12:00 p.m.
JMB • Joint CLEO/QELS Symposium on Novel Resonators: Cavity QED
Hui Cao; Northwestern Univ., USA, Presider

JMB1 • 10:15 a.m. Invited
Title to Be Announced, *Robert J. Schoelkopf; Yale Univ., USA.* Abstract not available.

JMB2 • 10:45 a.m. Invited
Novel Nanophotonic Resonators: Opportunities and Challenges, *Evelyn Hu[1], Kevin Hennessy[1,2], Antonio Badolato[2], Chiou-Fu Wang[1], Pierre M. Petroff[3], Atac Imamoglu[2]; [1]Univ. of California at Santa Barbara, USA, [2]ETH, Switzerland.* This talk will highlight the opportunities and challenges in some novel nanophotonic systems, including strongly-coupled quantum dot-photonic crystal cavities, and photonic crystal cavities fabricated from nanocrystalline diamond.

Ballroom A3 and A6 — CLEO

10:15 a.m.–12:00 p.m.
CMJ • Fiber Sensors
Martijn de Sterke; Univ. of Sydney, Australia, Presider

CMJ1 • 10:15 a.m.
Novel Photonic Crystal Fiber Sensors Using Splitting of a Degenerate Plasmonic Doublet, *Alireza Hassani, Bertrand Gauvreau, Maksim Skorobogatiy; Ecole Polytechnique de Montréal, Canada.* The concept of honeycomb photonic crystal fiber-based plasmonic sensor, having a sensing mechanism based on the detection of breaking of an degeneracy between the two near-IR plasmonic excitations with the resolution of $7.2e^{-6}$, is developed.

CMJ2 • 10:30 a.m.
Electro-Optic Sensor from High-Q Resonance between Optical D-Fiber and Slab Waveguide, *Richard S. Gibson, Richard Selfridge, Stephen Schultz; Brigham Young Univ., USA.* An electric-field sensor is specially fabricated with an optical D-fiber that utilizes weak evanescent coupling with a lithium niobate slab waveguide. Resonant modes with a Q-factor of ~13,000 yield high sensitivity for detecting electric fields.

CMJ3 • 10:45 a.m.
All-Fiber Capillary Electrophoresis with Novel Axial In-Line Detection, *Pär Jelger[1], Mårten Stjernström[2], Walter Margulis[3], Valdas Pasiskevicius[1], Fredrik Laurell[1]; [1]Dept. of Applied Physics, Royal Inst. of Technology, Sweden, [2]Dept. of Analytical Chemistry, Royal Inst. of Technology, Sweden, [3]Acreo AB, Sweden.* An all-fiber capillary electrophoresis system is presented. It enables sensitive in-line electrophoresis separation and fluorescence detection. As a proof of concept, a biological sample (FITC-BSA) is electrokinetically separated and analyzed.

CMJ4 • 11:00 a.m.
DNA Target Detection Using Gold-Coated Tilted Fiber Bragg Gratings in Aqueous Media, *Yanina Y. Shevchenko, David A. D. Blair, Maria C. Derosa, Jacques Albert; Carleton Univ., Canada.* Plasmon resonances in the transmission spectrum of a tilted Bragg grating in gold coated fibers are used to detect the binding of thiolated single stranded DNA and the further binding of the complementary target DNA.

Ballroom A4 and A5 — CLEO

10:15 a.m.–12:00 p.m.
CMK • Fiber and Waveguide Devices
Goëry Genty; Tampere Univ. of Technology, Finland, Presider

CMK1 • 10:15 a.m.
Physics of Electrically Switched Fiber Bragg Gratings, *Zhangwei Yu[1,2], Walter Margulis[2,3], Pierre-Yves Fonjallaz[2,3], Oleksandr Tarasenko[2,3]; [1]Joint Res. Ctr. of Photonics of the Royal Inst. of Technology and Zhejiang Univ., China, [2]Kista Photonics Res. Ctr., Royal Inst. of Technology, Sweden, [3]Acreo AB, Sweden.* The physics of electrically switched FBGs was studied in fibers with internal electrodes. Wavelength shifts due to mechanical effects (nanoseconds) and heat (milliseconds) depend quadratically on the electrical pulse voltage and linearly on pulse duration.

CMK2 • 10:30 a.m.
Highly Thermally Responsive Hybrid In-Fiber Slab Waveguide Grating Structure with a Plastic Core and a Silica Cladding, *Kaiming Zhou, Xianfeng Chen, Yicheng Lai, Kate Sugden, Lin Zhang, Ian Bennion; Photonic Res. Group, Aston Univ., UK.* A 1.2(height)×125(depth)×50 0(length) micro-slot was engraved along a fiber Bragg grating by chemically assisted femtosecond laser processing. By filling epoxy and UV-curing, waveguide with plastic-core and silica-cladding was created, presenting high thermal responding coefficient of 211 pm/°C.

CMK3 • 10:45 a.m.
Creating and Fixing a Metal Nanoparticle Layer on the Holes of Microstructured Fibers for Plasmonic Applications, *Christiano J. S. de Matos[1], Cristiano M. B. Cordeiro[2], Gustavo F. S. Andrade[3], Alexandre G. Brolo[3,4], Antonio M. Brito-Silva[5], Marcia L. A. Temperini[3], Andre Galembeck[5], Cid B. de Araujo[5]; [1]Univ. Presbiteriana Mackenzie, Brazil, [2]State Univ. of Campinas, Brazil, [3]Univ. de Sao Paulo, Brazil, [4]Univ. of Victoria, Canada, [5]Univ. Federal de Pernambuco, Brazil.* Methods to insert, keep and fix silver and gold nanoparticles to the inner walls of microstructured fibers are demonstrated. Fibers optimized for evanescent field interaction were employed and can result in efficient plasmonic chemical sensing.

CMK4 • 11:00 a.m.
Amplified Spontaneous Emission and Optical Gain Coefficient of SiO_x Based Planar Waveguide with Buried Silicon Nanocrystals on Silicon Substrate, *Cheng-Wei Lian, Gong-Ru Lin; Graduate Inst. of Photonics and Optoelectronics and Dept. of Electrical Engineering, Natl. Taiwan Univ., Taiwan.* Si-rich SiO_x planar waveguide with Si nanocrystals contributed amplified spontaneous emission at 750-850 nm is characterized by variable stripe length method to demonstrate optical gain and loss coefficients of 60 and 16 cm^{-1}, respectively.

10:15 a.m.–12:00 p.m.
QME • Quantum Logic
Dominic Berry; Macquarie Univ., Australia, Presider

QME1 • 10:15 a.m. Invited

Photonic Quantum Computing: Shor's Algorithm and the Road to Fault-Tolerance, *B. P. Lanyon, T. J. Weinhold, N. K. Langford, M. Barbieri, M. P. de Almeida, A. Gilchrist, D. F. V. James, Andrew G. White; Univ. of Queensland, Australia.* We implement Shor's algorithm in a photonic system, demonstrating for the first time the entangled states required for full-scale implementation. We introduce a general technique for comparing measured quantum-logic gate performance against predicted fault-tolerance thresholds.

QME2 • 10:45 a.m.

Complete Geometric Universal Single Qubit Operation of Cold Two-Level Atoms, *Hiromitsu Imai, Atsuo Morinaga; Tokyo Univ. of Science, Japan.* A complete geometric manipulation of universal single qubit operation on a two-level cold ensemble of sodium atoms was demonstrated using a combination of geometric rotations of the Bloch vector around axes 2 and 3.

QME3 • 11:00 a.m.

Fibre Implementation of a Controlled-NOT Gate, *Jeremie Fulconis[1], Alexander Clark[1], John Rarity[1], Jeremy O'Brien[1], William Wadsworth[2]; [1]Univ. of Bristol, UK, [2]Univ. of Bath, UK.* We demonstrate a fibre implementation of a Controlled-NOT gate using a fibre source of heralded single photons and three partially polarising couplers. We then estimate the bounds for the quantum process fidelity of this gate.

10:15 a.m.–12:00 p.m.
CML • Timing Stabilization and Distribution
Christopher W. Oates; NIST, USA, Presider

CML1 • 10:15 a.m.

Sub-Femtosecond Timing Distribution of an Ultrafast Optical Pulse Train over Multiple Fiber Links, *Jonathan A. Cox, Jungwon Kim, Jian Chen, Franz X. Kaertner; MIT, USA.* The distribution of ultrafast optical pulse trains across 300 meters of fiber with sub-femtosecond timing jitter and 83 femtoseconds of drift over 25 hours, as measured between the outputs from two independent links, is demonstrated.

CML2 • 10:30 a.m.

Practical Performance Limits on Optical Frequency Transfer over Fiber-Optic Links, *Paul A. Williams, William C. Swann, Nathan R. Newbury; NIST, USA.* We present theory and experiment quantifying the limitations to stable transport of optical frequencies over optical fiber. These are fundamental fiber noise, propagation delay, bidirectional propagation and system noise in the measurement interferometers.

CML3 • 10:45 a.m. Invited

Fiber Length Stabilization System for Long-Baseline Phased-Array Radio Telescopes (ALMA), *Mitsuru Musha[1], Ken'-ichi Nakagawa[1], Ken'-ichi Ueda[1], Masato Ishiguro[2], Akitoshi Ueda[2]; [1]Univ. of Electro-Communications, Japan, [2]Natl. Astronomical Observatory of Japan, Japan.* We've developed local oscillator dissemination system for ALMA. The high-purity 120-GHz local oscillator was delivered as a heterodyne beat signal over 25 km through length corrected optical fibers with phase fluctuation of 10^{-2} radian.

10:15 a.m.–12:00 p.m.
CMM • Terahertz Sources
Ki-Yong Kim; Los Alamos Natl. Lab, USA, Presider

CMM1 • 10:15 a.m.

Performance of THz-TDS Using 1.5 µm Femtosecond Fiber Laser with InP Schottky and DAST Emitters, *Masayoshi Tonouchi[1], Hiroki Koga[1], Kei Takeya[1], Iwao Kawayama[1], Hironaru Murakami[1], Yoshinori Takahashi[2], Masashi Yoshimura[2], Yusuke Mori[2]; [1]Inst. of Laser Engineering, Osaka Univ., Japan, [2]Graduate School of Engineering, Osaka Univ., Japan.* The InP emitter generates THz waves efficiently and it has proven that the fiber-laser-based THz-TDS using the InP and DAST emitter is a potential broadband spectroscopy system.

CMM2 • 10:30 a.m.

Observation of THz Emission from InAs Nanowires, *Denis Seletskiy[1], Michael P. Hasselbeck[1], Mansoor Sheik-Bahae[1], Jeffrey G. Cederberg[2], Linus C. Chuang[3], Michael Moewe[3], Connie J. Chang-Hasnain[3]; [1]Univ. of New Mexico, USA, [2]Sandia Natl. Lab, USA, [3]Univ. of California at Berkeley, USA.* We report THz emission from free standing InAs nanowires. The radiation is attributed to coherent plasmon motion excited by ultrashort laser pulses and exhibits power enhancement and spectral redshift compared to an InAs planar surface.

CMM3 • 10:45 a.m.

Fiber Laser Pumped High Average Power Single-Cycle THz Pulse Source, *Matthias C. Hoffmann[1], Ka-Lo Yeh[1], Harold Y. Hwang[1], Thomas S. Sosnowski[2], János Hebling[1,3], Keith A. Nelson[1]; [1]MIT, USA, [2]Clark-MXR, Inc., USA, [3]Dept. of Experimental Physics, Univ. of Pécs, Hungary.* Single-cycle THz radiation was generated by optical rectification of Yb-fiber laser pulses with 250 fs duration and 10 µJ energy. We obtained an average power of 0.5 mW at 1 MHz repetition rate.

CMM4 • 11:00 a.m.

High-Power Broadband THz Generation in a GaP Waveguide, *Charles J. Divin[1], Guoqing Chang[1], Malakeh Musheinish[1], Steven L. Williamson[2], Tom S. Sosnowski[3], Theodore B. Norris[1]; [1]Univ. of Michigan, USA, [2]Picometrix LLC, USA, [3]Clark MXR, USA.* Broadband THz generation is demonstrated using optical rectification in 6 mm GaP waveguides pumped by a high power, high repetition rate, ultrafast Yb-doped fiber amplifier. 150 µW THz radiation is obtained from 10 W pump power.

10:15 a.m.–12:00 p.m.
QMF • Ultrafast and Ultraintense
Alexander Gaeta; Cornell Univ., USA, Presider

QMF1 • 10:15 a.m. Tutorial

Harnessing Attosecond Science for Visualizing the Nanoworld, *Margaret M. Murnane[1], Jorge Rocca[2], John Miao[3], Ronggui Yang[1], Keith Nelson[4], Eric Anderson[5], Martin Aeschlimann[6], Carmen Menoni[2], Mario Marconi[2], Henry C. Kapteyn[1]; [1]JILA and Univ. of Colorado, USA, [2]Colorado State Univ., USA, [3]Univ. of California at Los Angeles, USA, [4]MIT, USA, [5]Ctr. for X-Ray Optics, USA, [6]Univ. of Kaiserlautern, Germany.* New science and technology is enabled by manipulating and controlling electrons on attosecond timescales. Applications range from new table-top sources of coherent x-rays to high-resolution tabletop coherent imaging of molecules, nanostructures and materials.

Margaret Murnane is a Fellow of JILA and a member of the faculty in the Departments of Physics and ECE at the University of Colorado. Her research interests include the development of ultrafast laser and x-ray sources, as well as pioneering the application of table-top coherent x-ray beams in imaging, holography, diffractive microscopy, photoacoustic metrology, surface science, molecular science, and radiation chemistry. She is a Fellow of the Optical Society of America and the American Physical Society, and is a Member of the US National Academy of Sciences.

10:15 a.m.–12:00 p.m. CMN • High-Power Semiconductor Lasers

Jesper Mörk; Technical Univ. of Denmark, Denmark, Presider

CMN1 • 10:15 a.m.
High-Power Coherent Beam Combination of Semiconductor Laser Arrays, *Robin K. Huang, Bien Chann, Leo J. Missaggia, Steven J. Augst, Reuel B. Swint, Joseph P. Donnelly, Antonio Sanchez-Rubio, George W. Turner; MIT Lincoln Lab, USA.* We have coherently combined a total power of 7.2 W CW using an individually addressable 10-element-array of 980-nm Slab-Coupled Optical Waveguide Lasers (SCOWLs). The robust, passive phase-locking is accomplished using a fractional Talbot external cavity.

CMN2 • 10:30 a.m.
Peak Power from 60-µm Broad Area Single Emitter Limited to 50-W by Carrier Escape, *Agnieszka Pietrzak, Paul Crump, Ralf Staske, Hans Wenzel, Götz Erbert, Günther Tränkle; Ferdinand-Braun-Inst. für Höchstfrequenztechnik, Germany.* Passivated 1100-nm broad area lasers reach maximum power of 50-W from a 60-µm stripe under short pulse conditions. Simulations predict and spontaneous emission measurements confirm power is limited by carrier escape from the active region.

CMN3 • 10:45 a.m.
808-nm TM Polarised High-Power Broad-Area Lasers with 69.5% Power Conversion Efficiency at 71-W, *Paul A. Crump, Hans Wenzel, Götz Erbert, Sven Einfeldt, Peter Ressel, Martin Zorn, Frank Bugge, Martin Spreemann, Frank Dittmar, Ralf Staske, Günther Tränkle; Ferdinand-Braun-Inst. für Höchstfrequenztechnik, Germany.* We report TM polarized 808-nm Lasers bars with 69.5% efficiency at 15°C. Performance is limited by the low-strained InGaAsP quantum well, which has high threshold, low slope and high sensitivity to packaging induced stress.

CMN4 • 11:00 a.m.
15-W Reliable Operation of 96-µm Aperture Broad-Area Diode Lasers Emitting at 980 nm, *Katrin J. Paschke, Sven Einfeldt, Armin Ginolas, Karl Häusler, Peter Ressel, Bernd Sumpf, Hans Wenzel, Götz Erbert; Ferdinand-Braun-Inst. für Höchstfrequenztechnik, Germany.* High-power broad area diode lasers emitting at 980 nm with a maximum output power of 20 W at 15°C and with reliable operation over 2000 h at 15 W and 25°C will be presented.

10:15 a.m.–12:00 p.m. CMO • Novel Techniques in Beam Shaping and Sensing

Lawrence Shah; IMRA America, Inc., USA, Presider

CMO1 • 10:15 a.m.
Full Field Imaging and Spectroscopy of Individual Gold Nanoparticles, *Emilie Absil[1], Gilles Tessier[1], Danièle Fournier[1], Michel Gross[2], Michael Atlan[2]; [1]ESPCI, Lab Photons et Matière, France, [2]ENS, Lab Kastler Brossel, France.* We present a method using either laser or white evanescent illumination combined to spatial modulation and camera lock-in detection allowing the measurement of scattering images and spectra of individual gold nanoparticles.

CMO2 • 10:30 a.m.
Structured Illumination for Imaging Interferometric Microscopy, *Alexander Neumann, Yuliya Kuznetsova, S. R. J. Brueck; Ctr. for High Technology Materials, Univ. of New Mexico, USA.* Imaging interferometric microscopy is a synthetic aperture approach to achieving resolutions approaching lambda/4n with a low-NA objective. Structured illumination, adapted to implementation in existing microscopes, extends its capabilities.

CMO3 • 10:45 a.m.
Rapid Beam Shaping Using Tunable Acoustic Gradient Index of Refraction Lenses, *Euan McLeod, Alexandre Mermillod-Blondin, Craig B. Arnold; Princeton Univ., USA.* A MHz-rate device employing acoustic waves within a fluid is used to modulate an incident laser beam and form patterns including focal spots, Bessel beams, and doughnut beams. Theory, experiment, and applications are presented.

CMO4 • 11:00 a.m.
High-Power Radial Polarization Conversion Using Photonic Crystal Segmented Half-Wave-Plate, *Poh-Boon Phua[1,2], Wenn-Jing Lai[2], Yuan-Liang Lim[1], Beng-Sing Tan[1], RuiFen Wu[1], Kin-Seng Lai[1], Hong-Wee Tan[1]; [1]DSO Natl. Labs, Singapore, [2]Nanyang Technological Univ., Singapore.* We generated 110 watts of radial polarized laser beam from Yb fiber laser using photonic-crystal segmented half-wave-plate. This is a promising external radial polarization converter for fiber laser used in the laser cutting industry.

10:15 a.m.–12:00 p.m. CMP • Microwave Photonics

Tetsuya Kawanishi; Natl. Inst. of Information and Communication, Japan, Presider

CMP1 • 10:15 a.m.
Electro-Optic Microwave-Lightwave Converter Using Antenna-Coupled Electrodes and Polarization-Reversed Structures, *Hiroshi Murata, Noriyoshi Suda, Yasuyuki Okamura; Osaka Univ., Japan.* A novel electro-optic microwave-lightwave converter using antenna-coupled modulation electrodes and polarization-reversed structures is proposed. It can convert several wireless signals coming from different directions to different optical signals respectively. Basic operations at 15 GHz were presented.

CMP2 • 10:30 a.m.
Microwave Phase Shifter Based on Mach-Zehnder Intensity Modulator and Polarization Rotation in an SOA, *Weiqi Xue[1], Filip Öhman[1], Søren Blaaberg[1], Yaohui Chen[1], Jesper Mørk[1], Salvador Sales[2]; [1]Dept. of Communications, Optics and Materials, Technical Univ. of Denmark, Denmark, [2]Inst. of Telecommunications and Multimedia Applications, Univ. Politécnica de Valencia, Spain.* We introduce a novel scheme based on nonlinear polarization rotation in an SOA and the polarization characteristics of a Mach-Zehnder intensity modulator, to implement a large controllable phase shift over 20 GHz modulation bandwidth.

CMP3 • 10:45 a.m.
Photonic RF-Receiver Based on All-Optical Down-Conversion in an Optomechanical Oscillator, *Mani Hossein-Zadeh, Kerry J. Vahala; Caltech, USA.* We present a photonic RF down-converter based on *optomechanical* oscillation in a silica microtoroid. Preliminary results show that the optomechanical oscillator can simultaneously serve as mixer and local oscillator in photonic RF-receiver architectures.

CMP4 • 11:00 a.m.
A Linearized Phase-Modulated Analog Optical Link, *Jason D. McKinney, Keith J. Williams; NRL, USA.* We demonstrate a linearized phase-modulated analog link that achieves a fifth-order-limited spurious-free dynamic range of ~130 dB-HZ$^{4/5}$. This result represents a 17 dB improvement over conventional (single-detector) intensity-modulated links for the same received photocurrent.

10:15 a.m.–12:00 p.m. CMQ • Remote Sensing

Sukesh Roy; Innovative Scientific Solutions, Inc., USA, Presider

CMQ1 • 10:15 a.m.
The Lunar Orbiter Laser Altimeter (LOLA) on NASA's Lunar Reconnaissance Orbiter (LRO) Mission, *Haris Riris[1], Xiaoli Sun[1], John F. Cavanaugh[1], Luis Ramos-Izquierdo[1], Pete Liiva[2], Glenn B. Jackson[1], Steve Schmidt[1], Jan McGarry[1], David E. Smith[1]; [1]NASA Goddard Space Flight Ctr., USA, [2]Sigma Space Corp., USA.* We describe the Lunar Orbiter Laser Altimeter instrument on NASA's Lunar Reconnaissance Orbiter mission, scheduled to launch in October 2008, which will provide a precise lunar high-resolution global topographic map using laser altimetry.

CMQ2 • 10:30 a.m.
Laser Transmitter for the Lunar Orbit Laser Altimeter (LOLA) Instrument, *Anthony W. Yu[1], Anne Marie Novo-Gradac[1], George B. Shaw[1], Steven X. Li[1], Danny C. Krebs[1], Luis A. Ramos-Izquierdo[1], Glenn L. Unger[1], Alan Lukemire[2]; [1]NASA Goddard Space Flight Ctr., USA, [2]Space Power Electronics Inc., USA.* We present the final configuration of the space flight laser transmitter as delivered to the LOLA instrument. The laser consists of two oscillators on a single bench, each capable of providing one billion plus shots.

CMQ3 • 10:45 a.m.
1.5 µm All Fiber Pulsed Lidar For Wake Vortex Monitoring, *Agnès Dolfi-Bouteyre[1], Béatrice Augére[1], Claudine Besson[1], Guillaume Canat[1], Didier Fleury[1], Thierry Gaudo[1], Didier Goular[1], Laurent Lombard[1], Christophe Planchat[1], Mathieu Valla[1], Jean-Pierre Cariou[2], Olivier Petilon[2], Julius Lawson-Daku[2]; [1]Office Natl. d'Etudes et de Recherches Aérospatiales, France, [2]LEOSPHERE, France.* A pulsed fibre lidar based on 1.5 µm fibre technology has been demonstrated for wake vortex monitoring on airport sites. The wake vortex cores position resolution is ±2 m, the error on circulation 10%.

CMQ4 • 11:00 a.m.
The (Critical) Clamped Intensity of a Plasma Filament Induced by a Femtosecond Laser Pulse in Helium, *Jens Bernhardt[1], Weiwei Liu[1,2], Mehdi Sharifi[1], Huailiang Xu[1], Francis Théberge[1,3], See Leang Chin[1]; [1]Ctr. d'Optique, Photonique et Lasers, Univ. Laval, Canada, [2]Inst. of Modern Optics, Nankai Univ., China, [3]Defence Res. and Development Canada-Valcartier, Canada.* The clamped intensity of a plasma-filament induced by a femtosecond laser pulse in one-atmospheric-pressure helium was measured. The measured electron density of ~7×10^{17} cm^{-3} corresponds to a clamped intensity of about 7.8×10^{14} W/cm^2.

Marriott San Jose
Salon 5 and 6

CLEO

10:15 a.m.–12:00 p.m.
CMR • Organic LEDs for Solid-State Lighting
Zakya Kafafi; Natl. Science Foundation, USA, Presider

CMR1 • 10:15 a.m. **Tutorial**
OLEDs for Solid-State Lighting, *Anil R. Duggal; GE Global Res., USA.* Organic light emitting devices represent an exciting potential technology for solid state lighting. In this tutorial, key areas of progress in performance and low cost fabrication are described and compared to solid-state lighting needs.

Anil Duggal joined GE Global Research in 1992 where he has been active in the fields of optical and electrical materials and devices. He currently leads the Organic Electronics Advanced Technology Program for GE. Dr. Duggal has been issued more than 70 U.S. Patents and has authored a similar number of technical publications.

NOTES

QMD • Metamaterials II—Continued

QMD4 • 11:15 a.m.
Metal Nanocluster Metamaterial, *Qi Wu, Jin Hyoung Lee, Jihye Ahn, Wounjhang Park; Univ. of Colorado at Boulder, USA.* We present theoretical and experimental studies on a new metamaterial architecture based on metal nanoclusters. The nanoclusters support magnetic Mie resonance and a nanocluster array may exhibit negative permeability at optical frequencies.

QMD5 • 11:30 a.m.
Development of Composite Silver-Polymer Metamaterials, *Mohammad Mayy, Guohua Zhu, Yu Barnakov, M. A. Noginov; Norfolk State Univ., USA.* We have synthesized and studied a series of composite silver-polymer photonic metamaterials with composition-tunable electric permittivity ε. The demonstrated value ε'=12.8 at λ=2.4 μm appears to be the highest in the near-to-mid-IR spectral range.

QMD6 • 11:45 a.m.
Dispersion Relation of Light in Metamaterials, *Carsten Rockstuhl[1], Thomas Paul[1], Christoph Menzel[1], Falk Lederer[1], Thomas Pertsch[2]; [1]Inst. of Condensed Matter Theory and Solid State Optics, Friedrich Schiller Univ. Jena, Germany, [2]Inst. of Applied Physics, Friedrich Schiller Univ. Jena, Germany.* We derive the dispersion relation of light in metamaterials and define an effective index. Emphasis is on propagation directions deviating from the principal crystallographic axis. This index is compared with results from a finite slab.

JMB • Joint CLEO/QELS Symposium on Novel Resonators: Cavity QED—Continued

JMB3 • 11:15 a.m.
Coupling Single NV Centers in Diamond to Optical Microcavities, *Kai-Mei C. Fu[1], Charles Santori[1], Sean M. Spillane[1], David Fattal[1], Qianfan Xu[1], Marco Fiorentino[1], Raymond Beausoleil[1], Paul E. Barclay[2], Oskar Painter[2]; [1]Hewlett-Packard Labs, USA, [2]Caltech, USA.* Coupling of the NV^- ZPL to a silica microcavity and tapered fiber is demonstrated at cryogenic temperatures. Coupling to a high-Q cavity should enhance the usefulness of the NV^- for quantum information applications.

JMB4 • 11:30 a.m.
Probing a Quantum Dot in the Weak Coupling Regime, *Ilya Fushman, Dirk Englund, Andrei Faraon, Jelena Vučković; Stanford Univ., USA.* An InAs quantum dot inside a photonic crystal cavity in the regime of weak coupling modulates the intensity of a resonant beam by 50%, and is nonlinear at powers of one photon per lifetime.

JMB5 • 11:45 a.m.
Photon-Photon Correlations from a Resonantly Driven Quantum Dot in a Microcavity, *Edward B. Flagg[1], Andreas Muller[1], John W. Robertson[1], Thai Tran[1], Dennis G. Deppe[2], Jaiyu Zhang[3], Wenquan Ma[3], Gregory Salamo[3], Chih-Kang Shih[1]; [1]Univ. of Texas at Austin, USA, [2]Univ. of Central Florida, USA, [3]Univ. of Arkansas, USA.* We demonstrate strongly driven resonance fluorescence from a single InGaAs quantum dot in a planar microcavity by measuring the coherent oscillations in the second-order correlation function, $g^{(2)}(t)$, of the photoluminescence.

CMJ • Fiber Sensors—Continued

CMJ5 • 11:15 a.m.
Fiber Bragg Grating Interrogation for a Sensing System Based on a Continuous-Wave Fourier Domain Mode Locking Fiber Laser, *Daru Chen[1,2,3], Mable P. Fok[1,3], Chester Shu[1,3], Sailing He[2,3]; [1]Dept. of Electronic Engineering and Ctr. for Advanced Res. in Photonics, The Chinese Univ. of Hong Kong, China, [2]Ctr. for Optical and Electromagnetic Res., Zijingang Campus, Zhejiang Univ., China, [3]Joint Res. Ctr. of Advanced Photonics of The Chinese Univ. of Hong Kong and Zhejiang Univ., China.* A fiber Bragg grating sensing system is demonstrated based on a continuous-wave Fourier domain mode locking fiber laser. Fiber Bragg grating interrogation is realized by mapping wavelength measurement to time measurement with an oscilloscope.

CMJ6 • 11:30 a.m.
Temperature and Pressure Compensated Microfluidic Optical Sensor, *Misha Sumetsky, Yury Dulashko, Robert S. Windeler; OFS Labs, USA.* We demonstrate a robust double-capillary microfluidic ring resonator optical sensor imbedded into a solid polymer matrix. The device is capable of compensating the temperature and pressure variations and can be generalized to a multi-capillary lab-on-a-chip.

CMJ7 • 11:45 a.m.
High Sensitivity Refractometric Sensor Based on Embedded Optical Microfiber Loop Resonator, *Fei Xu[1], Valerio Pruneri[2,3], Vittoria Finazzi[2], Gilberto Brambilla[1]; [1]Optoelectronics Res. Ctr., Univ. of Southampton, UK, [2]ICFO-Inst. de Ciencies Fotoniques, Spain, [3]ICREA-Institució Catalana de Recerca i Estudis Avançats, Spain.* A novel refractometric sensor based on an embedded optical microfiber loop resonator is presented. The device sensitivity has been studied in two typical configurations, and its dependence on the nanowire diameter and coating thickness determined.

CMK • Fiber and Waveguide Devices—Continued

CMK5 • 11:15 a.m.
Grating Induced Transparency (GIT) and the Dark Mode in Optical Waveguides, *Hsi-Chun Liu, Amnon Yariv; Caltech, USA.* A new type of optical mode that possesses a formal analogy to the Dark atomic state involved in Electromagnetically Induced Transparency. It displays a transparency and Slow light behavior free from bandwidth-delay product constraint.

CMK6 • 11:30 a.m.
Optical Amplification and Lasing in Self-Written Active Waveguide, *Kenichi Yamashita, Akira Kitanobou, Eshin Fukuzawa, Masahiro Itoh, Kunishige Oe; Kyoto Inst. of Technology, Japan.* A novel type of self-formed active waveguide structure is proposed. The waveguides are self-aligned with input/output fibers and can be easily made to have optical feedback cavities. The optical amplification and laser oscillation were demonstrated.

CMK7 • 11:45 a.m.
Observation of Optical Emission from High Refractive Index Waveguide Excited by Traveling Electron Beam, *Yuji Kuwamura, Minoru Yamada, Ryuichi Okamoto, Takeshi Kanai, Hesham Fares; Univ. of Kanazawa, Japan.* A new scheme for optical emission using a high refractive index waveguide and the traveling electron beam in vacuum was demonstrated. Optical emission around wavelength of 1.5 μm was observed for electron acceleration voltage of 40 KV.

12:00 p.m.–1:30 p.m., Lunch Break *(on your own)*

QME • Quantum Logic—Continued

QME4 • 11:15 a.m.
Continuous Variable CNOT Gate Based on Quadripartite Box Cluster Optical Entangled States, *Aihong Tan, Yu Wang, Xiaoli Jin, Xiaolong Su, Xiaojun Jia, Changde Xie, Kunchi Peng; State Key Lab of Quantum Optics and Quantum Optics Devices, Inst. of Opto-Electronics, Shanxi Univ., China.* We experimentally prepared the quadripartite box cluster entangled states using a pair of Einstein-Podolsky-Rosen entangled optical beams and propose a scheme to demonstrate CNOT gate of continuous variables based on the prepared box cluster states.

QME5 • 11:30 a.m.
Controlled-Rotation Quantum Logic Gate in a Single Self-Assembled Quantum Dot, *Stephen J. Boyle[1], Andrew J. Ramsay[1], Mark Fox[1], Maurice S. Skolnick[1], Hiu Y. Liu[2], Mark Hopkinson[2]; [1]Dept. of Physics and Astronomy, Univ. of Sheffield, UK, [2]EPSRC Natl. Ctr. for III-V Technologies, Univ. of Sheffield, UK.* We demonstrate conditional exciton-biexciton Rabi rotations in a single self-assembled InGaAs quantum dot using picosecond optical excitation and photocurrent readout, thereby implementing a two-qubit controlled-rotation (C-rot) quantum logic gate.

QME6 • 11:45 a.m.
Realizing Quantum Controlled Phase-Flip Gate through Quantum Dot in Silicon Photonic Crystal Waveguide, *Jie Gao, Fangwen Sun, Xiaodong Yang, Chee Wei Wong; Columbia Univ., USA.* Scheme to realize controlled phase gate through single quantum dot in slow-light silicon photonic crystal waveguide is proposed. Enhanced Purcell factor and β-factor lead to high gate fidelity over broadband frequencies compared to cavity-assisted system.

CML • Timing Stabilization and Distribution—Continued

CML4 • 11:15 a.m.
Microwave Signal Regeneration from Mode-Locked Lasers with 1.9×10^{-19} Stability, *Jungwon Kim, Franz Kaertner; MIT, USA.* A 10.225-GHz microwave signal is regenerated from a 200.5-MHz repetition rate mode-locked fiber laser with 6.8 fs rms relative timing jitter in 1-MHz bandwidth integrated over 10 hours. This corresponds to the stability of 1.9×10^{-19}.

CML5 • 11:30 a.m.
Influence of Erbium-Doped Fiber Amplifiers on the Timing Stability of Optical Pulse Trains, *Florian Loehl[1], Vladimir Arsov[1], Matthias Felber[1], Kirsten Hacker[1], Bastian Lorbeer[1], Frank Ludwig[1], Karl-Heinz Matthiesen[1], Jost Mueller[2], Holger Schlarb[1], Bernhard Schmidt[1], Sebastian Schulz[1], Axel Winter[3], Johann Zemella[3]; [1]Deutsches Elektronen-Synchrotron, Germany, [2]Technische Univ. Hamburg-Harburg, Germany, [3]Univ. Hamburg, Germany.* The influence of an erbium-doped fiber amplifier on the timing stability of an optical pulse train was characterized with balanced optical cross-correlation. Under optimized conditions, an added timing jitter of 0.5 fs was achieved.

CML6 • 11:45 a.m.
Passive Timing Synchronization between Ti:Sapphire Laser and Yb-Doped Fiber Laser, *Yohei Kobayashi[1,2], Xiangyu Zhou[1,2], Dai Yoshitomi[1,2], Kenji Torizuka[1,2]; [1]Natl. Inst. of Advanced Industrial Science and Technology (AIST), Japan, [2]Core Res. for Evolutional Science and Technology, Japan Science and Technology Agency, Japan.* We demonstrated passive timing stabilization of mode-locked Ti:sapphire and Yb-fiber oscillators. The timing jitter of two femtosecond laser pulses was 3.2 fs from 10-kHz to 1-Hz integration.

CMM • Terahertz Sources—Continued

CMM5 • 11:15 a.m.
Efficient Broadband Terahertz Microstrip Waveguide, *Xiang Shou, Amit K. Agrawal, Ajay Nahata; Dept. of Electrical and Computer Engineering, Univ. of Utah, USA.* We present a novel subwavelength microstrip architecture for efficient broadband THz waveguiding that utilizes dipole antennas at the input-face for enhanced THz coupling. Experiments as well as simulation results demonstrate efficient broadband waveguiding capability.

CMM6 • 11:30 a.m.
Interference between Monochromatic Terahertz Sources, *Sascha Preu[1], Micah Hanson[2], Jeramy D. Zimmerman[2], Stefan Malzer[1], Arthur C. Gossard[2], Gottfried H. Dohler[1], Lijun Wang[1]; [1]Max Planck Res. Group, Univ. Erlangen-Nuremberg, Germany, [2]Materials Dept., Univ. of California at Santa Barbara, USA.* We report on a method to improve spatial resolution and available power at the same time by mutual coherent emission of distant CW-Terahertz photomixers spaced by less than the coherence length of the mixing lasers.

CMM7 • 11:45 a.m.
Highly Directed Terahertz Photonic Transmitter by Using the Design of Planar Antenna Arrays, *Yu-Ru Huang[1], Chung-Chiu Kuo[1], Chui-Min Chiu[1], Hung-Ping Chen[1], Tzeng-Fu Kao[1], Pei-Chin Chiu[2], Jen-Inn Chyi[2], Yi-Chun Chen[3], An-Shyi Liu[3], Ruey-Beei Wu[3], Chi-Kuang Sun[1,4]; [1]Dept. of Electrical Engineering, Graduate Inst. of Photonics and Optoelectronics, Natl. Taiwan Univ., Taiwan, [2]Optical Sciences Ctr., Natl. Central Univ., Taiwan, [3]Dept. of Electrical Engineering, Graduate Inst. of Communication Engineering, Natl. Taiwan Univ., Taiwan, [4]Res. Ctr. for Applied Sciences, Academia Sinica, Taiwan.* By adopting a novel CPW-fed rampart slot array antenna, we demonstrate a compact highly-directed THz photonic transmitter with a single photodetector source. 3dB radiation beam widths in both E- and H-planes are significantly reduced.

QMF • Ultrafast and Ultraintense—Continued

QMF2 • 11:15 a.m.
High Harmonic Spectral Minimum and Phase in Argon and Nitrogen, *Brian K. McFarland, Joseph P. Farrell, Markus Guehr, Philip H. Bucksbaum; Stanford PULSE Ctr., Stanford Univ., USA.* Measurements of the high harmonic amplitude and phase in Argon and N_2 display amplitude and phase modulations which can be related to a Cooper Minimum in Argon and recombination interference in N_2.

QMF3 • 11:30 a.m.
Full Characterization of an Ultrahigh-Repetition-Rate Train of Ultrashort Pulses Generated with Phase-Coherent Raman Sidebands, *Masayuki Katsuragawa[1,2], Takashi Onose[1], Takayuki Suzuki[1,2], Kazuhiko Misawa[3,4]; [1]Univ. of Electro-Communications, Japan, [2]PRESTO, Japan Science and Technology Agency, Japan, [3]Tokyo Univ. of Agriculture and Technology, Japan, [4]CREST, Japan Science and Technology Agency, Japan.* We generated a train of highly stable, ultrashort pulses with a repetition rate of 10.6 THz by synthesizing phase-coherent rotational-Raman-sidebands in para-hydrogen. We show full characterization of its temporal waveform based on a frequency-resolved-optical-gating method.

QMF4 • 11:45 a.m.
Selective Excitation of Vibrational Mode and Fourier-Transform Four-Wave-Mixing Spectroscopy Using an Ultra-Broadband Laser, *Keisuke Isobe[1], Akira Suda[1], Masahiro Tanaka[2], Fumihiko Kannari[2], Hiroyuki Kawano[1], Hideaki Mizuno[1], Atsushi Miyawaki[1], Katsumi Midorikawa[1]; [1]RIKEN, Japan, [2]Keio Univ., Japan.* We show that the selective excitation of vibrational mode is achieved by a single broadband pulse to focus its bandwidth into a narrow spectral region. The spectral focusing is performed by controlling the spectral phase.

12:00 p.m.–1:30 p.m., Lunch Break *(on your own)*

CLEO

CMN • High-Power Semiconductor Lasers—Continued

CMN5 • 11:15 a.m.
Diffraction Coupling of Tapered Laser Diodes in an External Talbot Cavity, *Imen Hassiaoui[1], Nicolas Michel[1], Michel Calligaro[1], Michel Lecomte[1], Olivier Parillaud[1], Michel Krakowski[1], Gilbert Bourdet[2], Jean-Pierre Huignard[3]; [1]Alcatel Thales III-V Lab, France, [2]LULI, Ecole Polytechnique, France, [3]Thales Res. and Technology, France.* We demonstrate the in-phase coherent coupling of a tapered laser diode array in an external Talbot cavity. The divergence of the central peak is 0.27° FWHM at 3.1A with an output power of 931mW CW.

CMN6 • 11:30 a.m.
Spatially Resolved Spectroscopy of Lateral Modes of Broad-Area Laser Diodes by Self-Heterodyning, *Nikolai M. Stelmakh, Michael Vasilyev; Univ. of Texas, Arlington, USA.* The fine structure of broad-area laser diode optical spectrum is investigated with ~30 MHz resolution using spatially-resolved self-heterodyning. Demonstrated method is capable of measuring the individual lateral mode intensity and spacing.

CMN7 • 11:45 a.m.
Improving the Efficiency of High-Power Semiconductor Optical Amplifiers, *Jason J. Plant, Anish K. Goyal, Douglas C. Oakley, David C. Chapman, Antonio Napoleone, Paul W. Juodawlkis; MIT Lincoln Lab, USA.* We demonstrate a 71% electrical-to-optical conversion efficiency increase in a slab-coupled optical waveguide amplifier (SCOWA) by employing multiple contacts. At an output power of 26.4-dBm, the amplifier gain and efficiency are 15-dB and 11.5%, respectively.

CMO • Novel Techniques in Beam Shaping and Sensing—Continued

CMO5 • 11:15 a.m.
Development of High Damage Threshold Apodizers for Laser Applications, *Patrick K. Rambo[1], Jens Schwarz[1], Mark Kimmel[1], Briggs W. Atherton[1], Austin Bergstrom[2], Brian Fluscheˆ[2]; [1]Sandia Natl. Labs, USA, [2]Dept. of Physics, US Air Force Acad., USA.* Using laser ablation of a transmissive fused silica window, high damage threshold apodizers were produced in order to modify the spatial and amplitude profile of a high energy laser beam.

CMO6 • 11:30 a.m.
Refractive Index Sensing Utilizing CW Photonic Crystal Nanolaser and Its Arrayed Configuration, *Shota Kita[1,2], Kengo Nozaki[1,2], Toshihiko Baba[1,2]; [1]Yokohama Natl. Univ., Japan, [2]CREST, Japan Science and Technology Agency, Japan.* We achieved a record high index sensitivity of 400 nm/RIU in a cw photonic crystal nanolaser with a potential spectral linewidth of 0.1 pm order. We also demonstrated spectrometer-free sensing utilizing nanolaser array.

CMO7 • 11:45 a.m.
Mie Scattering of a Laguerre-Gaussian Beam for Position Detection of Microbubbles, *Valeria Garbin[1], Giovanni Volpe[2], Enrico Ferrari[3], Gregory Kozyreff[4], Michel Versluis[1], Dmitri Petrov[2], Dan Cojoc[3]; [1]Univ. of Twente, Netherlands, [2]ICFO, Spain, [3]Lab Nazionale TASC, Italy, [4]Univ. Libre de Bruxelles, Belgium.* The Mie scattering of a Laguerre-Gaussian beam is studied. Applications to position detection in optical tweezers are considered. The cross-talk between the position signals predicted by simulations is confirmed in experiments.

CMP • Microwave Photonics—Continued

CMP5 • 11:15 a.m. Invited
Advances in Microwave Photonic Devices, *Masayuki Izutsu; Natl. Inst. of Information and Communication Technology, Japan.* Devices for rf/light signal conversions are very essential to build various microwave photonics systems. Among variety of photonic devices for MWP systems, the present talk will be focused especially on devices based on electrooptic modulation.

CMP6 • 11:45 a.m.
Optimally Biased Coherent I/Q Analog Photonic Link, *Michael L. Dennis, Thomas R. Clark Jr.; Johns Hopkins Univ. Applied Physics Lab, USA.* Optimal operation for a homodyne analog link with in-phase/quadrature detection is obtained for biasing to equalize photocurrents. Net link gain >5 dB with <15 dB noise figure can be obtained with >12 mA photocurrent.

CMQ • Remote Sensing—Continued

CMQ5 • 11:15 a.m. Invited
Laser-Induced Breakdown Spectroscopy (LIBS) for Aerosol Analysis, *David Hahn, Prasoon K. Diwakar, Philip B. Jackson; Univ. of Florida, USA.* This paper will focus on the status of LIBS for quantitative analysis of individual aerosol particles. Emphasis is on recent efforts to understand the laser-particle interactions, and the improvement of analyte response and precision.

CMQ6 • 11:45 a.m.
Silicon Photomultiplier: Detector for Highly Sensitive Detection of Fluorescence Signals, *Vinit H. Dhulla, Lu Cheng, Georgiy Gudkov, Andriy Tsupryk, Ivan Tovkach, Vera Gorfinkel; Stony Brook Univ., USA.* We demonstrate use of silicon photomultipliers (SiPMs) in single photon counting mode for detection of very weak laser induced fluorescence (LIF). Detection of LIF in DNA-sequencing has been performed with three different commercially available SiPMs.

12:00 p.m.–1:30 p.m., Lunch Break *(on your own)*

CMR • Organic LEDs for Solid-State Lighting—Continued

CMR2 • 11:15 a.m.
Highly Efficient, Charge Balanced Blue Phosphorescent OLEDs Employing Wide Band Gap Host with p-i-n Architecture, *Neetu Chopra, Jaewon Lee, Franky So; Univ. of Florida, USA.* The use of a wide band gap host host p-bis (triphenylsilyly) benzene (UGH2) and a p-i-n structure was used to fabricate FIrpic based devices and EQE of 20% is achieved.

CMR3 • 11:30 a.m.
Paper Withdrawn

CMR4 • 11:45 a.m.
Triplet Energy Confinement Effect in Blue Phosphorescent Organic Light Emitting Devices, *Jaewon Lee, Neetu Chopra, Franky So; Univ. of Florida, USA.* The Effects of triplet energy confinement and charge balance by hole and electron transport layers are investigated on blue phosphorescent organic light emitting devices (PHOLEDs).

12:00 p.m.–1:30 p.m.
Lunch Break *(on your own)*

NOTES

Ballroom A1 and A8 — QELS

1:30 p.m.–3:15 p.m.
QMG • Metamaterials III
Demetrios Christodoulides; College of Optics and Photonics, Univ. of Central Florida, USA, Presider

QMG1 • 1:30 p.m. Invited
Three-Dimensional Metamaterials at Optical Frequencies, *Na Liu[1], Liwei Fu[1], Hongcang Guo[1], Stafan Kaiser[2], Heinz Schweizer[1], Harald Giessen[1]; [1]4th Physikalisches Inst., Univ. of Stuttgart, Germany, [2]1st Physikalisches Inst., Univ. of Stuttgart, Germany.* We experimentally demonstrate the implementation of three-dimensional optical metamaterials. We investigate the interaction between adjacent stacked layers using the method of plasmon hybridization and analyze the optical properties of stacked metamaterials with increasing layer numbers.

QMG2 • 2:00 p.m.
Frequency Tunable Terahertz Metamaterials, *Hou-Tong Chen[1], Abul K. Azad[1], David Shrekenhamer[2], Willie J. Padilla[2], Richard D. Averitt[3], Antoinette J. Taylor[1], John F. O'Hara[1]; [1]Los Alamos Natl. Lab, USA, [2]Boston College, USA, [3]Boston Univ., USA.* We present a hybrid metamaterial semiconductor device capable of 20% tunability of the center resonance frequency via photoexcitation of the semiconductor regions, thereby addressing the metamaterials drawback of narrow bandwidth operation.

QMG3 • 2:15 p.m.
Nonlinear Optical Spectroscopy of Photonic Metamaterials, *Evgenia Kim[1], Feng Wang[1], Wei Wu[2], Zhaoning Yu[2], Ron Shen[1]; [1]Univ. of California at Berkeley, USA, [2]HP Labs, USA.* We probe the nonlinear optical properties of a fishnet metamaterial via second harmonic generation and third harmonic generation spectroscopy. We show that the resonance enhancement of nonlinear response in metamaterials is distinct from molecular case.

Ballroom A2 and A7 — JOINT

1:30 p.m.–3:15 p.m.
JMC • Joint CLEO/QELS Symposium on Novel Resonators: Integrated Resonators
Kerry Vahala; Caltech, USA, Presider

JMC1 • 1:30 p.m. Invited
Silicon Micro-Resonators for On-Chip Optical Networks, *Yurii A. Vlasov, Fengnian Xia, Solomon Assefa, William M. J. Green; IBM T.J. Watson Res. Ctr., USA.* Recent results on compact silicon photonic circuits employing micro-resonators is reported including optical delay lines, electro-optic modulators, broadband optical switches, wavelength filters, etc.

JMC2 • 2:00 p.m.
Small Modal Volume Integrated Dielectric Resonator, *Alexander Gondarenko, Michal Lipson; Cornell Univ., USA.* We demonstrate a bowtie geometry in a silicon planar resonator with an ultra-small modal volume $.01(\lambda/2n)^3$. Bowtie, ring resonators and 1-D and 2-D photonic crystal resonators are compared for tradeoffs in confinement and quality factors.

JMC3 • 2:15 p.m.
Observation of Wavelength- and Loss-Splitting of Supermodes in Coupled Photonic-Crystal Microcavities, *Kirill Atlasov, Karl Fredrik Karlsson, Alok Rudra, Benjamin Dwir, Eli Kapon; Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland.* Splitting of mode wavelength and loss are observed in coupled photonic-crystal cavities. The characteristics of loss splitting are shown to have important impact on the optical energy transfer between such coupled resonators.

Ballroom A3 and A6 — CLEO

1:30 p.m.–3:15 p.m.
CMS • Applications of Ultrafast Imaging
Randy Bartels; Colorado State Univ., USA, Presider

CMS1 • 1:30 p.m.
Shortening of Laser Pulses at the Focus of a Chromatic Lens, *Yuelin Li; Argonne Natl. Lab, USA.* We show that a long self-modulated laser pulse can be shortened at the focus of a chromatic lens as the result of a destructive superposition of the field due to the radius-dependent group delay.

CMS2 • 1:45 p.m.
Supercontinuum Coherent Anti-Stokes Raman Scattering (CARS) Spectroscopy, *Kebin Shi, Peng Li, Zhiwen Liu; Dept. of Electrical Engineering, Pennsylvania State Univ., USA.* We investigate broad-band CARS spectroscopy in supercontinuum optical trap. Methods for suppressing or smoothing non-resonant background are demonstrated.

CMS3 • 2:00 p.m.
Chromatic Two Photon Imaging, *Qian Xu, Kebin Shi, Shizhuo Yin, Zhiwen Liu; Pennsylvania State Univ., USA.* We report on a chromatic two-photon imaging technique which can effectively realize z-scanning by using a Fresnel lens to focus excitation pulses at different wavelengths to different depth positions. Preliminary imaging result will be presented.

CMS4 • 2:15 p.m. Invited
***In vivo* Cellular Level Imaging Using Nonlinear Optical Microendoscopy,** *Mark Schnitzer; Stanford Univ., USA.* Multiple contrast modalities can be used to perform minimally invasive optical microendoscopy in live subjects. I will describe applications of second-harmonic generation and one- and two-photon excited fluorescence microendoscopy in the mammalian nervous system.

Ballroom A4 and A5 — CLEO

1:30 p.m.–3:15 p.m.
CMT • Supercontinuum Generation I
John Harvey; Univ. of Auckland, New Zealand, Presider

CMT1 • 1:30 p.m. Invited
Fiber Networks for Ultrastable Frequency Standards and Timing Distribution, *Seth M. Foreman; Stanford Univ., USA.* Optical fiber networks employing active phase noise cancellation are discussed. Instabilities below 10^{-17} at 1-s and timing jitter below 0.08 fs (10-mHz to 10-MHz) are achieved for a 10-km-scale urban link.

CMT2 • 2:00 p.m.
Generation of Ultrahigh-Power Supercontinua and Self-Compressed Single-Cycle Pulses in Metal-Dielectric Hollow Waveguides, *Anton Husakou, Joachim Herrmann; Max Born Inst. for Nonlinear Optics and Short Pulse Spectroscopy, Germany.* We investigate a novel approach for ultrahigh-power soliton-induced supercontinuum generation based on argon-filled metal-dielectric hollow waveguides and predict the generation of MW/nm spectral power densities with ~0.1 mJ energy and self-compressed isolated 1.7-fs pulses.

CMT3 • 2:15 p.m.
A New Model for CW Supercontinuum Generation, *J. C. Travers, S. V. Popov, J. R. Taylor; Femtosecond Optics Group, Physics Dept., Imperial College London, UK.* We have developed a new pump source model for CW supercontinuum generation which shows closer agreement to experiment, and rests on a stronger physical basis, than previous models.

1:30 p.m.–3:15 p.m.
QMH • Higher-Dimensional Entanglement

Luiz Davidovich; Univ. Federal do Rio de Janeiro, Brazil, Presider

QMH1 • 1:30 p.m.
Angular Dimensionality of Two-Photon Entanglement, *Bart-Jan Pors, Sumant S. R. Oemrawsingh, Martin P. van Exter, Andrea Aiello, Gert W. 't Hooft, Eric R. Eliel, Johannes P. Woerdman; Leiden Univ., Netherlands.* We pass twin-photons through rotatable angular phase plates, and detect entanglement that has a continuously variable angular dimensionality *D*. Experimentally, *D* was varied from 2 to 6 and values up to 50 are practically feasible.

QMH2 • 1:45 p.m.
Manipulation of Single-Photon States Encoded in Orbital Angular Momentum, *Antonio Picón, Gabriel Fernandez Calvo; Univ. Autònoma de Barcelona, Spain*. We analyze possibilities to create/manipulate photon states encoded in spatial degrees of freedom. We show stringent limits for symplectic transforms acting on paraxial modes, and how to overcome these with novel classes of non-Gaussian operations.

QMH3 • 2:00 p.m.
Extrinsic Orbital Angular Momentum Carried by Photon-Pairs in Spontaneous Parametric Down-Conversion, *Sheng Feng, Prem Kumar; Northwestern Univ., USA*. We show in theory that the down-converted photon-pairs carry extrinsic orbital angular momentum in the degrees of freedom of relative movement of one photon with respect to its twin in type-II spontaneous parametric down-conversion.

QMH4 • 2:15 p.m.
Single-Photon Spin-Orbit Coupling and LOQC, *Cody C. Leary, Michael Raymer; Oregon Ctr. for Optics, USA*. When a photon propagates in an inhomogeneous medium, its spin and orbital degrees of freedom are coupled. We explore consequences of this effect for fiber-based cluster state linear optical quantum computing (LOQC).

1:30 p.m.–3:15 p.m.
CMU • Optical Frequency Control and Applications

Kristan L. Corwin; Kansas State Univ., USA, Presider

CMU1 • 1:30 p.m.
Time and Frequency Filtering of Optical Combs, *Danielle A. Braje[1], Matt Kirchner[1], Tara Fortier[1], Vela Mbele[1], Richard Fox[1], Andrew M. Weiner[1,2], Scott A. Diddams[1], Leo W. Hollberg[1]; [1]NIST, USA, [2]Purdue Univ., USA.* Fabry-Perot cavity filtering of broadband optical frequency combs is studied experimentally and theoretically. Effects of dispersion, mirror coatings, and carrier envelope offset frequency are analyzed while highlighting applications to waveform generation and spectroscopic references.

CMU2 • 1:45 p.m.
Relative-Phase Measurement of Multicolor Pulses for Characterization of Fourier-Synthesized Waveform, *Dai Yoshitomi[1,2], Yohei Kobayashi[1,2], Kenji Torizuka[1,2]; [1]Natl. Inst. of Advanced Industrial Science and Technology (AIST), Japan, [2]Core Res. for Evolutional Science and Technology, Japan Science and Technology Agency, Japan.* The phase relation among phase-locked multicolor pulses was measured by interference between dual simultaneous frequency-mixing processes in a thin nonlinear crystal for characterization of Fourier-synthesized waveform.

CMU3 • 2:00 p.m.
Fast and Simple High-Resolution Optical Spectrum Analyzer, *Kai-Uwe Lauterbach[1], Thomas Schneider[1], Ronny Henker[1], Max J. Ammann[2], Andreas T. Schwarzbacher[2]; [1]Hochschule für Telekommunikation Leipzig, Germany, [2]Dublin Inst. of Technology, Ireland.* A simple method for fast optical spectroscopy with high resolution is shown. The method is based on the narrowband Brillouin gain process in optical fibers.

CMU4 • 2:15 p.m.
An Accurate Positioning System Based on Optical Zooming Method, *Mariko Kajima, Hirokazu Matsumoto; Natl. Inst. of Advanced Industrial Science and Technology (AIST), Japan.* A positioning system based on optical zooming interferometer was developed using stabilized diode lasers by fs-comb. It achieved 1.3 nm accuracy and 30 pm stability by simplify the system and treatment of optical source's polarization.

1:30 p.m.–3:15 p.m.
CMV • THz QCL I

Juraj Darmo; Inst. of Solid-State Electronics, Austria, Presider

CMV1 • 1:30 p.m. Tutorial
Terahertz Quantum Cascade Lasers: Design and Applications, *Jérôme Faist; Univ. of Neuchatel, Switzerland.* Operation of terahertz quantum cascade lasers have now been demonstrated between 1.2 and 4.9 THz. Extremely narrow linewidths and continuous tunability have been reported, with applications in imaging, radio-astronomy and process control.

After earning a Ph.D. at EPFL, Jérôme Faist worked at IBM and then Bell Labs (1991-1997). He then became full professor at the University of Neuchatel and, since 2007, at ETH in Zurich. His central role in the invention and first demonstration of the quantum cascade (QC) laser in 1994 was recognized by numerous prizes and honors.

1:30 p.m.–3:15 p.m.
QMI • Slow Light and Multilevel Effects

Stephen C. Rand; Division of Applied Physics, Univ. of Michigan, USA, Presider

QMI1 • 1:30 p.m.
Slow and Fast Light in Liquid Crystal Light Valves, *Stefania Residori[1], Umberto Bortolozzo[2], Jean-Pierre Huignard[3]; [1]Inst. Non Lineaire de Nice, Univ. de Nice Sophia-Antipolis, France, [2]Lab de Physique Statistique de l'ENS, France, [3]Thales Res. & Technology, France.* We show that fast and slow light occurs in a liquid crystal light valve when two-wave mixing occurs in the Raman-Nath diffraction regime. Light pulses are slowed at group velocities as low as 0.2 mm/s.

QMI2 • 1:45 p.m.
Storage and Retrieval of Optical Pulses Using a Two-Color Optical Memory, *Ryan M. Camacho, Praveen K. Vudyasetu, John C. Howell; Univ. of Rochester, USA*. Signal pulses and frequency-shifted idler pulses are simultaneously stored in an atomic vapor for up to 500 microseconds, and then released while maintaining separate waveforms.

QMI3 • 2:00 p.m.
Stored Light in Optical Fibers via Stimulated Brillouin Scattering, *Zhaoming Zhu[1], Daniel J. Gauthier[1], Robert W. Boyd[2]; [1]Dept. of Physics, Duke Univ., USA, [2]Inst. of Optics, Univ. of Rochester, USA.* We report a new method for storing and retrieving sequences of optical data pulses via induced acoustic excitations in an optical fiber through the process of stimulated Brillouin scattering.

QMI4 • 2:15 p.m.
STIRAP in Waveguides: Linear and Nonlinear Effects in an Adiabatic Three-Core System, *Yoav Lahini[1], Francesca Pozzi[2], Mark Sorel[1], Roberto Morandotti[3], D. N. Christodoulides[4], Y. Silberberg[1]; [1]Weizmann Inst. of Science, Israel, [2]Dept. of Electrical and Electronic Engineering, Univ. of Glasgow, UK, [3]Inst. Natl. de la Recherche Scientifique, Canada, [4]College of Optics and Photonics, CREOL, USA*. We demonstrate an adiabatic passage between uncoupled waveguides, in analogy with the quantum effects of STIRAP. In the nonlinear regime the associated adiabatic light passage is found to critically depend on the excitation power levels.

CLEO

1:30 p.m.–3:15 p.m.
CMW • VCSEL I
Presider to Be Announced

CMW1 • 1:30 p.m.
High-Speed Single-Mode Photonic Crystal VCSEL Design, *Chen Chen[1], Paul O. Leisher[2], Kent D. Choquette[1]; [1]Univ. of Illinois at Urbana-Champaign, USA, [2]nLight Corp., USA.* Photonic crystal VCSELs engineer the spatial overlap between optical mode and gain for improved high-speed operation and reduced RIN. The implant aperture should be ≤4um larger than the optical aperture to avoid excessive electrical parasitics.

CMW2 • 1:45 p.m.
17 G Directly Modulated Datacom VCSELs, *Ralph H. Johnson[1], Darwin K. Serkland[2]; [1]Finisar, USA, [2]Sandia Natl. Labs, USA.* This paper is a first look at whether directly modulated VCSELs designed and targed for production 17 G applications will be suitable. Design considerations and initial results are presented.

CMW3 • 2:00 p.m.
25 Gbit/s-100°C Operation and High Reliability of 1.1-µm-Range VCSELs with InGaAs/GaAsP Strain-Compensated MQWs, *Hiroshi Hatakeyama, Takeshi Akagawa, Kimiyoshi Fukatsu, Naofumi Suzuki, Kenichiro Yashiki, Keiichi Tokutome, Takayoshi Anan, Masayoshi Tsuji; NEC Corp., Japan.* We developed 1.1-µm-range oxide-implant VCSELs with InGaAs/GaAsP strain-compensated MQWs. 25 Gbit/s-100°C error-free operation and high reliability over 3000 hours under 150°C operation were successfully demonstrated.

CMW4 • 2:15 p.m.
107-GHz Resonance Frequency of 1.55-µm VCSELs under Ultra-High Optical Injection Locking, *Xiaoxue Zhao[1], Erwin K. Lau[1], Devang Parekh[1], Hyuk-Kee Sung[2], Werner Hofmann[3], Markus C. Amann[3], Ming C. Wu[1], Connie J. Chang-Hasnain[1]; [1]Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA, [2]School of Electronic and Electrical Engineering, Hongik Univ., Republic of Korea, [3]Walter Schottky Inst., Technical Univ. of Munich, Germany.* We demonstrate a record resonance frequency enhancement of 1.55-µm VCSELs from 10 GHz to 107 GHz under ultra-high optical injection locking. Detuning and injection-ratio dependence are characterized to show the broad applicability of the technique.

1:30 p.m.–3:15 p.m.
CMX • Nano- and Micro-Processing of Materials with Femtosecond Laser Pulses
Martin Richardson; Univ. of Central Florida, USA, Presider

CMX1 • 1:30 p.m. Invited
Laser Precision Engineering: From Microprocessing to Nanofabrication, *Ming Hui Hong, Z. Q. Huang, Y. Lin, J. Yun, L. S. Tan, L. P. Shi, T. C. Chong; Data Storage Inst., Agency for Science, Technology and Res. and Dept. of Electrical and Computer Engineering, Natl. Univ. of Singapore, Singapore.* Laser precision engineering has advantages of non-contact process, flexible setup and high speed processing. Combined with other advanced processing tools, laser nanofabrication will play a much more important role in the next generation manufacturing.

CMX2 • 2:00 p.m.
Laser Direct Write Near-Field Nanopatterning Using Optically Trapped Microspheres, *Euan McLeod, Craig B. Arnold; Princeton Univ., USA.* We use Bessel beam optical traps to self-position microsphere objectives near surfaces. Pulsed laser illumination of these objectives is used to perform near-field direct-write subwavelength optical nanopatterning with 100 nm feature sizes.

CMX3 • 2:15 p.m.
Realization of an Ultra-Flat Silica Surface with Angstrom-Scale Average Roughness Using Nanophotonic Polishing, *Takashi Yatsui[1], Wataru Nomura[2], Motoichi Ohtsu[1,2], Kazuya Hirata[3], Yoshinori Tabata[3]; [1]Japan Science and Technology Agency, Japan, [2]Univ. of Tokyo, Japan, [3]SIGMA KOKI Co., Ltd., Japan.* We report that nanophotonic polishing of a silica substrate using a nonadiabatic photochemical reaction drastically reduced the average surface roughness, R_a, and the dispersion of R_a.

1:30 p.m.–3:15 p.m.
CMY • Optical Filters
John M. Fini; OFS Labs, USA, Presider

CMY1 • 1:30 p.m.
Novel Long Period Fiber Grating-Based Filter Configuration Enabling Arbitrary Linear Filtering Characteristics, *Radan Slavik[1], Yongwoo Park[2], Jose Azana[2], Mykola Kulishov[3]; [1]Inst. of Photonics and Electronics, Acad. of Sciences of the Czech Republic, Czech Republic, [2]Inst. Natl. de la Recherche Scientifique, Canada, [3]HTA Photomask Inc., USA.* The novel filtering scheme proposed here allows for implementation of arbitrary spectral transfer functions. It is demonstrated on design and realization of a filter for transform-limited 1.6-ps flat-top pulse synthesis.

CMY2 • 1:45 p.m.
On-Chip High-Order Frequency Filter with Fabrication Error Recovery, *Nicolás Sherwood-Droz, Michael Schmidt, Long Chen, Hod Lipson, Michal Lipson; Cornell Univ., USA.* We demonstrate a high-order frequency filter based on microring pairs, capable of restoring distorted transmission functions by dynamically adjusting resonance parameters. Individual rings are thermo-optically tunable and are adjusted based on an evolutionary algorithm.

CMY3 • 2:00 p.m.
Implementation of High Resolution Planar Wavelength Demultiplexers Using Strong Dispersion in Photonic Crystals, *Babak Momeni, Maysamreza Chamanzar, Ehsan Shah Hosseini, Murtaza Askari, Mohammad Soltani, Ali Adibi; Georgia Tech, USA.* We investigate the implementation of superprism-based planar photonic crystal wavelength demultiplexers in higher photonic bands to improve their spectral resolution. Major challenges in realization of these devices are examined and appropriate solutions are presented.

CMY4 • 2:15 p.m.
Inhomogeneous Anisotropic Subwavelength Structures for the Excitation of Single Hollow Waveguide Modes, *Avi Niv, Yaniv Yirmiyahu, Gabriel Biener, Vladimir Kleiner, Erez Hasman; Technion-Israel Inst. of Technology, Israel.* We propose a general approach for coupling a free space uniformly polarized beam to a desired hollow waveguide mode, thus enabling a single mode operation. Required polarization manipulations are achieved by inhomogeneous anisotropic subwavelength structures.

1:30 p.m.–3:15 p.m.
CMZ • Fiber-, Waveguide- and Cavity-Based Sensing I
Presider to Be Announced

CMZ1 • 1:30 p.m.
Quasi-Static Fiber Strain Sensing with FM Spectroscopy, *Jong H. Chow, Ian C. M. Littler, David E. McClelland, Malcolm B. Gray; Australian Natl. Univ., Australia.* We present a highly sensitive detection system for quasi-static fiber strain, employing FM spectroscopy with a gas cell as absolute frequency reference, demonstrating a few tens of pε/√Hz sensitivity between 1 - 6 Hz.

CMZ2 • 1:45 p.m.
Brillouin Optical Correlation-Domain Reflectometry with 13-mm Spatial Resolution and 50-Hz Sampling Rate, *Yosuke Mizuno, Zuyuan He, Kazuo Hotate; Univ. of Tokyo, Japan.* Distributed strain sensing with a 13-mm spatial resolution and 50-Hz sampling rate is demonstrated in optical fibers based on Brillouin optical correlation-domain reflectometry. This resolution is the best result ever reported in Brillouin-based reflectometries.

CMZ3 • 2:00 p.m.
A Pressure Sensor Based on the Loss Birefringence of a Microstructured Optical Fiber Containing Metal Coated Elliptical Inclusions, *Elio Pone, Alireza Hassani, Suzanne Lacroix, Maksim Skorobogatiy; Ecole Polytechnique de Montreal, Canada.* By measuring splitting in the wavelengths of maximum propagation losses of the two originally degenerate plasmonic/fiber core modes, one can detect $8x10^{-4}$ ellipticity of the silver coated air inclusions. Application in pressure sensing is suggested.

CMZ4 • 2:15 p.m.
Large-Scale FBG Sensors Utilizing Code Division Multiplexing, *Y. H. Huang[1], Chao Lu[1], P. K. A. Wai[1], H. Y. Tam[2]; [1]Electronic and Information Engineering Dept., Hong Kong Polytechnic Univ., Hong Kong, [2]Electrical Engineering Dept., Hong Kong Polytechnic Univ., Hong Kong.* We propose practical low-cost interrogation system for large scale FBG sensor arrays utilizing code division multiplexing. For 100-sensor system, detection speed can increase 250 times comparing with TDM based scheme without compromise on detection accuracy.

1:30 p.m.–3:15 p.m.
CMAA • LED Device Physics

Mary Crawford; Sandia Natl. Labs, USA, Presider

CMAA1 • 1:30 p.m.
Time-Resolved Optical Studies of InGaN LED Structures Grown on Semipolar and Nonpolar Bulk GaN Substrates, *Gregory A. Garrett[1], Hongen Shen[1], Michael Wraback[1], Anurag Tyagi[2], Mathew C. Schmidt[2], Zhongyuan Jia[2], James S. Speck[2], Steven P. DenBaars[2], Shuji Nakamura[2]; [1]ARL, USA, [2]Univ. of California at Santa Barbara, USA.* We present time-resolved photoluminescence on InGaN/GaN multiple-quantum well LEDs grown on nonpolar and semipolar bulk GaN substrates and investigate increasing indium concentrations toward higher power, longer wavelength light emitters.

CMAA2 • 1:45 p.m.
Spontaneous Recombination Rate and Luminescence Efficiency of Staggered InGaN Quantum Wells Light Emitting Diodes, *Ronald A. Arif, Hongping Zhao, Yik-Khoon Ee, Samson Tafon Penn, Volkmar Dierolf, Nelson Tansu; Lehigh Univ., USA.* Spontaneous emission characteristics and power-dependent cathodoluminescence of staggered InGaN quantum wells light emitting diodes were analyzed. The measurements indicated ~4-times improvement in integrated CL intensity and ~50% reduction in non-radiative recombination rate.

CMAA3 • 2:00 p.m. Invited
The Origin of Efficiency Droop in GaN-Based Light-Emitting Diodes and Its Solution, *Jong Kyu Kim[1], Min-Ho Kim[2], Martin F. Schubert[1], Qi Dai[3], Tan Sakong[2], Sukho Yoon[2], Cheolsoo Sone[2], Yongjo Park[2], Joachim Piprek[4], E. Fred Schubert[1,3]; [1]Electrical, Computer and Systems Engineering Dept., Rensselaer Polytechnic Inst., USA, [2]Central R&D Inst., Samsung Electro-Mechanics, Republic of Korea, [3]Dept. of Physics, Applied Physics and Astronomy, Rensselaer Polytechnic Inst., USA, [4]NUSOD Inst. LLC, USA.* The physical origin of efficiency droop in GaN-based light-emitting diodes when driven with high current is systematically investigated. Based on our simulations and experimental results, a polarization-matched active region is proposed as the solution.

NOTES

QMG • Metamaterials III—Continued

QMG4 • 2:30 p.m.
Absolute Extinction Cross Section of Individual Magnetic Split-Ring Resonators, *Martin Husnik[1], Matthias W. Klein[1], Martin Wegener[1], Michael König[2], Jens Niegemann[2], Kurt Busch[2], Nils Feth[3], Stefan Linden[3]; [1]Inst. für Angewandte Physik, Univ. Karlsruhe (TH), Germany, [2]Inst. für Theoretische Festkörperphysik, Univ. Karlsruhe (TH), Germany, [3]Inst. für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Germany.* We measure the absolute extinction cross section spectra of individual split-ring resonators (fundamental magnetic resonance at 1.4-μm wavelength). The experiments are compared with a simple electric-circuit model and with microscopic calculations.

QMG5 • 2:45 p.m.
From Positive- to Negative-Index Materials: Transitional Phenomena, *Natalia M. Litchinitser[1], Andrei I. Maimistov[2], Ildar R. Gabitov[3], Vladimir M. Shalaev[4]; [1]Univ. of Michigan, USA, [2]Moscow Engineering Physics Inst., Russian Federation, [3]Univ. of Arizona, USA, [4]Purdue Univ., USA.* We investigate light propagation through a transition layer between the positive- and negative-index materials with linearly changing material parameters. Strong enhancement of TE- and TM-wave components near the point of zero refractive index is predicted.

QMG6 • 3:00 p.m.
Asymmetric Transmission through Chiral Symmetry Breaking in Planar Metamaterials, *Eric Plum, Vassili A. Fedotov, Nikolay I. Zheludev; Univ. of Southampton, UK.* We report that small chiral asymmetry of the unit cell of planar metamaterials leads to strong resonant asymmetric transmission for circularly polarized light due to excitation of enantiomerically sensitive trapped modes.

JMC • Joint CLEO/QELS Symposium on Novel Resonators: Integrated Resonators—Continued

JMC4 • 2:30 p.m. Invited
Vertical Integration of Ultrafast Semiconductor Lasers, *B. Rudin, D. J. H. C. Maas, A.-R. Bellancourt, M. Golling, T. Südmeyer, Ursula Keller; Eidgenössische Technische Zurich, Switzerland.* We discuss a passively modelocked VECSEL with both gain and saturable absorber integrated into a single semiconductor structure. We refer to this new kind of laser as the modelocked integrated external-cavity surface emitting laser (MIXSEL).

JMC5 • 3:00 p.m.
Room Temperature Continuous Wave Operation of Single-Mode, Edge-Emitting Photonic Crystal Bragg Lasers, *Lin Zhu, Xiankai Sun, Guy DeRose, Axel Scherer, Amnon Yariv; Caltech, USA.* We report the first room temperature CW operation of two dimensional single-mode edge-emitting photonic crystal Bragg lasers. Single-mode lasing with single-lobed, diffraction limited far-fields is obtained for 100 μm wide and 550 μm long on-chip devices.

CMS • Applications of Ultrafast Imaging—Continued

CMS5 • 2:45 p.m.
Spectral Phase Shaping for High Resolution CARS Spectroscopy around 3000 cm^{-1}, *Sytse Postma, Alexander C. W. van Rhijn, Jeroen P. Korterik, Jennifer L. Herek, Herman L. Offerhaus; Univ. of Twente, Netherlands.* We demonstrate high resolution (cm^{-1}) spectroscopy around 3000 cm^{-1} by combining a broadband shaped pulse (pump and probe) with a narrow Stokes pulse. We introduce new phase shaping strategies for the removal of the non-resonant background.

CMS6 • 3:00 p.m.
High-Power, Femtosecond, Thermal-Lens-Shaped Yb:KGW Laser, *Walter A. Schroeder, Joel A. Berger, Michael J. Greco; Univ. of Illinois at Chicago, USA.* Thermal lens shaping for astigmatism compensation is extended to a 65MHz, diode-pumped Yb:KGW oscillator mode-locked with the aid of a saturable Bragg reflector to yield 250fs (347fs) pulses at an output power of 3.5W (5W).

CMT • Supercontinuum Generation I—Continued

CMT4 • 2:30 p.m.
Influence of the Wavelength Dependence of the Effective Area on Infrared Supercontinuum Generation, *Guillaume Canat, Thomas Laverre, Laurent Lombard, Véronique Jolivet, Pierre Bourdon; Office Natl. d'Etude et de Recherche pour l'Aéronautique, France.* Influence of the effective area spectral dependence on midinfrared supercontinuum generation is demonstrated. The behaviors of photonic crystal and step index fibers are compared. A 700nm width reduction is shown in step index ZBLAN fibers.

CMT5 • 2:45 p.m.
Visibly "White" Light Generation in Uniform Photonic Crystal Fiber Using a Microchip Laser, *James M. Stone[1], Jonathan C. Knight[1], John Clowes[2]; [1]Univ. of Bath, UK, [2]Fianium Ltd., UK.* We describe how to extend the bandwidth of the supercontinuum generated in uniform fibers pumped at 1064 nm. The spectra extend to ~400 nm, some 50nm deeper into the blue than previously with the same pump source.

CMT6 • 3:00 p.m.
Quasi Super Continuum Generation Using Programmably Controlled Wavelength Tunable Soliton Pulses for Optical Coherence Tomography, *Kazuhiko Sumimura, Takefumi Ohta, Norihiko Nishizawa; Osaka Univ., Japan.* Quasi super continuum generation for ultrahigh resolution optical coherence tomography is demonstrated using ultrahigh speed wavelength tuning of femtosecond soliton pulse. In this light source, center wavelength, bandwidth, and spectrum shape can be changed arbitrarily.

3:15 p.m.–3:45 p.m., Coffee Break, *Concourse Level*

QMH • Higher-Dimensional Entanglement—Continued

QMH5 • 2:30 p.m.
Topological Phase for Spin-Orbit Transformations on a Laser Beam, *Carlos Eduardo R. Souza[1], Jose Augusto O. Huguenin[1], Perola Milman[2], Antonio Z. Khoury[1]; [1]Inst. de Física, Univ. Federal Fluminense, Brazil, [2]Lab de Materiaux et Phénomènes Quantiques, Univ. Paris Diderot, France.* We investigate the topological phase associated with the *SO*(3) representation in terms of maximally entangled states. An experimental demonstration of this topological phase is provided for polarization and spatial mode transformations of a laser beam.

QMH6 • 2:45 p.m.
Polarization-Squeezed Triphoton States and Their Wigner Representation on the Poincaré Sphere, *Lynden K. Shalm, Robert B. A. Adamson, Aephraim M. Steinberg; Dept. of Physics, Univ. of Toronto, Canada.* We present reconstructions of Wigner distributions for the polarization state of three indistinguishable photons on the generalized Poincaré sphere. We study a variety of states including coherent, phase and NOON states.

QMH7 • 3:00 p.m.
Process Characterization of Experimental Photonic One-Way Quantum Computing, *Yuuki Tokunaga[1,2,3], Shin Kuwashiro[2,3], Takashi Yamamoto[2,3], Masato Koashi[2,3], Nobuyuki Imoto[2,3]; [1]NTT, Japan, [2]Osaka Univ., Japan, [3]CREST Photonic Quantum Information Project, Japan.* We demonstrate process characterization of basic gates of an optical cluster-state quantum computing. We present complete process tomography of a single-qubit gate and evaluate the bounds on the process fidelity of a two-qubit gate.

CMU • Optical Frequency Control and Applications—Continued

CMU5 • 2:30 p.m.
Complete Determination of the First-Order Degree of Coherence of Amplified Spontaneous Emission Sources with Femtosecond Resolution, *Carlos R. Fernández-Pousa, Haroldo Maestre, Adrián J. Torregrosa, Juan Capmany; Univ. Miguel Hernández, Spain.* Using radio-frequency spectral analysis we experimentally retrieve the amplitude and phase of the degree of coherence of a broadband ASE source around 1550 nm with a resolution of 6.5 fs along a 3-ps span.

CMU6 • 2:45 p.m.
Achromatic Characteristics in 3-D Sagnac Interferometer Based on Geometric Phase Shift, *Kaito Yokochi[1], Alexander V. Tavrov[2], Jun Nishikawa[2], Lyu Abe[2], Motohide Tamura[2], Mitsuo Takeda[3], Takashi Kurokawa[1]; [1]Tokyo Univ. of Agriculture and Technology, Japan, [2]Natl. Astronomical Observatory of Japan, Japan, [3]Univ. of Electro-Communications, Japan.* A three-dimensional Sagnac interferometer based on geometric phase is constructed and its nulling characteristics are measured to be 5E-5 for green and red laser light simultaneously.

CMU7 • 3:00 p.m.
Fine Tuning of Nonlinear Interactions in a Solid-State Ring Laser Gyroscope, *Sylvain Schwartz[1], François Gutty[2], Gilles Feugnet[1], Jean-Paul Pocholle[1]; [1]Thales Res. and Technology, France, [2]Thales Avionics, France.* We report a strong reduction of nonlinear interactions in a solid-state ring laser gyroscope when the gain medium is vibrated inside the cavity. This considerably improves the quality of rotation sensing for this device.

CMV • THz QCL I—Continued

CMV2 • 2:30 p.m.
Terahertz Quantum Cascade Lasers Operating up to 178 K with Copper Metal-Metal Waveguides, *Suraj P. Khanna[1], Mikhail A. Belkin[2], Jonathan A. Fan[2], Sahand Hormoz[2], Mohamed Lachab[1], Federico Capasso[2], A. Giles Davies[1], Edmund H. Linfield[1]; [1]School of Electronic and Electrical Engineering, Univ. of Leeds, UK, [2]Harvard School of Engineering and Applied Sciences, Harvard Univ., USA.* We report terahertz quantum cascade lasers, with a three-quantum-well active region design and copper metal-metal waveguides, operating up to a record temperature of 178K. Their performance is compared to devices with gold metal-metal waveguides.

CMV3 • 2:45 p.m.
Wide Ridge Low-Divergence Metal-Metal Terahertz Quantum Cascade Lasers, *Jonathan Fan[1], Mikhail Belkin[1], Federico Capasso[1], Suraj Khanna[2], Mohamed Lachab[2], Giles Davies[2], Edmund Linfield[2]; [1]Harvard Univ., USA, [2]Univ. of Leeds, UK.* We utilize plasmonic side-absorbers to enforce lasing in the TM_{00} mode in wide ridge metal-metal terahertz quantum cascade lasers, which results in improved power outcoupling and reduced far-field divergence for both surface- and edge-emitting devices.

CMV4 • 3:00 p.m.
Photonic Crystal THz Lasers with Boundary Conditions Control, *Yannick Chassagneuz[1], Raffaele Colombelli[1], S. Barbieri[2], C. Sirtori[2], Harvey Beere[3], D. Ritchie[3]; [1]Inst. d'Electronique Fondamentale, Univ. Paris Sud, France, [2]Materiaux et Phenomènes, Univ. Paris 7, France, [3]Cavendish Lab, UK.* We demonstrate single-mode, surface-emitting terahertz-lasers at 110μm wavelength employing photonic-crystal resonators. Photonic-crystal is implemented by the sole patterning of the top-metal contact. In addition, we elucidate the role of the boundary-conditions of the photonic-crystal resonator.

QMI • Slow Light and Multilevel Effects—Continued

QMI5 • 2:30 p.m.
Adiabatic Transfer of Light in Optical Waveguide Arrays, *Giuseppe Della Valle[1], Marco Ornigotti[1], Toney Toney Fernandez[1], Andrea Coppa[2], Vittorio Foglietti[2], Paolo Laporta[1], Stefano Longhi[1]; [1]Politecnico di Milano, Italy, [2]Inst. di Fotonica e Nanotecnologie, Italy.* We report on the experimental demonstration of efficient adiabatic light transfer between the outer waveguides in a finite array of evanescently-coupled optical waveguides with negligible excitation of all the intermediate waveguides.

QMI6 • 2:45 p.m.
Demonstration of Enhanced Spontaneous Raman Scattering in Slow-Light Silicon Photonic Crystal Waveguides, *James F. McMillan[1], Mingbin Yu[2], Dim-Lee Kwong[2], Chee Wei Wong[1]; [1]Optical Nanostructures Lab, Columbia Univ., USA, [2]Inst. of Microelectronics, Singapore.* The direct observation of spontaneous Raman scattering in silicon photonic crystal waveguides is reported. In addition, enhancement of the spontaneous Raman scattering observed in the slow-light region of the fundamental mode on-set.

QMI7 • 3:00 p.m.
Passively Mode-Locked Slow Pump Optical Parametric Oscillators, *Jacob B. Khurgin[1], Jean Michel Melkonian[2], Antoine Godard[2], Emmanuel Rosencher[2]; [1]Johns Hopkins Univ., USA, [2]Office Natl. d'Etudes et de Recherches Aerospatiales, France.* We propose to use Bragg grating to induce large walk-off between the signal and slow pump in nonlinear crystal for developing passively mode-locked OPO's in which a CW pump is efficiently converted into short pulses.

3:15 p.m.–3:45 p.m., Coffee Break, *Concourse Level*

CMW • VCSEL I—Continued

CMW5 • 2:30 p.m.
Data Inversion and Adjustable Chirp in 10-Gbps Directly-Modulated Injection-Locked 1.55-μm VCSELs, *Xiaoxue Zhao[1], Bo Zhang[2], Louis Christen[2], Devang Parekh[1], Fumio Koyama[3], Werner Hofmann[4], Markus C. Amann[4], Alan E. Willner[2], Connie J. Chang-Hasnain[1]; [1]Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA, [2]Dept. of Electrical Engineering-Systems, Univ. of Southern California, USA, [3]Tokyo Inst. of Technology, Japan, [4]Walter Schottky Inst., Technical Univ. of Munich, Germany.* We demonstrate adjustable chirp of directly-modulated injection-locked VCSELs at 10-Gbps resulting from a novel data pattern inversion phenomenon, which leads to chromatic dispersion compensation and a 10x distance increase over standard single-mode fiber.

CMW6 • 2:45 p.m.
Optically Injection-Locked VCSEL for Bi-Directional Optical Communication, *Qing Gu[1], Werner Hofmann[2], Markus-Christian Amann[2], Lukas Chrostowski[1]; [1]Univ. of British Columbia, Canada, [2]Technische Univ. München, Germany.* We propose and experimentally demonstrate for the first time a communication system scheme with an OIL-VCSEL acting both as a transmitter and as a receiver, under an identical forward-bias condition.

CMW7 • 3:00 p.m.
Long-Wavelength 2-D VCSEL Arrays for Optical Interconnects, *Werner H. Hofmann[1], Markus Görblich[1], Gerhard Böhm[1], Markus Ortsiefer[2], Liang Xie[3], Markus-Christian Amann[1]; [1]Walter Schottky Inst., Germany, [2]Vertilas GmbH, Germany, [3]Natl. Res. Ctr. for Optoelectronic Technology, China.* We present a monolithically integrated, individually addressable 2-D VCSEL array. These lasers, based on InP, emit at 1.55 μm and provide, with 10 GHz modulation bandwidth at moderate biasing conditions, high-speed capabilities for optical interconnects.

CMX • Nano- and Micro-Processing of Materials with Femtosecond Laser Pulses—Continued

CMX4 • 2:30 p.m.
Substrate Study of Tungsten Nano-Gratings Deposited by a Single Femtosecond Laser Beam, *Mingzhen Tang, Haitao Zhang, Tsing-Hua Her; Univ. of North Carolina at Charlotte, USA.* Subwavelength tungsten nano-gratings were grown using a single femtosecond laser beam on many substrates. Quantitative study of substrate reveals that substrates play a significant role in controlling the growth conditions and physical attributes of tungsten-nano-gratings.

CMX5 • 2:45 p.m.
Extreme Ultraviolet Interferometric Lithography with a Desk-Top System, *Przemyslaw W. Wachulak[1], Mario C. Marconi[1], Willie Rockward[2], David Hill[2], Erik H. Anderson[3], Carmen S. Menoni[1], Jorge J. Rocca[1]; [1]Colorado State Univ., USA, [2]Morehouse College, USA, [3]Lawrence Berkeley Natl. Lab, USA.* We demonstrate an amplitude division interferometer that using illumination from a high brightness desk top extreme ultraviolet (EUV) laser creates large area arrays of lines, holes and dots with sub-100nm feature size.

CMX6 • 3:00 p.m.
Laser Drilling Using a High Repetition Rate and High Average Power Femtosecond Fiber CPA System, *Antonio Ancona[1,2], Katja Rademaker[2], Fabian Röser[2], Jens Limpert[2], Stefan Nolte[2], Andreas Tünnermann[2]; [1]CNR-INFM Regional Lab, Italy, [2]Inst. of Applied Physics, Friedrich Schiller Univ. Jena, Germany, [3]Fraunhofer Inst. for Applied Optics and Precision Engineering IOF, Germany.* We report on laser drilling experiments on copper and stainless steel samples using a novel ultrafast fiber CPA laser amplifier. Effects of particle shielding and heat accumulation at high average powers are discussed.

CMY • Optical Filters—Continued

CMY5 • 2:30 p.m.
Observation of Frequency Division and Chaos Behavior in a Laser Diode Driven by a Resonant Tunneling Diode, *Bruno Romeira[1], José M. L. Figueiredo[1], Thomas J. Slight[2], Liquan Wang[2], Edward Wasige[2], Charles N. Ironside[2], José M. Quintana[3], Maria J. Avedillo[3]; [1]Ctr. de Electrónica, Optoelectrónica e Telecomunicações, Univ. do Algarve, Portugal, [2]Dept. of Electronics and Electrical Engineering, Univ. of Glasgow, UK, [3]Ctr. Nacional de Microelectrónica, Inst. de Microelectrónica de Sevilla, Univ. de Sevilla, Spain.* We report optical experimental frequency division and chaos results in a resonant tunneling diode laser diode driver configuration that forms a self-oscillating circuit. Circuit behavior and laser output results are well predicted using Liénard's equation.

CMY6 • 2:45 p.m.
Digital Reconstruction of Nonlinear Beam Propagation, *Christopher Barsi, Wenjie Wan, Jason W. Fleischer; Princeton Univ., USA.* We extend the technique of digital holography to the case of propagation through nonlinear media. We experimentally verify the technique by reconstructing nonlinear wave dynamics within a self-defocusing medium and nonlinearly imaging through it.

CMY7 • 3:00 p.m.
268 nm Period Bragg Gratings and Integrated Circuits Produced by Direct UV Writing, *Dmytro O. Kundys, James C. Gates, Huw E. Major, Corin B. E. Gawith, Peter G. R. Smith; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* We demonstrate 268nm period planar Bragg gratings and Mach-Zehnder interferometers fabricated by direct UV-writing. Grating reflectivities of ~30dB and FWHM of ~0.16nm were measured at operational wavelengths around 800nm.

CMZ • Fiber-, Waveguide- and Cavity-Based Sensing I—Continued

CMZ5 • 2:30 p.m.
Integration of Three-Dimensional Photonic Crystals for Refractive Index Sensing in Microfluidics, *Jing Wu, Daniel Day, Min Gu; Ctr. for Micro-Photonics, Swinburne Univ. of Technology, Australia.* We present the concept of a refractive index sensor based on integration of a three-dimensional photonic crystal with a microchannel by femtosecond laser fabrication. The sensor performance was characterized by FTIR spectroscopy.

CMZ6 • 2:45 p.m.
Quantitative Broadband Chemical Sensing in Air-Suspended Solid-Core Fibers, *Tijmen G. Euser[1], Jocelyn S. Y. Chen[1], Nicky J. Farrer[2], Michael Scharrer[1], Peter J. Sadler[2], Philip St. J. Russell[1]; [1]Max-Planck Res. Group, Inst. of Optics, Information and Photonics, Germany, [2]Dept. of Chemistry, Univ. of Warwick, UK.* We report a sensitive evanescent field sensor using air-suspended solid-core fibers. Excellent agreement between measured and calculated mode profiles allows us to measure quantitative broadband absorption spectra with sample volumes as low as 1 μL.

CMZ7 • 3:00 p.m.
Surface Plasmon Resonance Spectroscopy in the Mid-Infrared Range, *Sylvain Herminjard[1], Lorenzo Sirigu[1], Hans-Peter Herzig[1], Eric Studemann[2], Andrea Crottini[2], Jean-Paul Pellaux[2], Tobias Gresch[3], Milan Fischer[3], Jerome Faist[3]; [1]Inst. of Microtechnology, Univ. of Neuchatel, Switzerland, [2]Hach Ultra Analytics, Switzerland, [3]Inst. for Quantum Electronics, Switzerland.* A surface plasmon resonance sensor has been successfully designed in the mid-infrared range. Evidence for surface plasmon resonance will be presented and early results on gas sensing performed with this sensor will be discussed.

3:15 p.m.–3:45 p.m., Coffee Break, *Concourse Level*

CMAA • LED Device Physics—Continued

CMAA4 • 2:30 p.m.
Efficiency of InGaN LEDs Incorporating Surface Plasmon Polaritons, *Christopher Wiesmann[1], Norbert Linder[1], Ulrich T. Schwarz[2]; [1]OSRAM Optosemiconductors, Germany, [2]Univ. Regensburg, Germany.* We estimated the influence of Surface Plasmon Polaritons on the internal efficiency of LEDs by 3-D FDTD calculations. It turns out, that SPP LEDs outperform standard LEDs if non-radiative losses are high.

CMAA5 • 2:45 p.m.
Improving Quantum Efficiency with Nanostructured Semipolar III-Nitride Light Emitters, *Taeil Jung, P. C. Ku; Univ. of Michigan, USA.* We demonstrated nanostructured semipolar III-nitride light emitters on low cost c-plane GaN templates using one-step epitaxy. The total light emission efficiency is improved by a factor of 2.6 compared to polar emitters at room temperature.

CMAA6 • 3:00 p.m.
Nitride/Organic Hybrid Heterostructures for Photodetector Devices, *Hyunjin Kim[1], Qiang Zhang[1], Arto Nurmikko[1], Qian Sun[2], Jung Han[2]; [1]Brown Univ., USA, [2]Yale Univ., USA.* We report on the study of incorporation of organic semiconductors with GaN to explore new types of optoelecronic devices. Photovoltaic effect and photoconductivity gain were demonstrated using Organic/Inorganic heterostructure, which offer new type of photodetectors.

3:15 p.m.–3:45 p.m.
Coffee Break, *Concourse Level*

NOTES

CLEO

3:45 p.m.–5:30 p.m.
CMBB • Nonlinear Wave Mixing
Jason W. Fleischer; Princeton Univ., USA, Presider

CMBB1 • 3:45 p.m.
Passive Mode Locking of Optical Parametric Oscillators: An Efficient Technique for Generating Sub-Picosecond Pulses, *Jacob B. Khurgin[1], Jean Michel Melkonian[2], Antoine Godard[2], Michel Lefebvre[2], Emmanuel Rosencher[2,3]; [1]Johns Hopkins Univ., USA, [2]Office Natl. d'Etudes et de Recherches Aérospatiales, France, [3]Dept. de Physique, Ecole Polytechnique, France.* We show that gain in an OPO with a large walkoff between the pump and signal saturates just like a laser gain and thus CW pumped OPO can be directly mode-locked with high conversion efficiency.

CMBB2 • 4:00 p.m.
Modulation Instability of Coherent-Incoherent Mixtures, *Dmitry V. Dylov, Jason W. Fleischer; Princeton Univ., USA.* We study, experimentally and theoretically, the modulation instability of a mixture of coherent and spatially-incoherent beams. In contrast with incoherent-MI, which requires a threshold nonlinearity, we show that any amount of coherent component triggers instability.

CMBB3 • 4:15 p.m.
Inherent Enhancement of Nonlinear Generation Terms in DC-Induced Three Wave Mixing Coupled Mode Equations, *Christopher A. Sapiano, J. Stewart Aitchison, Li Qian; Univ. of Toronto, Canada.* Coupled mode equations are derived for three wave mixing processes induced in centrosymmetric materials by thermal poling. It is found that degeneracy of the DC field involved inherently doubles terms associated with nonlinear generation.

CMBB4 • 4:30 p.m.
Tunable Delays via Conversion-Dispersion Using On-Chip Four-Wave-Mixing, *Yoshitomo Okawachi, Mark A. Foster, Amy C. Turner, Reza Salem, Jacob S. Levy, Michal Lipson, Alexander L. Gaeta; Cornell Univ., USA.* We demonstrate tunable optical delays of 10 Gbit/s data pulses over a total range of 12 ns using a combination of wavelength conversion via four-wave-mixing on a silicon chip and a dispersive element.

JOINT

3:45 p.m.–5:30 p.m.
JMD • Joint CLEO/QELS Symposium on Novel Resonators: Cavity Opto-Mechanics
Gerard Milburn; Univ. of Queensland, Australia, Presider

JMD1 • 3:45 p.m.
Optomechanics of Strongly Coupled Stacked Monolithic Microdisks, *Matt Eichenfield, Oskar J. Painter; Caltech, USA.* We demonstrate a pair of strongly-coupled, stacked monolithic silicon nitride microdisk resonators coupled to a tapered optical fiber. High-frequency optomechanical interactions between the two microdisks are induced by both optical force and photothermal effects.

JMD2 • 4:00 p.m.
Self-Aligning "Smart" Microcavities and Picometer-Scale Optomechanical Control through Optical Forces and Potentials, *Peter T. Rakich, Milos A. Popovic, Marin Soljacic, Erich P. Ippen; MIT, USA.* We propose a new class of all-optical self-adaptive optomechanical circuits, enabling the manipulation of cavity resonances through resonantly tailored optomechanical potentials, leading to control of cantilevers with picometer precision and self-aligning microcavities.

JMD3 • 4:15 p.m. Invited
Cavity Opto-Mechanics, *Kerry Vahala[1], Tobias Kippenberg[2]; [1]Caltech, USA, [2]Max Planck Inst. für Quantenoptik, Germany.* The union of optical microcavities and micro-mechanical resonators in certain devices has enabled radiation-pressure cooling to Kelvin temperatures and realization of new micro-mechanical oscillators. These results, their importance and future prospects are reviewed.

CLEO

3:45 p.m.–5:30 p.m.
CMCC • Short Wavelength Imaging
Paolo Villoresi; Univ. degli Studi di Padova, Italy, Presider

CMCC1 • 3:45 p.m.
Intense XUV Femtosecond Pulses Selected by a Time-Delay-Compensated Monochromator, *Enrico Benedetti[1], Federico Ferrari[1], Salvatore Stagira[1], Giuseppe Sansone[1], Mauro Nisoli[1], Luca Poletto[2], Paolo Villoresi[2]; [1]Consiglio Natl. delle Ricerche, Inst. Natl. per La Fisica della Materia, Dept. di Fisica, Politecnico di Milano, Italy, [2]Consiglio Natl. delle Ricerche, Inst. Natl. per La Fisica della Materia, DEI, Univ. di Padova, Italy.* Extreme-ultraviolet pulses, produced by high-order-harmonic generation, have been spectrally selected by a time-delay-compensated monochromator. Temporal characterization has been obtained using cross-correlation method: pulses as short as 8 fs, with high photon flux, have been measured.

CMCC2 • 4:00 p.m.
High-Order Harmonics from Targets Containing an Abundance of Metal Nanoparticles, *Luc Bertrand Elouga Bom, Jalal Abdul-Hadi, Tsuneyuki Ozaki; Ctr. Enérgie, Matériaux et Télécommunications, Inst. Natl. de la Res. Scientifique, Canada.* We generate high-order harmonics from ablation plasma containing an abundance of nanoparticles. Results show that the use of nanoparticles targets enhances the harmonic intensity, and also shifts the harmonic spectrum in wavelength.

CMCC3 • 4:15 p.m.
Extreme Ultraviolet Holography with Wavelength Resolution, *Przemyslaw W. Wachulak, Mario C. Marconi, Randy Bartels, Carmen S. Menoni, Jorge J. Rocca; Colorado State Univ., USA.* Holographic images of carbon nanotubes 50-80 nm in diameter were obtained with a spatial resolution matching the wavelength of the compact capillary discharge extreme ultraviolet (EUV) laser used for illumination, 46.9 nm.

CMCC4 • 4:30 p.m.
Multiple Reference Fourier Transform Holography Using Coherent High-Harmonic Soft-X-Rays, *Daisy A. Raymondson[1,2], Richard L. Sandberg[1,2], Chan La-o-vorakiat[1,2], Ariel Paul[1,2], Margaret M. Murnane[1,2], Henry C. Kapteyn[1,2], William F. Schlotter[3]; [1]JILA and Dept. of Physics, Univ. of Colorado, USA, [2]NIST, USA, [3]Stanford Synchrotron Radiation Lab, Stanford Linear Accelerator Ctr., and Dept. of Applied Physics, Stanford Univ., USA.* We demonstrate multiple reference Fourier transform holography with coherent soft X-rays from a tabletop high harmonic source for the first time. Simple reconstruction using a two-dimensional Fourier Transform shows a 90nm resolution.

CLEO

3:45 p.m.–5:30 p.m.
CMDD • Supercontinuum Generation II
Mark A. Foster; Cornell Univ., USA, Presider

CMDD1 • 3:45 p.m.
High-Power 29 W CW Supercontinuum Source, *B. A. Cumberland, J. C. Travers, S. V. Popov, J. R. Taylor; Femtosecond Optics Group, Physics Dept., Imperial College London, UK.* We report a 29 W CW supercontinuum spanning 1.06-1.67μm with a spectral power density of 50mW/nm up to 1.4μm generated in a double-zero PCF. The dynamics of formation are analyzed.

CMDD2 • 4:00 p.m.
Raman Response Function and Supercontinuum Generation in Chalcogenide Fiber, *Jonathan Hu[1], Curtis R. Menyuk[1], L. Brandon Shaw[2], Jasbinder S. Sanghera[2], Ishwar D. Aggarwal[2]; [1]Univ. of Maryland, Baltimore County, USA, [2]NRL, USA.* We show the Raman response function and dispersion curve for a chalcogenide fiber. We then model and reproduce the experimental bandwidth of IR supercontinuum generation using a chalcogenide PCF.

CMDD3 • 4:15 p.m.
The Impact of Nonlinearity During Femtosecond Pulse Compression in Fibers on Continuum Coherence, *Jeffrey W. Nicholson, Andrew D. Yablon, Man F. Yan, Patrick Wisk, Jim Fleming, Eric Monberg, Frank Dimarcello, Ryan Bise, Dennis J. Trevor, John Alonzo, Tom Stockert; OFS Labs, USA.* Amplified erbium-fiber-laser pulses compressed in large-mode-area fiber show significantly reduced nonlinearity compared to standard-single-mode fiber. Consequently, supercontinuum generated with the pulses compressed in large-mode-area fiber show a 10 dB increase in cross-coherence fringe visibility.

CMDD4 • 4:30 p.m.
Waveguide Fabrication and Supercontinuum Generation in an Ultrafast Laser Inscribed Chalcogenide Glass Waveguide, *Nicholas D. Psaila[1], Robert R. Thomson[1], Henry T. Bookey[1], Ajoy K. Kar[1], Nicola Chiodo[2], Roberto Osellame[2], Giulio Cerullo[2], Shaoxiong Shen[3], Animesh Jha[3]; [1]Heriot-Watt Univ., UK, [2]Politecnico di Milano, Italy, [3]Univ. of Leeds, UK.* We report on the fabrication and characterisation of waveguides fabricated in a GeS based chalcogenide glass. A wide range of waveguiding structures were fabricated, and supercontinuum generation was demonstrated for a highly multimode waveguide.

QELS

3:45 p.m.–5:30 p.m.
QMJ • Single-Photon Detectors
Sae Woo Nam; NIST, USA, Presider

QMJ1 • 3:45 p.m.
Superconducting Nanowire Photon Number Resolving Detector at Telecom Wavelength, *Francesco Marsili[1,2], David Bitauld[2], Aleksander Divochiy[3], Alessandro Gaggero[4], Roberto Leoni[4], Francesco Mattioli[4], Alexander Korneev[3], Vitaliy Seleznev[3], Nataliya Kaurova[3], Olga Minaeva[3], Gregory Gol'tsman[3], Konstantinos G. Lagoudakis[1], Moushab Benkhaoul[1], Francis Lévy[1], Andrea Fiore[2]; [1]Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland, [2]Eindhoven Univ. of Technology, Netherlands, [3]Moscow State Pedagogical Univ. (MSPU), Russian Federation, [4]Inst. di Fotonica e Nanotecnologie (IFN), Italy.* We demonstrate a photon-number-resolving (PNR) detector, based on parallel superconducting nanowires, capable of resolving up to 5 photons in the telecommunication wavelength range, with sensitivity and speed far exceeding existing approaches.

QMJ2 • 4:00 p.m.
High-Fidelity Photon-Number-Resolution Using Multi-Element Superconducting Nanowire Single Photon Detectors, *Eric A. Dauler[1,2], Richard Molnar[2], Andrew J. Kerman[2], Bryan S. Robinson[2], Vikas Anant[1], Xiaolong Hu[1], Joel K. W. Yang[1], Karl K. Berggren[1]; [1]MIT, USA, [2]MIT Lincoln Lab, USA.* Achieving photon-number-resolution using superconducting nanowire single photon detectors (SNSPDs) can enable high-speed source characterization and high-rate conditional state preparation. We report improved fidelity photon-number-resolution using high system-detection-efficiency four-element SNSPDs.

QMJ3 • 4:15 p.m.
Single-Photon Detection at the Nanoscale with Superconducting Nanowires, *David Bitauld[1], Francesco Marsili[1], Andrea Fiore[1], Alessandro Gaggero[2], Roberto Leoni[2], Francesco Mattioli[2], Moushab Benkahoul[3], Francis Lévy[3]; [1]Eindhoven Univ. of Technology, Netherlands, [2]Inst. di Fotonica e Nanotecnologie (IFN), CNR, Italy, [3]Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland.* We evidence the nanoscale nature of photodetection in superconducting nanowire single-photon detectors by a spatially-resolved efficiency measurement. A novel nanoscale detector, with 100x100 nm^2 active area, is also demonstrated using an artificial constriction.

QMJ4 • 4:30 p.m.
Investigation of Local Photon Detection Efficiency Distributions in Nanowire Superconducting Single-Photon Detectors, *Burm Baek[1], Eric J. Gansen[1], Martin J. Stevens[1], Richard P. Mirin[1], Sae Woo Nam[1], Robert H. Hadfield[2], Paul A. Dalgarno[2], John A. O'Connor[2], Euan Ramsay[2], Richard J. Warburton[2]; [1]NIST, USA, [2]Heriot-Watt Univ., UK.* Uniform meander structure is one of the key issues in developing high-detection-efficiency nanowire superconducting single photon detectors. We present our effort on investigating their local photon detection efficiency distribution in high spatial resolution.

CLEO

3:45 p.m.–5:30 p.m.
CMEE • Advanced Optical Length Metrology
Kaoru Minoshima; AIST, Japan, Presider

CMEE1 • 3:45 p.m.
Precision Measurement of Refractive Indices of the Atmospheric Gases Using a Frequency Comb, *Jie Zhang, Zehuang Lu, Lijun Wang; Max-Planck Res. Group, Inst. of Optics, Information and Photonics, Univ. of Erlangen-Nuremberg, Germany.* We report high precision refractive indices measurement of air and its constitute gases using an unbalanced Mach-Zehnder interferometer with frequency combs. Our experiments demonstrate sensitivities in levels of 10^{-9}.

CMEE2 • 4:00 p.m.
High-Accuracy Interferometer with a Prism Pair for Measurement of the Absolute Refractive Index of Glass, *Yasuaki Hori, Akiko Hirai, Kaoru Minoshima, Hirokazu Matsumoto; Natl. Inst. of Advanced Industrial Science and Technology, Japan.* Interferometer for precise refractive-index measurement of glass-prism without prior knowledge is developed using a direct comparison of optical-path-changes in glass and air. Preliminary result shows uncertainty of 4.4×10^{-5} agreeing with the manufacturer's values.

CMEE3 • 4:15 p.m.
Three-Dimensional Measurement Using Electronically Controlled Wavelength-Tunable Ultrashort Pulse Fiber Laser, *Takefumi Ohta[1], Norihiko Nishizawa[1], Kazuyoshi Itoh[1], Tetsuya Ozawa[2]; [1]Osaka Univ., Japan, [2]Miyagi Natl. College of Technology, Japan.* High-speed 3-dimensional measurement system is demonstrated using electronically controlled wavelength-tunable ultrashort pulse fiber laser and fiber interferometer. Clear images of metallic samples are obtained from a few meter long distance at speed of 1,000 points/s.

CMEE4 • 4:30 p.m.
Three-Dimensional Microscopic Interferometer by Frequency Sweep of Supercontinuum Frequency Comb, *Samuel Choi, Naoyuki Tamura, Ryo Kobe, Tatsutoshi Shoida, Yosuke Tanaka, Takashi Kurokawa; Tokyo Univ. of Agriculture and Technology, Japan.* A three-dimensional microscopic interferometer by the interval frequency sweep of the supercontinuum frequency comb generated by a optical pulse synthesizer was demonstrated. The spectral bandwidth was 80 nm. The interferometric peak width was 35 μm.

3:45 p.m.–5:30 p.m.
CMFF • THz QCL II
Hou-Tong Chen; Los Alamos Natl. Lab, USA, Presider

CMFF1 • 3:45 p.m. Invited
Terahertz Semiconductor Gain Medium: Static Properties and Dynamic Behavior, *Juraj Darmo[1], J. Kröll[1], M. Martl[1], D. Dietze[1], S. Barbieri[2], C. Sirtori[2], K. Unterrainer[1]; [1]Photonics Inst., Vienna Univ. of Technology, Austria, [2]Materiaux at Phénemenes Quantiques Lab, Univ. Paris, Austria.* Study of gain medium of terahertz quantum cascade lasers based on the interaction with broadband coherent radiation is presented. The phase resolved emitted field provides information on gain bandwidth, saturation recovery dynamics and coherent processes.

CMFF2 • 4:15 p.m.
Spectral Gain Narrowing in THz Quantum Cascade Lasers above Laser Threshold Using THz-Time Domain Spectroscopy, *Nathan Jukam[1], Sukhdeep S. Dhillon[1], Dimitri Oustinov[1], Zhen-Yu Zhao[1], Sophie Hameau[1], Stefano Barbieri[2], Pascal Filloux[2], Xavier Marcadet[3], Carlo Sirtori[2], Jerome Tignon[1]; [1]Lab Pierre Aigrain, Ecole Normale Superieure, France, [2]Materiaux et Phenomenes Quantiques, Univ. Denis Diderot, France, [3]III-V Lab, France.* Terahertz time-domain spectroscopy is used to determine the gain of terahertz quantum-cascade lasers. Gain clamping and spectral gain narrowing are observed above threshold, giving insight into subband alignment as a function of the applied voltage.

CMFF3 • 4:30 p.m.
THz Quantum Cascade Lasers Grown by Low-Pressure Metalorganic Vapor Phase Epitaxy, *Lorenzo Sirigu[1], Alok Rudra[2], Maria I. Amanti[3], Giacomo Scalari[3], Milan Fischer[3], Marcella Giovannini[1], Jerome Faist[3], Eli Kapon[2]; [1]Inst. of Microtechnology, Univ. of Neuchatel, Switzerland, [2]Lab of Physics of Nanostructures-EPFL, Switzerland, [3]Inst. of Quantum Electronics, ETH-Zurich, Switzerland.* A terahertz quantum cascade laser (QCL) has been successfully grown by low-pressure MOVPE. Very high quality semiconductor interfaces are demonstrated as well as very promising lasing performance as compared to MBE-grown THz QCLs.

QELS

3:45 p.m.–5:30 p.m.
QMK • Solitons
Demetrios Christodoulides; College of Optics and Photonics, Univ. of Central Florida, USA, Presider

QMK1 • 3:45 p.m.
Optical Shock Waves on a Partially Incoherent Background, *Dmitry V. Dylov, Wenjie Wan, Christopher Barsi, Jason W. Fleischer; Princeton Univ., USA.* We experimentally study dispersive optical shock waves on a partially-spatially-incoherent background. We observe statistical wave damping and demonstrate shock waves using both self-defocusing and self-focusing nonlinearities, corresponding to positive and negative optical fluid pressures.

QMK2 • 4:00 p.m.
Soliton Molecules: Phase Profiles and Binding Mechanism, *Alexander Hause, Haldor Hartwig, Michael Böhm, Fedor Mitschke; Univ. of Rostock, Germany.* Temporal soliton molecules in dispersion-managed fibers are characterized with the new VAMPIRE technique. Based on the revealed phase and power profiles an analytical model is discussed to explain the binding mechanism of these stable compounds.

QMK3 • 4:15 p.m.
An Uncertainty Principle for Solitons, *Michael Böhm, Fedor Mitschke; Univ. of Rostock, Germany.* The soliton content in optical fibers with realistic attenuation is determined using the novel "soliton-radiation beat analysis" which does not require integrability. Previous approaches describe the soliton decay in a misleading way.

QMK4 • 4:30 p.m.
Observation of Soliton Tunneling Phenomena and Soliton Emission, *Assaf Barak[1], Or Peleg[1], Mordechai Segev[1], Avy Soffer[2], Chris Stucchio[2]; [1]Technion, Israel Inst. of Technology, Israel, [2]Rutgers Univ., USA.* We study, theoretically and experimentally, nonlinear dynamics of a wavepacket launched inside a potential well. Increasing the power of the wavepacket transforms its dynamics from linear tunneling, to soliton tunneling, and eventually to soliton emission.

3:45 p.m.–5:30 p.m.
CMGG • VCSEL II
Richard Jones; Intel Corp., USA, Presider

CMGG1 • 3:45 p.m.
Ultra Thin HCG in a NEMO Tunable VCSEL, *Michael C. Y. Huang, Ye Zhou, Connie J. Chang-Hasnain; Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA.* We present nano-electromechanical optoelectronic (NEMO) tunable VCSELs utilizing ultra-thin electrostatic-actuated single-layer (140nm), high-contrast subwavelength grating designed to strongly reflect TE-polarized light. A 2mW single-mode (SMSR ~45dB) VCSEL with ultra-fast tuning speed ~90 ns is demonstrated.

CMGG2 • 4:00 p.m.
Characterization and Analysis of Micro-Fluidic VCSELS, *Joshua D. Sulkin, Ansas M. Kasten, Dominic F. Siriani, Kent D. Choquette; Univ. of Illinois, USA.* A parametric study of micro-fluidic photonic crystal vertical-cavity surface-emitting lasers is carried out which shows a larger fluid-induced wavelength shift with smaller lattice constant. An effective index model is developed which is consistent with measurements.

CMGG3 • 4:15 p.m.
Visible Split Beam VCSEL for Compact Sensor Applications, *Markus Maute[1], Volker Gerhardt[1], John D. Lambkin[1], Stephen A. Slattery[2], John P. Justice[2], Steven P. Hegarty[2], Guillaume Huyet[2], Brian Corbett[2]; [1]Firecomms, Ireland, [2]Tyndall Natl. Inst., Ireland.* We present a visible VCSEL with integrated beam splitter. By focusing one beam onto a moving target and monitoring the power variation in the second beam, these devices can be used as Doppler-based velocity sensors.

CMGG4 • 4:30 p.m. Invited
Threshold Current Reduction and Electrical Modulation of Degree of Circular Polarization in InAs/GaAs Quantum Dot Spin-VCSELs, *Debashish Basu, Chung Chiang Wu, Dipankar Saha, Zetian Mi, Pallab Bhattachar; Univ. of Michigan, USA.* Threshold current reduction and polarization modulation of an electrically injected spin-polarized VCSEL operating at 200 K have been investigated experimentally and theoretically.

3:45 p.m.–5:30 p.m.
CMHH • Femtosecond Lasers in Biology: Cell/Tissue Ablation and Biosensor Fabrication
Peter Herman; Univ. of Toronto, Canada, Presider

CMHH1 • 3:45 p.m. Tutorial
Femtosecond and Nanosecond Laser-Induced Nanoeffects for Cell Surgery and Modifications of Glass, *Alfred Vogel[1], Norbert Linz[1], Sebastian Freidank[1], Joachim Noack[1], Günther Paltauf[2]; [1]Inst. of Biomedical Optics, Univ. of Lübeck, Germany, [2]Physics Inst., Karl-Franzens-Univ. Graz, Austria.* Both femtosecond and nanosecond pulses can create low-density plasmas in transparent dielectrics suitable for nano-cell surgery and modification of glasses. The variation of mechanisms with pulse repetition rate and duration will be discussed.

Alfred Vogel received his Ph.D. in physics in 1987 from the University of Goettingen, and is presently Associate Professor of Physics and Deputy Chair of the Institute of Biomedical Optics at the University of Luebeck, Germany. He authored 77 peer-reviewed publications, and serves on the editorial boards of *Optics Express* and *Journal of Biomedical Optics.*

3:45 p.m.–5:30 p.m.
CMII • A/D Conversion and Waveform Processing
Paul W. Juodawlkis; MIT Lincoln Lab, USA, Presider

CMII1 • 3:45 p.m.
7-ENOB Resolution Photonic Analog-to-Digital Conversion of Narrowband Microwave Signals at 40 GHz, *Jungwon Kim, Matthew Park, Michael H. Perrott, Franz X. Kärtner; MIT, USA.* An optical sub-sampling downconversion receiver for analog-to-digital conversion of narrowband high-frequency microwave signals is demonstrated. The measured SNDR in 2-MHz bandwidth at 40-GHz carrier frequency is 44 dB corresponding to 7-ENOB resolution.

CMII2 • 4:00 p.m.
Demonstrations of Analog-to-Digital Conversion Using a Frequency Domain Stretched Processor, *Randy R. Reibel[1], Calvin Harrington[1], Jason Dahl[1], Charles Ostrander[1], Peter A. Roos[1], R. Krishna Mohan[1], Wm. Randall Babbitt[1,2], Trenton J. Berg[2]; [1]Spectrum Lab, Montana State Univ., USA, [2]S2 Corp., USA.* Proof-of-concept analog-to-digital conversion demonstrations are presented for a photonics based frequency-domain, stretched processor. Here 800 MHz bandwidths and >26dB dynamic range are shown, with models suggesting 10-bit performance over 20 GHz bandwidths.

CMII3 • 4:15 p.m.
Compensation Algorithm for Deterministic Phase Ripple, *Josh A. Conway, George A. Sefler, George C. Valley, Jason T. Chou; Aerospace Corp., USA.* Phase ripple arising from imperfections in novel dispersive devices can severely distort broadband optical signals. We experimentally and theoretically demonstrate an algorithm that corrects for these distortions while simultaneously reducing the effects of additive noise.

CMII4 • 4:30 p.m.
Adaptive Error Compensation for Photonic Analog-to-Digital Converters, *Anatol Khilo, Jonathan R. Birge, Franz X. Kärtner; MIT, USA.* Factors limiting the accuracy of a wideband optically sampled analog-to-digital converter are analyzed. An algorithm for adaptive error compensation in a post-processing step is proposed and shown to be effective against various system imperfections.

3:45 p.m.–5:30 p.m.
CMJJ • Fiber-, Waveguide- and Cavity-Based Sensing II
Robert P. Lucht; Purdue Univ., USA, Presider

CMJJ1 • 3:45 p.m.
Fiber Surface Enhanced Raman Scattering (SERS) Sensors Based on a Double Substrate "Sandwich" Structure, *Chao Shi, Claire Gu, Debraj Ghosh, Leo Seballos, Shaowei Chen, Jin Z. Zhang; Univ. of California at Santa Cruz, USA.* A new configuration was designed and tested based on "sandwiching" target analyte molecules between two metal nanostructure substrates using surface enhanced Raman scattering (SERS), which exhibits significantly higher SERS enhancement compared to just one substrate.

CMJJ2 • 4:00 p.m.
Detection of Explosives and CO_2 Dissolved in Water with an Evanescent Field Sensor, *Rozalia Orghici[1], Ulrike Willer[1,2], Magdalena Gierszewska[1], Siegfried R. Waldvogel[2,3], Wolfgang Schade[1,2]; [1]Inst. für Physik und Physikalische Technologien, Clausthal Univ. of Technology, Germany, [2]Laser Anwendungs Centrum, Clausthal Univ. of Technology, Germany, [3]Kekule Inst. for Organic Chemistry and Biochemistry, Univ. Bonn, Germany.* A fiber optic approach for the determination of the carbon dioxide concentration in the gas or fluid phase during sequestration as well as for the sensing of the explosive TNT will be presented.

CMJJ3 • 4:15 p.m.
Evanescent Field Sensing in Novel Flat Fiber, *Christopher Holmes, F. R. Mahamd Adikan, Andrew S. Webb, James C. Gates, Corin B. E. Gawith, Jayanta K. Sahu, Peter G. R. Smith, David N. Payne; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* Recently developed novel 'flat fiber' substrate promises flexible, long-haul integrated optical devices. Here, we present the first demonstration of one such device; an evanescent field sensor, based upon direct UV written Bragg gratings.

CMJJ4 • 4:30 p.m.
Hollow Waveguide as an Online Microliter Spectroscopy Sensor for Gas Chromatography, *Andrei Deev, Sheng Wu, Yongchun Tang; Caltech, USA.* Quantum Cascade laser is coupled into Hollow Waveguide as an inline sensor after GC separation. We show the sensor has high ppbV sensitivity for carbon and other species, yet maintaining the GC peaks.

3:45 p.m.–5:30 p.m.
CMKK • Novel LED and OLED Device Structures

Franky So; Univ. of Florida, USA, Presider

CMKK1 • 3:45 p.m. Invited
OLEDs on Fibers and AFM Cantilevers, *Max Shtein[1], Brendan O'Connor[2], Yiying Zhao[1], Kevin P. Pipe[2]; [1]Dept. of Materials Science and Engineering, Univ. of Michigan, USA, [2]Dept. of Mechanical Engineering, Univ. of Michigan, USA*. This talk will discuss recent work on novel device architectures that include ITO-free OLEDs deposited on fibers, on highly corrugated surfaces and sharp tips for for solid-state lighting and microscopy applications.

CMKK2 • 4:15 p.m.
High-Resolution Mapping of Electric Field inside Organic Optoelectronic Devices, *Michele Celebrano, Calogero Sciascia, Giulio Cerullo, Guglielmo Lanzani, Juan Cabanillas-Gonzalez; Politecnico di Milano, Italy.* By combining confocal microscopy with electroreflectance spectroscopy we directly map electric field amplitude distribution between electrodes in a prototypical organic semiconductor device. We demonstrate this approach on a copper phthalocyanine photodetector.

CMKK3 • 4:30 p.m.
Emission Characteristics of a Surface-Emitting Composite Organic Photonic-Crystal Laser, *Sidney S. Yang, Li-Wen Chang, Chong-Jie Huang; Inst. of Photonics Technologies, Natl. Tsing Hua Univ., Taiwan*. Lasing action of a composite organic thin-film laser with a 2nd-order two-dimensional photonic crystal structure of triangular lattice is investigated. The analysis of band theory is adopted and the emission pattern is also presented.

NOTES

CLEO | JOINT | CLEO

CMBB • Nonlinear Wave Mixing—Continued

CMBB5 • 4:45 p.m.
Photorefractive Two-Wave Mixing in $Sn_2P_2S_6$:Te at 1.55 µm, *Roger Mosimann[1], Patrick Marty[1], Mojca Jazbinsek[1], Peter Gunter[1], Alexander A. Grabar[2]; [1]Eidgenössische Technische Zurich, Switzerland, [2]Uzhgorod Natl. Univ., Ukraine.* We demonstrate fast photorefractive two-wave mixing with a cw-laser at the telecommunication wavelength 1.55µm for the first time in a bulk ferroelectric crystal ($Sn_2P_2S_6$:Te). A high gain (6cm^{-1}) was achieved without applying an external E-field.

CMBB6 • 5:00 p.m.
Comparison of Four-Wave Mixing in Quantum Dots and Quantum Wells for Wavelength Conversion, *David Nielsen[1], Shun-Lien Chuang[1], N. J. Kim[2], D. Lee[2], S. H. Pyun[3], W. G. Jeong[3], C. Y, Chen[4], T. S. Lay[4]; [1]Univ. of Illinois at Urbana-Champaign, USA, [2]Chungnam Natl. Univ., Republic of Korea, [3]Sungkyunkwan Univ., Republic of Korea, [4]Natl. Sun Yat-Sen Univ., Taiwan.* We experimentally investigate wavelength conversion in quantum-dot and quantum-well optical amplifiers via four-wave mixing. Our results show superior conversion efficiency in a quantum dot device compared to a quantum well device with identical gain.

CMBB7 • 5:15 p.m.
Apex-Enhanced Second Harmonic Generation from Asymmetric Nanoscale Arrays in a Gold Film, *Fatemeh Eftekhari, Reuven Gordon; Univ. of Victoria, Canada.* The second harmonic generation from a non-centrosymmetric nanostructure in gold film is studied comprehensively. The sunglass aperture shape is chosen to have an apex to increase the local field.

JMD • Joint CLEO/QELS Symposium on Novel Resonators: Cavity Opto-Mechanics—Continued

JMD4 • 4:45 p.m.
Optomechanical Effects in a Dispersively Coupled High Finesse Cavity and Micromechanical Membrane, *Benjamin Zwickl[1], Jeff E. Thompson[1], Andrew M. Jayich[1], Cheng Yang[1], Florian Marquardt[2], Steven M. Girvin[1,3], Jack G. E. Harris[1,3]; [1]Physics Dept., Yale Univ., USA, [2]Physics Dept., Ctr. for NanoScience, and Arnold Sommerfeld Ctr. for Theoretical Physics, Ludwig Maximillians Univ., Germany, [3]Dept. of Applied Physics, Yale Univ., USA.* By dispersively coupling a dielectric membrane to an optical cavity, we laser-cooled it from 294K to 6.82mK. Further, the cavity couples to the square of the membrane's displacement—a key for QND energy measurements.

JMD5 • 5:00 p.m. Invited
Resolved Sideband Laser Cooling of a Micro-Mechanical Oscillator, *Albert Schliesser, Rémi Rivière, Georg Anetsberger, Olivier Arcizet, Tobias Kippenberg; Max-Planck-Inst. of Quantum Optics, Germany.* Mechanical oscillation-induced sidebands are resolved by the >20-times narrower resonances of ultrahigh-finesse optical microcavities. Tuning a laser to the first lower sideband thus permits resolved sideband cooling from room temperature to phonon occupations below 6,000.

CMCC • Short Wavelength Imaging—Continued

CMCC5 • 4:45 p.m.
70 nm Lensless Diffractive Microscopy Using Tabletop Soft X-Ray Sources, *Richard L. Sandberg[1], Changyong Song[2], Przemyslaw W. Wachulak[3], Daisy A. Raymondson[1], Ariel Paul[1], Bagrat Amirbekian[2], Anne E. Sakdinawat[4], Edwin Lee[2], Chan La-O-Vorakiat[1], Mario C. Marconi[3], Carmen S. Menoni[3], Margaret M. Murnane[1], Jorge J. Rocca[3], Henry C. Kapteyn[1], Janwei Miao[2]; [1]JILA and Univ. of Colorado at Boulder, USA, [2]California Nanosystems Inst. and Dept. of Physics and Astronomy, Univ. of California at Los Angeles, USA, [3]Dept. of Electrical and Computer Engineering, Colorado State Univ., USA, [4]Ctr. for X-Ray Optics, Lawrence Berkeley Natl. Lab, USA.* We use curvature correction and high-numerical-aperture imaging to demonstrate a soft-x-ray diffraction microscope with 70-90 nm resolution using two tabletop coherent sources. This near-diffraction-limited resolution of 1.5λ is a first for x-ray diffractive imaging.

CMCC6 • 5:00 p.m.
Phase Coherent, Injection-Seeded Table-Top Soft X-Ray Lasers at Wavelengths down to 13.9 nm, *Yong Wang, Francesco Pedaci, Mark Berrill, Brad Luther, E. Granados, Dave Alessi, Jorge J. Rocca; Colorado State Univ., USA.* We have realized the first demonstration of soft x-ray lasers with essentially full spatial and temporal coherence at sub-20nm wavelengths by high harmonic seeding of soft x-ray plasma amplifiers created by irradiation of solid targets.

CMCC7 • 5:15 p.m.
Near-Wavelength Resolution Extreme Ultraviolet Imaging with a Desktop-Size Laser, *Fernando Brizuela[1], Courtney A. Brewer[1], Dale Martz[1], Mario C. Marconi[1], Jorge J. Rocca[1], Carmen S. Menoni[1], Weilun Chao[2,3], Erik H. Anderson[2,3], David T. Attwood[2,3], Alexander V. Vinogradov[4], Igor A. Artioukov[4], Alexander G. Ponomareko[5], Valeriy V. Kondratenko[5]; [1]Colorado State Univ., USA, [2]Lawrence Berkeley Natl. Lab, USA, [3]Univ. of California at Berkeley, USA, [4]P. N. Lebedev Physical Inst., Russian Federation, [5]Natl. Technical Univ., Ukraine.* We have realized the first demonstration of imaging in the extreme ultraviolet (EUV) with near-wavelength spatial resolution, 54 nm, using a uniquely compact full-field microscope that can produce images with a single one nanosecond exposure.

CMDD • Supercontinuum Generation II—Continued

CMDD5 • 4:45 p.m.
Optimizing the Bandwidth and Coherence of Supercontinuum in Soft Glass Microstructured Fibers, *Wen Qi Zhang, Shahraam Afshar Vahid, Tanya M. Monro; Ctr. of Expertise in Photonics, School of Chemistry and Physics, Univ. of Adelaide, Australia.* A genetic algorithm is used for the first time to design soft glass microstructured optical fibers with low flat dispersion that can be used to generate highly coherent supercontinuum extending into the mid-infrared.

CMDD6 • 5:00 p.m.
Low-Energy Threshold Supercontinuum Generated in Highly Nonlinear As_2Se_3 Chalcogenide Submicron Tapers, *Dong-Il Yeom, Eric C. Mägi, Michael R. E. Lamont, Michaël A. F. Roelens, Libin Fu, Benjamin J. Eggleton; ARC Ctr. for Ultrahigh Bandwith Devices for Optical Systems, School of Physics, Univ. of Sydney, Australia.* We fabricate sub-micron chalcogenide fiber tapers exhibiting ultra-high nonlinearity up to γ ~ 93 /W/m. This high nonlinearity, with combination of tailored anomalous dispersion, enables low-energy threshold soliton fission leading to supercontinuum generation.

CMDD7 • 5:15 p.m.
Broadband Supercontinuum Using Single-Mode/Dual-Mode Tellurite Glass Holey Fibers with Large Mode Area, *Xian Feng, Wei H. Loh, Angela Camerlingo, Sonali Dasgupta, Joanne C. Flanagan, Periklis Petropoulos, Ken E. Frampton, Nicholas M. White, Harvey N. Rutt, David J. Richardson; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* We demonstrate broadband 1.0-2.4µm infrared supercontinuum generation with 0.4mW output, using single-mode and few-mode tellurite holey fibers with very large mode area, of up to 3000$µm^2$.

Monday, May 5

5:30 p.m.–6:00 p.m., Break *(Civic Auditorium doors will open at 5:45 p.m. for the Plenary)*

6:00 p.m.–7:30 p.m., CLEO Plenary Session, *Civic Auditorium*

QMJ • Single-Photon Detectors—Continued

QMJ5 • 4:45 p.m.
Homodyne State Tomography with Photon Number Resolving Detectors, *Graciana Puentes, Jeff S. Lundeen, Matthijs P. A. Branderhorst, Hendrik B. Coldenstrodt-Ronge, Brian J. Smith, Ian A. Walmsley; Oxford Univ., UK.* We introduce a complete tomographic reconstruction scheme geared toward low photon-number states. To demonstrate this method we reconstruct various single-mode coherent states.

QMJ6 • 5:00 p.m.
Polarization Dependence of Superconducting Single Photon Detectors, *Eduard F. C. Driessen[1], Floris Braakman[1], Elisabeth M. Reiger[2], Valery Zwiller[2], Michiel J. A. de Dood[1]; [1]Huygens Lab, Univ. Leiden, Netherlands, [2]Kavli Inst. for Nanoscience, Technische Univ. Delft, Netherlands.* We have measured the polarization dependence of the detection efficiency of NbN superconducting single photon detectors. This behavior is explained by the calculated absorption efficiency of a parallel set of metal lines.

QMJ7 • 5:15 p.m.
Time-Resolved Characterization of Single Photons by Upconversion, *Onur Kuzucu[1], Franco N. C. Wong[1], Sunao Kurimura[2], Sergey Tovstonog[2]; [1]MIT, USA, [2]Natl. Inst. for Materials Science, Japan.* We demonstrate a new technique of efficient, time-resolved, infrared single-photon detection using noncollinearly phase-matched frequency upconversion by an ultrafast pump, allowing nearly background-free sub-picosecond characterization of 1582-nm time anti-correlated entangled photons.

CMEE • Advanced Optical Length Metrology—Continued

CMEE5 • 4:45 p.m.
A Distance Meter Using a Sub-Terahertz Intermode Beat in an Optical Frequency Comb, *Shuko Yokoyama, Takeshi Yasui, Tsutomu Araki, Yuki Hagihara; Osaka Univ., Japan.* We proposed a novel method of phase measurement of terahertz intermode beat in optical frequency comb, to enhance the dynamic-range of distance meter. Utilizing nonlinear optical process, distance measurement with 130GHz equivalent frequency was realized.

CMEE6 • 5:00 p.m.
Picometrology of Ultra-Thin Gold Film by Spinning-Disc Interferometry, *Xuefeng Wang, David D. Nolte; Dept. of Physics, Purdue Univ., USA.* We obtain the complex refractive index of ultra-thin gold film (down to 20 picometers) on thermal oxide on silicon by the combination of in-line (IL) and differential-phase-contrast (DPC) channels of spinning-disc interferometry (SDI).

CMEE7 • 5:15 p.m.
Remote and *in situ* Calibration of Linear Scale by Low-Coherence Tandem Interferometer, *Akiko Hirai[1], Junichiro Kitta[2], Fumio Kobayashi[3], Kaoru Sasaki[1], Hirokazu Matsumoto[1]; [1]Natl. Inst. of Advanced Industrial Science and Technology, Japan, [2]Japan Quality Assurance Organization, Japan, [3]Tokyo Univ. of Agriculture and Technology, Japan.* Technique of transferring length-information between two distantly-located low-coherence-interferometers through a single-mode-optical-fiber for remote and *in situ* calibration of linear scale is developed. Results of 200 nm-deviation and 100 nm-standard deviation for 50 mm-length is preliminary achieved.

CMFF • THz QCL II—Continued

CMFF4 • 4:45 p.m.
Vertically Emitting Microdisk Lasers, *Lukas Mahler[1], Alessandro Tredicucci[1], Richard P. Green[1], Fabio Beltram[1], Christoph Walther[2], Jerôme Faist[2], Harvey E. Beere[3], David A. Ritchie[3]; [1]NEST-INFM and Scoula Normale Superiore, Italy, [2]Inst. of Physics, Univ. of Neuchâtel, Switzerland, [3]Cavendish Lab, Univ. of Cambridge, UK.* We report the realization and modelling of microdisk lasers displaying vertical emission. The devices are THz quantum cascade lasers with metallic gratings fabricated along the circumference.

CMFF5 • 5:00 p.m.
Controlled Coupling of Terahertz Lasing Modes in Microdisk Photonic Molecules, *Gernot Fasching[1], Alexander Benz[1], Christoph Deutsch[1], Aaron Maxwell Andrews[1], Karl Unterrainer[1], Reinhard Zobl[2], Pavel Klang[2], Werner Schrenk[2], Vincas Tamosiunas[3,4]; [1]Photonics Inst., Ctr. for Micro- and Nanostructures, Vienna Univ. of Technology, Austria, [2]Inst. of Solid State Electronics, Ctr. for Micro- and Nanostructures, Vienna Univ. of Technology, Austria, [3]Semiconductor Physics Inst., Lithuania, [4]Vilnius Gediminas Technical Univ., Lithuania.* We present the observation of optical coupling in terahertz microdisk molecules based on quantum-cascade lasers and its tunability by the applied electric field. The spectral behaviour is in good accordance with performed Finite-Difference Time-Domain simulations.

CMFF6 • 5:15 p.m.
Microwatt-Level Terahertz Sources Based on Intra-Cavity Difference-Frequency Generation in Mid-Infrared Quantum Cascade Lasers, *Mikhail A. Belkin[1], Federico Capasso[1], Feng Xie[2], Alexey Belyanin[2], Milan Fischer[3], Andreas Wittmann[3], Jerome Faist[3]; [1]Harvard School of Engineering and Applied Sciences, Harvard Univ., USA, [2]Dept. of Physics, Texas A&M Univ., USA, [3]ETH Zurich, Switzerland.* We report 5THz quantum cascade laser sources based on intra-cavity difference-frequency generation in dual-wavelength mid-infrared quantum cascade lasers. Our devices produce microwatt-level terahertz output at 80K and still approximately 200nW output at 250K.

QMK • Solitons—Continued

QMK5 • 4:45 p.m.
Dynamics of Gap Solitons in Random Fiber Gratings, *Eduard N. Tsoy[1], C. Martijn de Sterke[1], Fatkhulla Kh. Abdullaev[2]; [1]School of Physics, Ctr. for Ultrahigh Bandwidth Devices for Optical Systems, Univ. of Sydney, Australia, [2]Physical-Technical Inst. of the Uzbek Acad. of Sciences, Uzbekistan.* We show that gap solitons self-average fluctuations in random gratings. The soliton trapping inside the grating is explained. The correlation functions of the force and the potential acting on the gap soliton are found.

QMK6 • 5:00 p.m.
Repulsive and Attractive Surface Soliton Potentials at Boundaries between Periodic Media, *Sergiy Suntsov[1], Konstantinos G. Makris[1], Demetrios N. Christodoulides[1], George I. Stegeman[1], Roberto Morandotti[2], Maite Volatier[3], Vincent Aimez[3], Richard Ares[3], Haeyeon Yang[4], Gregory J. Salamo[5]; [1]College of Optics and Photonics, CREOL, FPCE, Univ. of Central Florida, USA, [2]Inst. Natl. de la Recherche Scientifique, Univ. du Quebec, Canada, [3]Univ. de Sherbrooke, Canada, [4]Utah State Univ., USA, [5]Univ. of Arkansas, USA.* An interface between two periodic 1-D arrays with self-focusing Kerr nonlinearities is shown experimentally to support strikingly different families of surface solitons due to differences in surface potential near the boundary.

QMK7 • 5:15 p.m.
Observation of Two-Dimensional Lattice Interface Solitons, *Alexander Szameit[1], Yaroslav V. Kartashov[2], Felix Dreisow[1], Matthias Heinrich[1], Victor A. Vysloukh[3], Thomas Pertsch[1], Stefan Nolte[1], Andreas Tünnermann[1,4], Llouis Torner[2]; [1]Inst. of Applied Physics, Friedrich-Schiller Univ. Jena, Germany, [2]Inst. de Ciencies Fotoniques, Univ. Politecnica de Catalunya, Spain, [3]Univ. de la Americas, Mexico, [4]Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* We present the first experimental evidence of two-dimensional surface solitons at the interface between femtosecond laser-written square and hexagonal waveguide arrays in fused silica.

5:30 p.m.–6:00 p.m., Break *(Civic Auditorium doors will open at 5:45 p.m. for the Plenary)*

6:00 p.m.–7:30 p.m., CLEO Plenary Session, *Civic Auditorium*

CMGG • VCSEL II—Continued

CMGG5 • 5:00 p.m.
Polarization Mode Control in High Contrast Subwavelength Grating VCSEL, *Michael C. Y. Huang, Ye Zhou, Connie J. Chang-Hasnain; Dept. of Electrical Engineering and Computer Sciences, Univ. of California at Berkeley, USA.* We experimentally demonstrate deterministic polarization mode control in VCSEL utilizing a single-layer high-index-contrast subwavelength grating (HCG) mirror. Orthogonal polarization suppression ratio of 36 and 28 dB was obtained under both CW and large-signal pulsed operation.

CMGG6 • 5:15 p.m.
Spatially Resolved Thermal Coupling in VCSEL Arrays Using Thermoreflectance Microscopy, *Kathryn J. Greenberg, Joseph A. Summers, Maryam Farzaneh, Janice A. Hudgings; Mount Holyoke College, USA.* Thermoreflectance microscopy is used for simultaneous, spatially-resolved temperature measurements of VCSELs in a 1-D array. Significant thermal effects such as thermal coupling between neighboring VCSELs and temperature distribution across the apertures are reported.

CMHH • Femtosecond Lasers in Biology: Cell/Tissue Ablation and Biosensor Fabrication—Continued

CMHH2 • 4:45 p.m.
Femtosecond Light Interaction with Skin: Microspectroscopy of Light-Induced Changes in Collagen Matrix, *Vladislav V. Yakovlev[1], Robert Thomas[2], Gary Noojin[3], Michael Denton[3]; [1]Univ. of Wisconsin at Milwaukee, USA, [2]AFRL. RHDO, USA, [3]Northrop Grumman Corp., USA.* Femtosecond pulses derived from a Ti:sapphire oscillator are used to locally modify collagen-rich tissue. Raman and fluorescence microspectroscopy are employed for *in situ* observations of structural transformations of collagen matrix.

CMHH3 • 5:00 p.m.
Integrated Optical Sensing in a Lab-on-Chip by Femtosecond Laser Written Waveguides, *Roberto Osellame[1], Rebeca Martinez Vazquez[1], Roberta Ramponi[2], Giulio Cerullo[2], Chaitanya Dongre[3], Ronald Dekker[3], Hugo J. W. Hoekstra[3], Markus Pollnau[3]; [1]IFN C.N.R., Italy, [2]Politecnico di Milano, Italy, [3]Univ. of Twente, Netherlands.* Integrated optical detection in a commercial microfluidic chip for capillary electrophoresis has been implemented by means of femtosecond laser written optical waveguides for excitation and a high numerical aperture optical fiber for collection.

CMHH4 • 5:15 p.m.
Fabrication of High Aspect Ratio Microfluidic Devices Using Direct FS Ablation, *Graham Smith[1], Dimitris Karnakis[2], Martyn Knowles[2], Alan Ferguson[2], Ian Bennion[1], Kate Sugden[1]; [1]Aston Univ., UK, [2]Oxford Lasers Ltd., UK.* We present a single stage direct fs ablation results which show that it is possible to make high quality and high aspect ratio devices in a single stage process using a CAD optimised approach.

CMII • A/D Conversion and Waveform Processing—Continued

CMII5 • 4:45 p.m.
640 Gb/s RZ Eye-Diagram Evaluation by Optical Sampling Oscilloscope without Post-Processing and ms Refresh Time, *Francesco Fresi[1], Andrea Chiuchiarelli[1], Antonio Malacarne[1], Luca Poti[2], Antonella Bogoni[2]; [1]Scuola Superiore Sant'Anna, Italy, [2]Consorzio Nazionale Interuniversitario per le Telecomunicazioni, Italy.* A polarization insensitive quasi-asynchronous optical sampling oscilloscope with sub-ps-resolution is presented. The scheme is able to resolve tens of ns and provides eye-diagram functionality. Experimental results for a 640 Gb/s data frame are reported.

CMII6 • 5:00 p.m.
Compression of Ultra-Wideband Microwave Arbitrary Waveforms via Optical Pulse Shaping, *Ehsan Hamidi, Ingrid S. Lin, Andrew M. Weiner; Purdue Univ., USA.* We report matched filtering of ultra-wideband microwave waveforms via programmable optical phase filters implemented in a hyperfine resolution pulse shaper. As an example we demonstrate compression of an 800-ps electrical chirp waveform to 42 ps.

CMII7 • 5:15 p.m.
Reconfigurable RF Waveform Generation Using Optical Incoherent Sources, *Victor Torres-Company[1], Jesús Lancis[1], Pedro Andrés[2], Lawrence R. Chen[3]; [1]Univ. Jaume I, Spain, [2]Univ. de Valencia, Spain, [3]McGill Univ., Canada.* An RF waveform generator operating with incoherent broadband light is successfully implemented. Complex RF ~10 GHz bandwidth waveforms are generated by means of incoherent wavelength-to-time mapping. Our technique can be scaled to the mm-wave range.

CMJJ • Fiber-, Waveguide- and Cavity-Based Sensing II—Continued

CMJJ5 • 4:45 p.m.
Demonstration of a Refractometric Sensor Based on Optical Microfiber Coil Resonator, *Gilberto Brambilla, Fei Xu; Optoelectronics Res. Ctr., Univ. of Southampton, UK.* We experimentally demonstrated a novel refractometric sensor based on a coated optical microfiber coil resonator which is robust, compact, and comprises an intrinsic fluidic channel. The measured sensitivity has an excellent agreement with theoretical predictions.

CMJJ6 • 5:00 p.m.
On-Chip Gas Detection in Silicon Optical Microcavities, *Jacob T. Robinson, Long Chen, Michal Lipson; Cornell Univ., USA.* We detect acetylene gas on a silicon chip using photonic microcavities and a chip-scale gas cell. We measure refractive index differences as small as 10^{-4} between air and acetylene at varying pressures in the near-IR.

CMJJ7 • 5:15 p.m.
MEMS Chemical Sensors Using Waveguide Fabry-Perot Microcavities, *Marcel W. Pruessner, Todd H. Stievater, William S. Rabinovich, R Andy McGill, Jennifer L. Stepnowski; NRL, USA.* We demonstrate waveguide Fabry-Perot microcavities coupled to in-plane microbeam resonators. The microcavities enable measurement of mechanical resonant frequency shifts resulting from mass loading due to analyte sorption. High selectivity sensor arrays are possible.

5:30 p.m.–6:00 p.m., Break *(Civic Auditorium doors will open at 5:45 p.m. for the Plenary)*

6:00 p.m.–7:30 p.m., CLEO Plenary Session, *Civic Auditorium*

CMKK • Novel LED and OLED Device Structures—Continued

CMKK4 • 4:45 p.m.
Enhanced Light Extraction of Light-Emitting Diodes with Photonic Crystal Pattern Fabricated by Nanoimprint, *Kyeong-Jae Byeon[1], Seon-Yong Hwang[1], Ki-Yeon Yang[1], Heon Lee[1], Chang-Hee Hong[2], Eun-Kyung Suh[2]; [1]Korea Univ., Republic of Korea, [2]Chonbuk Natl. Univ., Republic of Korea.* A hexagonal array of sub-micron sized holes was fabricated on InGaN/GaN quantum-well light-emitting diodes using nanoimprint lithography. Photoluminescence measurement confirms that light extraction of the LED was enhanced with two-dimensional photonic crystal patterns.

CMKK5 • 5:00 p.m.
Fabrication of Photonic Crystal Light-Emitting Diode with Photoelectrochemical Wet Etching and Phase Mask Interference, *Cheng-Yen Chen, Cheng-Hung Lin, Dong-Ming Yeh, Chih-Feng Lu, Chi-Feng Huang, C. C. Yang; Natl. Taiwan Univ., Taiwan.* We demonstrate the high light-extraction efficiency by using the photoelectrochemical etching technique for forming photonic crystal structures on an InGaN/GaN quantum-well light-emitting diode through phase-mask interference. More than 90% increase of output power is observed.

CMKK6 • 5:15 p.m.
Size Effects and Light Extraction Efficiency Optimization of III-Nitride Light Emitting Diodes with SiO_2/Polystyrene Microlens Arrays, *Yik-Khoon Ee, Pisist Kumnorkaew, Ronald A. Arif, Hua Tong, James F. Gilchrist, Nelson Tansu; Lehigh Univ., USA.* Optimization studies of InGaN quantum wells light emitting diodes employing SiO_2/polystyrene microlens arrays are conducted. The use of microlens arrays leads to increase in light extraction efficiency by 2.7-times, in agreement with simulation.

5:30 p.m.–6:00 p.m.
Break *(Civic Auditorium doors will open at 5:45 p.m. for the Plenary)*

6:00 p.m.–7:30 p.m.
CLEO Plenary Session,
Civic Auditorium

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