Room A1 | Room A2: **CLEO: Science & Innovations**

08:00–10:00 CM1A • Detectors & Sources
Patrick (Guo-Qiang) Lo, Institute of Microelectronics, Singapore, *Presider*

CM1A.1 • 08:00
Organic/Inorganic Hybrid Pixelless Near Infrared Imaging Device, Jun Chen[1], Jianchen Tao[1], Dayan Ban[1], Michael G. Helander[2], Zhibin Wang[2], Jacky Qiu[2], Zhenghong Lu[2]; [1]*Electrical and Computer Engineering, University of Waterloo, Canada;* [2]*Materials Science and Engineering, University of Toronto, Canada.* We report a highly simplified single-mesa organic/inorganic hybrid near-infrared-to-visible imaging upconversion device (spatial resolution ~10 µm). This device integrates an intrinsic-InGaAs substrate and an organic light emitting diode.

CM1A.2 • 08:15
High-speed photodetectors in a photonic crystal platform, Luisa Ottaviano[1], Elizaveta Semenova[1], Martin Schubert[1], Kresten Yvind[1], Andrea Armaroli[2], Gaetano Bellanca[2], Stefano Trillo[2], Thanh Nam Nguyen[3,4], Mathilde Gay[3,4], Laurent Bramerie[3,4], Jean Claude Simon[3,4]; [1]*Department of Photonics Engineering, DTU Fotonik, Denmark;* [2]*Engineering Department, University of Ferrara, Italy;* [3]*Universite Europeenne de Bretagne (UEB), France;* [4]*Foton Laboratory, CNRS, France.* We demonstrate a fast photodetector (f3dB > 40GHz) integrated into a high-index contrast photonic crystal platform. Device design, fabrication and characterization are presented.

CM1A.3 • 08:30
Low Breakdown Voltage Silicon Avalanche Photodetector Implemented by Interdigitated p-i-n junctions, Chih Kuo Tseng[1], Wei-Cheng Hung[1], Jhong-Da Tian[1], Kai-Ning Ku[1], Neil Na[2], Yung-Sheng Liu[1], Ming-Chang M. Lee[1]; [1]*National Tsing Hua University, Taiwan;* [2]*Intel Corporation, USA.* We report a silicon avalanche photodetector with low breakdown voltage of -6.44V. Through a design of narrow interdigitated junction spacing and Ni-silicide process, a high avalanche gain of 30 and low dark current are achieved.

CM1A.4 • 08:45
Theoretical and Experimental Investigations of Laser Characteristics of Novel Rear-Grating Structure and Its Application to Uncooled Light Source, Takeshi Fujisawa[1], Kiyoto Takahata[1], Wataru Kobayashi[1], Ryuzo Iga[1], Hiroyuki Ishii[1]; [1]*NTT Photonics Laboratories, Japan.* The mechanisms of increased output power and stable single-mode lasing characteristics of novel rear-grating laser are both theoretically and experimentally investigated and its application to uncooled light source is demonstrated for the first time.

08:00–10:00 CM1B • Ultrafast Mid-IR
Irina Sorokina, Norges Teknisk Naturvitenskapelige University, Norway, *Presider*

CM1B.1 • 08:00
Ultrafast Optical Parametric Oscillator Pumped by an All Normal Dispersion (ANDi) Yb:Fiber Oscillator, Matthew Kirchner[1], Andrew Niedringhaus[2], Charles G. Durfee[2], Frank W. Wise[3], Daisy Raymondson[1], Lora Nugent-Glandorf[5], Henry C. Kapteyn[6], Margaret M. Murnane[6], Sterling Backus[1,4]; [1]*KMLabs Inc., USA;* [2]*Colorado School of Mines, USA;* [3]*Cornell University, USA;* [4]*Colorado State University, USA;* [5]*National Institute of Standards and Technology, USA;* [6]*University of Colorado, USA.* We describe a 13 nJ, 100 fs, 60 MHz Yb:Fiber ANDi oscillator that pumps a MgO2:PPLN optical parametric oscillator (OPO), producing up to 300 mW (signal+idler) of total output, and overall efficiency of 37%.

CM1B.2 • 08:15
20 µJ, few-cycle Pulses at 3.1 µm and 160 kHz Repetition Rate from mid-IR OPCPA, Alexandre Thai[1], Matthias Baudisch[1], Michael Hemmer[1], Jens Biegert[1,2]; [1]*ICFO - The Institute of Photonics Sciences, Spain;* [2]*ICREA - Institucio Catalana de Recerca i Estudis Avancat, Spain.* We report on a 3.2 W average power, mid-IR OPCPA operating at 160 kHz repetition rate. The system delivers 20 µJ energy pulses with 67 fs duration and sub-250 mrad carrier-envelope-phase stability.

CM1B.3 • 08:30
Table-Top, High Repetition Rate, 1.5 mJ, Picosecond Optical Parametric Oscillator For Surgical Applications, Suddapalli Chaitanya Kumar[1], Antoniangelo Agnesi[3], Paolo Dallocchio[3], F. Pirzio[3], G. Reali[3], K. T. Zawilski[4], Peter G. Schunemann[4], Majid Ebrahim-Zadeh[1,2]; [1]*NLO, ICFO-The Institute of Photonic Sciences, Spain;* [2]*Institucio Catalana de Recerca i Estudis Avancats (ICREA), Spain;* [3]*Laser Source Laboratory, University of Pavia, Italy;* [4]*BAE Systems, Inc, USA.* We report a compact, efficient, 1.5 mJ, 450 MHz, mid-IR picosecond OPO based on CdSiP2, synchronously-pumped at 1064 nm, covering the technologically important wavelength range of 6091-6577 nm for surgical applications.

CM1B.4 • 08:45
Sub-150 fs Pulses from a Tm:KLuW Oscillator in the 2 µm Wavelength Range, Andreas Schmidt[1], Sun Young Choi[2], Dong-Il Yeom[2], Fabian Rotermund[2], Xavier Mateos[3], Martha Segura[3], Francesc Diaz[3], Valentin Petrov[1], Uwe Griebner[1]; [1]*Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy, Germany;* [2]*Division of Energy Systems Research, Ajou University, Republic of Korea;* [3]*Fisica i cristallografia de Materials i Nanomaterials, Universitat Rovira i Virgili, Spain.* Femtosecond mode-locking of a Tm:KLu(WO4)2 laser using a single-walled carbon nanotubes based saturable absorber is demonstrated. Pulses as short as 142 fs are generated at a wavelength of ~2040 nm.

Room A3: **CLEO: QELS-Fundamental Science**

08:00–10:00 QM1C • Transformation Optics
Harald Giessen, Universität Stuttgart, Germany, *Presider*

QM1C.1 • 08:00
Integrated Gradient Index Luneburg Lens for Robust Fiber-to-Chip Coupling, Lucas H. Gabrielli[1], Michal Lipson[1,2]; [1]*School of Electrical and Computer Engineering, Cornell University, USA;* [2]*Kavli Institute at Cornell, Cornell University, USA.* We demonstrate a high contrast, low loss, gradient index lens for robust fiber-to-chip coupling of silicon waveguides. We experimentally show increased alignment tolerance in comparison to a conventional inverse taper.

QM1C.2 • 08:15
Fiber-to-chip Coupler based on Transformation Optics, Petr Markov[1], Jason G. Valentine[2], Sharon M. Weiss[1]; [1]*Electrical Engineering and Computer Science, Vanderbilt University, USA;* [2]*Mechanical Engineering, Vanderbilt University, USA.* An integrated silicon photonics coupler for fiber to waveguide conversion was designed employing a transformation optics approach. The coupler exhibits a factor of 2 improvement over the benchmark performance of an inverse nanotaper design.

QM1C.3 • 08:30
Plasmonic Graded-index Planar Lens based on Subwavelength Features in the Effective Index Regime, Meir J. Grajower[1], Gilad Lerman[1], Ilya Goykhmann[1], Boris Desiatov[1], Avner Yanai[1], David R. Smith[2], Uriel Levy[1]; [1]*Applied Physics department, Hebrew University of Jerusalem, Israel;* [2]*Center for Metamaterials and Integrated Plasmonics, Department of Electrical and Computer Engineering, Duke University, USA.* We experimentally demonstrate the planar focusing of Surface Plasmon Polaritons using space variant PMMA subwavelength features on top of a metallic film. Focusing is obtained by creating an effective graded refractive index profile.

QM1C.4 • 08:45
Trapped Rainbow Techniques for Spectroscopy on a Chip and Fluorescence Enhancement, Vera Smolyaninova[1], Igor Smolyaninov[2], Alexander Kildishev[3], Vladimir Shalaev[3]; [1]*Towson University, USA;* [2]*University of Maryland, USA;* [3]*Purdue University, USA.* We have fabricated a large area array of tapered nano-waveguides, which exhibit broadband "trapped rainbow" effect. Considerable fluorescence enhancement due to slow light behavior in the array has been observed.

Room A4: **CLEO: Science & Innovations**

08:00–10:00 CM1D • Thin Disk and Pulsed High Power Lasers
Karoly Osvay, University of Szeged, Hungary, *Presider*

CM1D.1 • 08:00
Kilowatt level Yb:YAG thin-disk pump laser amplifier system for seeding FLASH2, Michael Schulz[1,2], Arik Willner[1,2], Robert Riedel[1], Mark J. Prandolini[1], Stefan Duesterer[2], Josef Feldhaus[2], Bart Faatz[2], Joerg Rossbach[3,4], Markus Drescher[3,4], Franz Tavella[1]; [1]*Helmholtz-Institute Jena, Germany;* [2]*Deutsches Elektronensynchrotron DESY, Germany;* [3]*University Hamburg, Germany;* [4]*Center for Free Electron Laser Science, Germany.* An Yb:YAG thin-disk laser amplifier is presented capable of amplifying pulses to a maximum average power of 4.45 kW at burst repetition rates of 100 kHz as pump amplifier for an optical parametric amplifier system.

CM1D.2 • 08:15
533W Peak Power Yb:YAG Composite Waveguide Laser, Takuya Takasaki[1], Hidenori Fukahori[1], Shuhei Yamamoto[2], Takayuki Yanagisawa[1], Yoshihito Hirano[1]; [1]*Mitsubishi Electric Corporation, Japan;* [2]*Mitsubishi Electric Corporation, Japan.* We demonstrated a Yb:YAG composite planar waveguide laser. Low-order mode waveguide is realized by refractive index difference between YAG and Yb:YAG. The peak power of 533-W was obtained at the Q-CW pumping power of 1506-W.

CM1D.3 • 08:30 Invited
Picosecond Thin-Disk Amplifiers with High Average Power for Pumping Optical Parametric Amplifiers, Thomas Metzger[1,2], Roswitha Graf[1,2], Moritz Ueffing[2], Hanieh Fattahi[1,2], Alexander Schwarz[2], Wolfram Helml[2,3], Jakub Novák[4], Michal Chyla[5], Martin Smrz[5], Dirk Sutter[6], Reinhard Kienberger[2,3], Georg Korn[4], Zsuzsanna Major[1,2], Ferenc Krausz[1,2]; [1]*Department of Physics, Ludwig-Maximilians-University München (LMU), Germany;* [2]*Laboratory for Attosecond Physics, Max-Planck-Institute of Quantum Optics, Germany;* [3]*Physik Department E11, Technische Universität München, Germany;* [4]*Department of Ultraintense Lasers, ELI Beamlines Project & Institute of Physics (FZU), Czech Republic;* [5]*Department of Diode-pumped Lasers, HiLASE Project & Institute of Physics (FZU), Czech Republic;* [6]*TRUMPF-Laser GmbH + Co. KG, Germany.* Short-pulse-pumped optical parametric amplification (OPA) calls for picosecond lasers with high average powers. We report on the current thin-disk laser development, the synchronization between pump and seed sources and first OPA results.

Room A5

CLEO: QELS-Fundamental Science

08:00–10:00
QM1E • Nonlinear Optical Lattices
Jason Fleisher, Princeton, USA, *Presider*

QM1E.1 • 08:00
Broadband control of exact dynamic localization bandwidth in curved, strongly coupled optical waveguide arrays, Arash Joushaghani[1], Rajiv Iyer[1], Jun Wan[2], Martijn de Sterke[3], Marc M. Dignam[4], Joyce K. Poon[1], J. Stewart Aitchison[1]; *[1]Electrical and Computer Engineering, University of Toronto, Canada; [2]Wilmer Institute, Johns Hopkins University, USA; [3]Department of Physics, Engineering Physics and Astronomy,, Queen's University, Canada; [4]School of Physics, University of Sydney, Australia.* We present the first experimental observation of exact dynamic localization in waveguide arrays with non-square-wave curvatures. The deviated square-wave profile offers broadband control over the bandwidth of the dynamic localization.

QM1E.2 • 08:15
Suppression of Transverse Instability of Stripe Beams by 1D Photonic Lattices, Jianke Yang[1], Daniel Gallardo[2], Alexandra Miller[2], Zhigang Chen[2]; *[1]Department of Mathematics and Statistics, University of Vermont, USA; [2]Department of Physics and Astronomy, San Francisco State University, USA.* We theoretically and experimentally demonstrate that transverse instability of soliton stripes can be greatly suppressed when the solitons propagate in a 1D lattice under self-defocusing nonlinearity.

QM1E.3 • 08:30 Invited
Relativistic Physics in Optical Waveguide Arrays: Simulating the Dirac Equation, Alexander Szameit[1], Mikael C. Rechtsman[2], Felix Dreisow[1], Julia M. Zeuner[1], Markus Gräfe[1], Andreas Tünnermann[1], Mordechai Segev[2], Stefan Nolte[1]; *[1]Physics, University of Jena, Germany; [2]Physics, Technion, Israel.* In contrast to popular belief, it is possible to simulate a relativistic Dirac equation in classical paraxial optical waveguide arrays. Here, we present various simulations of relativistic phenomena in different structures, including so-called "optical grapheme".

Room A6

CLEO: Science & Innovations

08:00–10:00
CM1F • Combustion & Chemical Reaction Diagnostics
Johannes Kiefer, University of Aberdeen, UK and Thomas Reichardt, Sandia National Labs, USA, *Co-Presiders*

CM1F.1 • 08:00
Spatially and Temporally Resolved Temperature Measurement Behind a Laser-induced Blastwave of Energetic Nanoparticles, Hans Stauffer[1], Sukesh Roy[1], Naibo Jiang[1], James R. Gord[2]; *[1]Spectral Energies, LLC, USA; [2]Wright-Patterson Aif Force Base, USA.* The first spatially and temporally resolved temperature measurements behind a blast wave following laser ignition of energetic nanomaterials using picosecond (ps) N2 coherent anti-Stokes Raman scattering (CARS) are presented.

CM1F.2 • 08:15
Kilohertz-Rate Femtosecond-Multi-Photon-Excited Fluorescence Imaging of Atomic Species in Gas-Phase Reacting Flows, Waruna D. Kulatilaka[1], Sukesh Roy[1], James R. Gord[2]; *[1]Spectral Energies, LLC, USA; [2]Propulsion Directorate, Air Force Research Laboratory, USA.* We demonstrate femtosecond two-photon-excited, laser-induced-fluorescence (TPLIF) imaging of atomic hydrogen in flames at 1-10 kHz. Unlike traditional ns or ps laser-based approaches, fs-TPLIF images are nearly free of photolytic interference.

CM1F.3 • 08:30
High-speed imaging of OH radicals in flames using fiber-coupled UV-PLIF, Paul S. Hsu[1], Waruna D. Kulatilaka[1], Stanislav Kostka[1], Sukesh Roy[1], Anil K. Patnaik[2], James R. Gord[3]; *[1]Spectral Energies, LLC, USA; [2]Innovative Scientific Solution, Inc., USA; [3]Air Force Research Laboratory, USA.* A fiber-coupled, high-speed UV-PLIF system employing a long multimode silica fiber is developed for detection of OH in harsh combustion environments. Single-laser-shot, 10-kHz, OH-PLIF imaging of unsteady flames is demonstrated.

CM1F.4 • 08:45
Raman Difference Spectroscopy Approach for Monitoring of a Bioreactor, Kristina Noack[1,2], Christina Dilk[2], Matthias Schirmer[3], Barbara C. Klein[3], Johannes Kiefer[4,2], Rainer Buchholz[3], Alfred Leipertz[1,2]; *[1]Engineering Thermodynamics, University Erlangen-Nuremberg, Germany; [2]Erlangen Graduate School in Advanced Optical Technologies, University Erlangen-Nuremberg, Germany; [3]Bioprocess Engineering, University Erlangen-Nuremberg, Germany; [4]School of Engineering, University of Aberdeen, United Kingdom.* We present polarization-resolved shifted excitation Raman difference spectroscopy (pol-SERDS) and its application to monitor a bioreactor in which the microalga Porphyridium purpureum produces antiviral exopolysaccharides and pigments.

Room A7

CLEO: QELS-Fundamental Science

08:00–10:00
QM1G • High Density, Electron-Hole Systems
Shin-ya Koshihara, Tokyo Institute of Technology, Japan, *Presider*

QM1G.1 • 08:00
Cooperative Phenomena in an Ultradense Electron-Hole Magneto-plasma, Ji-Hee Kim[1], G. Timothy Noe[1], Junichiro Kono[1], Yongrui Wang[2], Aleksander K. Wojcik[2], Alexey Belyanin[2], Stephen A. McGill[3]; *[1]Department of Electrical and Computer Engineering, Rice University, USA; [2]Department of Physics and Astronomy, Texas A&M University, USA; [3]National High Magnetic Field Laboratory, USA.* We performed ultrafast pump-probe and time-resolved photoluminescence experiments on highly excited semiconductor QWs in high magnetic fields, observing time-delayed superfluorescence bursts of coherent radiation with a sudden population drop.

QM1G.2 • 08:15
1.4ps Superradiant Pulses from a GaN-based Laser, Vojtech Olle[1], Peter P. Vasil'ev[1,2], Adrian Wonfor[1], Richard Penty[1], Ian White[1]; *[1]Electrical Engineering, University of Cambridge, United Kingdom; [2]PN Lebedev Physical Institute, Russian Federation.* The generation of picosecond superradiant pulses from 408nm a GaN/InGaN laser diode is demonstrated for the first time. Pulses with peak powers above 2.8W, pulse energy of 57pJ and durations of 1.4ps are generated.

QM1G.3 • 08:30
Room Temperature Polariton Lasing in a Single ZnO Nanowire Microcavity, Ayan Das[1], Junseok Heo[1], Wei Guo[1], Adrian Bayraktaroglu[1], Jamie Phillips[1], Pallab Bhattacharya[1]; *[1]Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, USA.* Polariton lasing is observed in a single ZnO nanowire-microcavity at room temperature. The Rabi splitting is 103 meV and the emission is polarized perpendicular to the nanowire c-axis.

QM1G.4 • 08:45
Electrically Injected Polariton Lasing from a GaAs-Based Microcavity under Magnetic Field, Pallab Bhattacharya[1], Ayan Das[1], Marc Jankowski[1], Sishir Bhowmick[1], Chi-Sen Lee[1], Shafat Jahangir[1]; *[1]Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, USA.* Suppression of relaxation bottleneck and subsequent polariton lasing is observed in a GaAs-based microcavity under the application of a magnetic field. The threshold injection current density is 0.32 A/cm2 at 7 Tesla.

Room A8

CLEO: QELS-Fundamental Science

08:00–10:00
QM1H • Spasers and Nanoemitters
Mikhail Noginov, Norfolk State University, USA, *Presider*

QM1H.1 • 08:00 Invited
Coherent Light Emission from Planar Plasmonic Metamaterials, Giorgio Adamo[1], Jun-Yu Ou[1], Jin-Kyu So[1], Mengxin Mengxin Ren[1,2], Eric Plum[1], Edward T. Rogers[1], Kevin F. MacDonald[1], Jingjun Xu[2], Nikolay I. Zheludev[1]; [1]*Optoelectronic Research Centre, University of Southampton, United Kingdom;* [2]*Key Laboratory of Weak Light Nonlinear Photonics, Nankai University, China.* We show experimentally that highly localized excitations in planar plasmonic metamaterials drive spatially-coherent, directional, threshold-free light emission, providing a platform for the development of a new generation of nanoscale light sources.

QM1H.2 • 08:30
Room-temperature and Continuous-wave Lasing with Nanoscale Coaxial Cavities, Mercedeh Khajavikhan[1], Aleksandar Simic[1], Michael Katz[1], Jin H. Lee[1], Boris Slutsky[1], Amit Mizrahi[1], Vitaliy Lomakin[1], Yeshaiahu Fainman[1]; [1]*mk, USA.*High mode confinement and modal sparsity in sub-wavelength metallic-plasmonic coaxial cavities enable the demonstration of continuous-wave and room-temperature lasing at telecommunication wavelengths in the smallest cavities to date.

QM1H.3 • 08:45
Compensating the loss in the plasmonic waveguides and feasibility of sub-wavelength plasmonic lasers, Jacob B. Khurgin[1], Greg Sun[2]; [1]*ECE,John Hopkins University;* [2]*Physics, University of Massachusetts, USA.* We show that compensation of loss in plasmonic waveguides with significantly sub-wavelength light confinement (less than λ/4n) requires current density in excess of 100 kA/cm2 making sub-wavelength in all three dimensions laser (spaser) impractical.

Room B2 & B3

CLEO: Science & Innovations

08:00–10:00
CM1I • Quantum Dot Lasers
Seth Bank, University of Texas at Austin, USA, *Presider*

CM1I.1 • 08:00 Tutorial
Physics and Applications of Quantum Dot Lasers, Peter M. Smowton[1]; [1]*Cardiff University, United Kingdom.,* The distinctive physics and properties of self assembled quantum dot material are discussed and demonstrated in InAs and InP dot systems with reference to laser and related device application.

Peter Smowton received the BSc. (Physics and Electronics) from UWIST (1987), spending 12 months at Philips Research Labs., and PhD, Cardiff (1991) for work on laser frequency stabilization, in conjunction with Renishaw Ltd. During postdoctoral positions in both Engineering and Physics departments he worked on semiconductor device fabrication, modeling and design and material and device characterization before becoming an academic (1998, full-Professor 2008) in Cardiff. His scientific interests encompass all aspects of the design, fabrication and characterization of optoelectronic devices. He is Program Chair for the IEEE-International Semiconductor Laser Conference 2012 and Program Co-Chair for CLEO, 2013 and serves as a member of the board of governors of the Photonics Society. He is a member of the editorial board of the journals Semiconductor Science and Technology and IET-Optoelectronics. He has published over 200 journal and conference papers and 3 book chapters and continues to work closely with industry.

Room C1 & C2

08:00–10:00
CM1J • Nonlinear Optical Phenomena
Darrell Armstrong, Sandia National Labs, USA, *Presider*

CM1J.1 • 08:00 Invited
Giant Enhancement of Stimulated Brillouin Scattering in the Sub-wavelength Limit, Peter T. Rakich[1], Charles M. Reinke[1], Ryan Camacho[1], Paul Davids[1], Zheng Wang[2]; [1]*Applied Photonic Microsystems Group, Sandia National Lab, USA;* [2]*Research Laboratory of Electronics, Massachusetts Institute of Technology, USA.* We show that tremendous radiation pressures radically alter stimulated Brillouin scattering (SBS) at nanoscales. Coherent interplay between radiation pressure and electrostriction yield giant enhancement of SBS and highly tailorable nonlinearities.

CM1J.2 • 08:30
Control of Forward Stimulated Polariton Scattering in Periodically Poled Nonlinear Crystals, Hoon Jang[1], Gustav Strömqvist[1], Valdas Pasiskevicius[1], Carlota Canalias[1], Fredrik Laurell[1]; [1]*Applied physics, KTH, Sweden.*Periodic poling in KTP leads to periodic phase reversal of the polaritons generated in Cherenkov phase-matched direction. This is responsible for the dependence of stimulated Raman scattering threshold on crystal rotation angle and poling period.

CM1J.3 • 08:45
Saturation of the all-optical Kerr effect in solids, Bastian Borchers[1], Simon Birkholz[1], Carsten Brée[1], Gunter Steinmeyer[1]; [1]*Max Born Institute, Germany.* We discuss the appearance of saturating higher-order Kerr contributions at extreme intensities inside dielectric solid-state materials. A complete theoretical framework for estimations of these effects is presented together with experimental results.

Room C3 & C4

JOINT

08:00–10:00
JM1K • Optomechanics
Hideo Mabuchi, Stanford University USA, *Presider*

JM1K.1 • 08:00 Invited
Quantum-Coherent Coupling of a Mechanical Oscillator to an Optical Cavity Mode, Ewold Verhagen[1], Samuel Deléglise[1], Stefan Weis[1,2], Albert Schliesser[1,2], Tobias Kippenberg[1,2]; [1]*Institute of Condensed Matter Physics, EPFL, Switzerland;* [2]*Max Plant Institute for the Science of Light, Germany.* We demonstrate an optomechanical microresonator in which optical and mechanical degrees of freedom exchange energy at a rate exceeding the relevant decoherence rates in the system, enabling quantum control of a mechanical oscillator with light.

JM1K.2 • 08:30
Storing an Optical Pulse as a Mechanical Excitation in a Silica Optomechanical Resonator, Victor Fiore[1], Yong Yang[1], Mark Kuzyk[1], Russell Barbour[1], Hailin Wang[1]; [1]*Physics, University of Oregon, USA.*We report an experimental demonstration of storing an optical pulse as a mechanical excitation in a silica microsphere. The storage lifetime is determined by the relatively long damping time of the mechanical excitation.

JM1K.3 • 08:45
Optomechanics in a Fiber Cavity, Nathan E. Flowers-Jacobs[1], Jack C. Sankey[1,2], Anna Kashkanova[1], Scott W. Hoch[1], Andrew M. Jayich[1], Christian Deutsch[3], Jakob Reichel[3], Jack G. Harris[1,4]; [1]*Physics, Yale University, USA;* [2]*Physics, McGill University, Canada;* [3]*Laboratoire Kastler Brossel, ENS/UPMC, France;* [4]*Applied Physics, Yale University, USA.* We have built an optomechanical device consisting of a fiber-based optical cavity and a silicon nitiride membrane with the goal of observing radiation pressure shot noise and generating squeezed light at room temperature.

Marriott San Jose Salon I & II | Marriott San Jose Salon III | Marriott San Jose Salon IV

CLEO: Science & Innovations

08:00–10:00
CM1L • Terahertz Spectroscopic Applications & Technology
Daniel Mittleman, Rice University, USA, *Presider*

CM1L.1 • 08:00
Mobile charge generation in P3HT:PCBM bulk heterojunctions observed by time-resolved terahertz spectroscopy, David G. Cooke[1], Frederik C. Krebs[2], Peter U. Jepsen[3]; [1]*Physics, McGill University, Canada;* [2]*Risoe National Laboratory for Sustainable Energy, Technical University of Denmark, Denmark;* [3]*Photonics Engineering, Technical University of Denmark, Denmark.*Ultra-broadband time-resolved terahertz spectroscopy is used to examine the sub-ps conductivity dynamics of a conjugated polymer bulk heterojunction film P3HT:PCBM. We directly observe mobile charge generation dynamics on a sub-100 fs time scale.

CM1L.2 • 08:15
Ultrabroadband THz spectroscopic investigation of As2S3, Maksim Zalkovskij[1], Radu Malureanu[1], Andrey Novitsky[1], Dan Savastru[2], Aurelian Popescu[2], Andrei V. Lavrinenko[1], Peter U. Jepsen[1]; [1]*DTU Fotonik, Technical University of Denmark, Denmark;* [2]*National Institute of R&D for Optoelectronics INOE 2000, Romania.* We perform ultrabroadband THz spectroscopy of the dielectric function of arsenic trisulfide (As2S3). We observe the transition from universal scaling of the absorption at low frequencies to medium- and short-range-order at higher frequencies.

CM1L.3 • 08:30
Terahertz Ellipsometry of Vertically Grown Carbon Nanotubes, Michael J. Paul[1], Nicholas A. Kuhta[1], Joseph L. Tomaino[1], Andrew D. Jameson[1], Tal Sharf[1], Nalin L. Rupesinghe[2], Kenneth B. Teo[2], Viktor A. Podolskiy[3], Ethan D. Minot[1], Yun-Shik Lee[1]; [1]*Physics, Oregon State University, USA;* [2]*AIXTRON Ltd,, United Kingdom;* [3]*Department of Physics and Applied Physics, University of Massachusetts Lowell, USA.* THz ellipsometry with broadband THz pulses reveals anisotropic THz responses from closely packed, vertically grown CNTs. Non-negligible conductivity in a direction normal to the CNT axis indicates carrier transport between adjacent CNTs.

CM1L.4 • 08:45
Polarization-sensitive Magnetic Field Induced Modulation of Broadband THz Pulses in Liquid, Mostafa Shalaby[1], Marco Peccianti[2], Yavuz Ozturk[1,3], Luca Razzari[4], Matteo Clerici[1], Anna Mazhorova[5], Maksim Skorobogatiy[5], Tsuneyuki Ozaki[1], Roberto Morandotti[1]; [1]*EMT, INRS, Canada;* [2]*Institute for Complex Systems, Italy;* [3]*Ege University, Turkey;* [4]*Italian Institute of Technology, Italy;* [5]*École Polytechnique de Montréal, Canada.* We demonstrate broadband THz modulation in liquid under the applications of suitable magnetic fields. 65% modulation has been obtained using 50mT. The modulation is polarization sensitive and achieved thanks to a magnetic-induced medium anisotropy.

08:00–10:00
CM1M • Microresonators I
Kartik Srinivasan, National Institute of Standards and Technology, USA, *Presider*

CM1M.1 • 08:00
Ultra-High-Q Wedge Resonators with Precise FSR control, Hansuek Lee[1], Tong Chen[1], Jiang Li[1], Ki Youl Yang[1], Oskar Painter[1], Kerry J. Vahala[1]; [1]*Applied Physics, Caltech, USA.* Resonators with Q values of nearly 1 billion are demonstrated, the highest for any chip-based devices. Fabrication uses only standard semiconductor processes, enabling precise size control and access to microwave-rate free-spectral-range operation.

CM1M.2 • 08:15
Angle-etched free-standing photonic crystal nanobeam cavities in single-crystal diamond, Michael J. Burek[1], Brendan J. Shields[2], Nathalie P. de Leon[2], Birgit Hausmann[1], Yiwen Chu[2], Qimin Quan[1], Mikhail D. Lukin[2], Marko Loncar[1]; [1]*School of Engineering and Applied Science, Harvard University, USA;*[2]*Department of Physics, Harvard University, USA.* A bulk nanomachining technique to realize suspended photonic structures in diamond is presented. The developed fabrication methodology employs oxygen plasma etching and yields free-standing nanobeam waveguides and photonic crystal cavities.

CM1M.3 • 08:30
Micro-Gear Resonator for Direct Coupling to Normal-Incident Waves, Ciyuan Qiu[1], Qianfan Xu[1]; [1]*ECE, Rice University, USA.* We show a diffraction-based coupling scheme that allows a high-Q micro-resonator to directly manipulate a free-space optical beam at normal incidence. The normal-incident transmission and reflection change 40% over a wavelength range of 0.3 nm.

CM1M.4 • 08:45
Directional Waveguide Coupling from a Wavelength-scale Deformed Microdisk, Brandon Redding[1], Li Ge[2], Glenn S. Solomon[3], Hui Cao[1]; [1]*Applied Physics, Yale University, USA;* [2]*Electrical Engineering, Princeton University, USA;* [3]*Joint Quantum Institute, NIST and University of Maryland, USA.* We demonstrate uni-directional evanescent coupling of lasing emission from a deformed microdisk to a waveguide. The clockwise and counter-clockwise propagating ray orbits are spatially separated by wave optics effects, enabling selective coupling.

08:00–10:00
CM1N • Fiber I
Shenping Li, Corning Inc., USA, *Presider*

CM1N.1 • 08:00
Towards Crystalline Electro-Optic Fibers For High-Voltage Sensing, Klaus Bohnert[1], Stephan Wildermuth[1], Hubert Brändle[1], Jean-Marie Fourmigue[2], Didier Perrodin[2]; [1]*Corporate Research Center, ABB Ltd, Switzerland;* [2]*Fibercryst, France.* Single crystal Bi4Ge3O12 fibers for high-voltage sensing are grown using the micro-pulling down technique. Optimum growth conditions are determined and the fibers characterized as to their optical properties and performance under voltage.

CM1N.2 • 08:15
Octave-Wide Characterization of Highly Nonlinear Fiber Dispersion, Faezeh Gholami[1], Evgeny Myslivets[1], Sanja Zlatanovic[1], Bill P.-P. Kuo[1], Stojan Radic[1], Nikola Alic[1]; [1]*University of California San Diego, USA.* We demonstrate wide-band technique to characterize dispersion properties of HNLF with record accuracy. The new method is based on processing of spectral fringes generated by balanced interferometer transfer function excited by super-continuum source.

CM1N.3 • 08:30
Anomalous Bend Loss in Large-Mode Area Leakage Channel Fibers, Roman Barankov[1], Kanxian Wei[2], Bryce Samson[2], Siddharth Ramachandran[1]; [1]*Electrical & Computer Engineering, Boston University, USA;* [2]*Nufern, USA.* Large-mode-area leakage channel fibers, designed to suppress higher-order modes, demonstrate dramatic power loss at critical radii of curvature. Using C^2 imaging, we experimentally characterize this anomaly, attributing it to resonant mode-coupling.

CM1N.4 • 08:45
Low-Loss, Broad-Band Coupling Between Single-Mode Optical Fibers with Very Different Mode-Field Diameters, Peter Hofmann[1,2], Arash Mafi[3], Clemence Jollivet[1], Tobias Tiess[1], Nasser Peyghambarian[2], Axel Schulzgen[1]; [1]*CREOL, College of Optics and Photonics, University of Central Florida, USA;* [2]*College of Optical Sciences, University of Arizona, USA;* [3]*Department of Electrical Engineering and Computer Science, University of Wisconsin-Milwaukee, USA.* An approach for efficient coupling between different single-mode fibers is demonstrated. It is shown that short segments of graded-index fiber can provide broadband, low-loss coupling even when the fibers have very different mode-field diameters.

Room A1 — CLEO: Science & Innovations

CM1A • Detectors & Sources—Continued

CM1A.5 • 09:00 Invited
100 Gb/s Photoreceivers for Short- and Long-Haul Optical Communications, Heinz-Gunter Bach[1], Reinhard Kunkel[1], Giorgis Gebre Mekonnen[1], Ruiyong Zhang[1], Detlef Schmidt[1]; *[1]Photonic Components, Heinrich Hertz Institute, Fraunhofer, Germany.* Photoreceivers suitable for 100 Gb/s data rates are presented, consisting either of monolithic pin-diodes with travelling-wave amplifiers followed by a copackaged DEMUX, or 90° optical hybrids integrated with balanced detectors forming coherent QPSK photoreceiver OEICs.

CM1A.6 • 09:30
150 dB/cm gain over 55 nm wavelength range near 1 µm in an Yb-doped waveguide amplifier, Dimitri Geskus[1], Shanmugam Aravazhi[1], Edward Bernhardi[1], Laura Agazzi[1], Sonia M. Garcia-Blanco[1], Markus Pollnau[1]; *[1]MESA+ Institute for Nanotechnology, University of Twente, Netherlands.* 150 dB/cm gain over 55 nm wavelength range between 977-1032 nm is obtained in a 47.5% Yb-doped potassium double tungstate waveguide amplifier. The dependence of luminescence lifetime and gain on Yb concentration is investigated.

CM1A.7 • 09:45
Towards Linear Interferometric Intensity Modulator for Photonic ADCs Using an Injection Locked AlInGaAs Quantum Well Fabry-Pérot Laser, Edris Sarailou[1], Abhijeet Ardey[1], Nazanin Hoghooghi[1], Peter Delfyett[1]; *[1]College of Optics and Photonics, University of Central Florida, USA.* A monolithic AlInGaAs quantum well Fabry-Pérot laser injection locked to a passively mode-locked monolithic laser is presented here. The FP laser cavity can be used as a true linear interferometric intensity modulator for pulsed light.

Room A2 — CLEO: Science & Innovations

CM1B • Ultrafast Mid-IR—Continued

CM1B.5 • 09:00
Mode locking of a $Tm:Sc_2O_3$ laser at 2 µm and 2.1 µm, Alexander Lagatsky[1], Philipp Koopmann[2,3], Peter Fuhrberg[3], Günter Huber[2], Christian T. Brown[1], Wilson Sibbett[1]; *[1]SUPA, Physics and Astronomy, University of St Andrews, United Kingdom; [2]Institute of Laser-Physics, University of Hamburg, Germany; [3]LISA laser products, Germany.* Passive mode locking of a Tm:Sc2O3 laser at around 2 µm and 2.1 µm is reported. The shortest pulse duration of 218 fs is achieved with an average power of 210 mW at 2107 nm.

CM1B.6 • 09:15
Tm:fiber amplifier coherently seeded by femtosecond Er:fiber technology, Sören Kumkar[1], Günter Krauss[1], Marcel Wunram[1], David Fehrenbacher[1], Umit Demirbas[1], Daniele Brida[1,2], Alfred Leitenstorfer[1]; *[1]Physics, University of Konstanz, Germany; [2]Physics, Politecnico di Milano, Italy.* Broadband seeding of a femtosecond Tm:fiber amplifier based on passively phase-locked Er:fiber technology is demonstrated. Excellent coherence properties of the seed are observed experimentally and analyzed theoretically.

CM1B.7 • 09:30
Stretched-pulse operation of a thulium-doped fiber laser with a fiber-based dispersion management, Andreas Wienke[1,2], Frithjof Haxsen[1,2], Dieter Wandt[1,2], Uwe Morgner[2,3], Jörg Neumann[1,2], Dietmar Kracht[1,2]; *[1]Laser Development Department, Laser Zentrum Hannover e.V., Germany; [2]Centre for Quantum Engineering and Space-Time Research - QUEST, Germany; [3]Institut für Quantenoptik, Leibniz Universität Hannover, Germany.* A normal-dispersion fiber was used for dispersion management in an ultrafast thulium-doped fiber laser. The laser provided pulse durations below 130 fs with an external pulse compression. The experimental results could be numerically verified.

CM1B.8 • 09:45
Generation of high-fidelity few-cycle pulses at 2 µm via XPW, Aurélien Ricci[1,2], Francisco Silva[3], Aurélie Jullien[1], Seth Cousin[3], Nicolas Forget[4], Dane Austin[3], Jens Biegert[3,5], Rodrigo Lopez-Martens[1]; *[1]Laboratoire d'Optique Appliquée, France; [2]Thales Optronique SA, Laser Solutions Unit, France; [3]ICFO - Institut de Ciencies Fotoniques, Spain; [4]Fastlite, France; [5]Institucio Catalana de Recerca i Estudis Avancats (ICREA), Spain.* We demonstrate the generation of spectrally clean few-cycle pulses at 2.1 µm by shortening of 40 fs pulses via cross-polarized wave (XPW) generation. Single-shot autocorrelation traces show 20 fs pulse duration.

Room A3 — CLEO: QELS-Fundamental Science

QM1C • Transformation Optics—Continued

QM1C.5 • 09:00 Tutorial
Defining New Optics with Metamaterials, David R. Smith[1]; *[1]Duke University, USA.* Metamaterials provide resources for the development of unconventional optical devices and the improvement of conventional ones. We review the methods of analyzing, constructing and characterizing metamaterials, and discuss their extension to infrared and visible wavelengths.

Dr. David R. Smith is currently the William Bevan Professor of Electrical and Computer Engineering Department at Duke University and serves as Director for the Center for Metamaterial and Integrated Plasmonics. Dr. Smith received his Ph.D. in 1994 in Physics from the University of California, San Diego (UCSD). Smith and his colleagues demonstrated the first left-handed (or negative index) metamaterial at microwave frequencies in 2000, and has continued to study the fundamentals and potential applications of negative index media since. In 2006, Smith and colleagues introduced the technique of transformation optics as a new design approach for electromagnetic media and followed with the experimental demonstration of a transformation optical designed "invisibility cloak." In 2006, Dr. Smith was selected as one of the "Scientific American 50." In 2009, Dr. Smith was named a "Citation Laureate" by Thomson-Reuters ISI Web of Knowledge.

Room A4 — CLEO: Science & Innovations

CM1D • Thin Disk and Pulsed High Power Lasers—Continued

CM1D.4 • 09:00
Generation of pseudo-radially-polarized beams in a diode-pumped solid-state laser, Jae M. Daniel[1], Andy Clarkson[1]; *[1]Optoelectronics Research Centre, University of Southampton, United Kingdom.* A simple technique for directly generating pseudo-radially-polarized or donut-shaped beams in a diode-pumped solid-state laser is presented. Preliminary results for a Nd:YAG laser are described and the further potential of this technique is discussed.

CM1D.5 • 09:15
Suppression of Population-Lifetime-Determined Energy Instability in a Femtosecond kHz Yb CPA, Giedrius Andriukaitis[1], Tadas Balciunas[1], Lingxiao Zhu[1], Tobias Flöry[1], Aart Verhoef[1], Alma Fernandez[1], Audrius Pugzlys[1], Andrius Baltuska[1], Mikhail Grishin[2], Andrejus Michailovas[2]; *[1]TU Wien Institute of Photonics, Austria; [2]EKSPLA Ltd., Lithuania.* Energy saturation is achieved by seeding 1-kHz Yb:CaF2 amplifier by µJ pulses from a monolithic Yb-fiber MOPA leading to 6-mJ output. The saturation is possible at any rep-rate with appropriate seed and optical loss levels.

CM1D.6 • 09:30 Invited
Ultrafast Thin Disk Lasers for Intralaser Extreme Nonlinear Optics, Clara Saraceno[1], Selina Pekarek[1], Oliver Heckl[1,2], Cyrill Baer[1], Cinia Schriber[1], Matthias Golling[1], Kolja Beil[3], Christian Kraenkel[1,3], Günter Huber[3], Ursula Keller[1], Thomas Sudmeyer[1,2]; *[1]ETH Zurich, Switzerland; [2]Universite de Neuchatel, Switzerland; [3]University of Hamburg, Germany.* We demonstrate a sub-100-fs modelocked thin disk laser (TDL) and detect for the first time the carrier envelope offset (CEO) of a TDL, two key enabling milestones for future intracavity nonlinear experiments.

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

Room A5

CLEO: QELS-Fundamental Science

QM1E • Nonlinear Optical Lattices—Continued

QM1E.4 • 09:00
Delocalization enhancement induced by weak disorder and nonlinearity, Uta Naether[1,2], Santiago Rojas-Rojas[1,2], Simon Stützer[3], Matthias Heinrich[3], Andreas Tünnermann[3], Stefan Nolte[3], Rodrigo A. Vicencio[1,2], Alexander Szameit[3]; [1]*Departamento de Fisica, Universidad de Chile, Chile;* [2]*Center for Optics and Photonics, Chile;* [3]*Institute of Applied Physics, University Jena, Germany.* We show theoretically and experimentally for planar and square lattices, that during the initial diffrac- tive broadening of a narrow excitation, small amounts of disorder may enhance delocalization. This effect is amplified by nonlinear propagation.

QM1E.5 • 09:15
Negative Coupling Between Two Defect Waveguides Embedded in an Array, Julia M. Zeuner[1], Mikael Rechtsman[2], Robert Keil[1], Felix Dreisow[1], Andreas Tünnermann[1], Stefan Nolte[1], Alexander Szameit[1]; [1]*Institute of Applied Physics, Friedrich-Schiller-University, Germany;* [2]*Solid State Institute and Physics Department, Technion, Israel.* We experimentally demonstrate negative coupling between two defect guides in a waveguide lattice and elaborate the required conditions to explain, why this effect can only be found for negative defects and certain geometric devices.

QM1E.6 • 09:30
Observation of Bloch-like oscillations in Glauber-Fock oscillator lattices, Robert Keil[2], Armando Perez-Leija[1], Hector Moya-Cessa[3], Alexander Szameit[2], Demetrios N. Christodoulides[1]; [1]*The college of Optics and Photonics, CREOL, USA;* [2]*Institute of Applied Physics, Friedrich-Schiller-Universität Jena, Max-Wien-Platz, Germany;* [3]*INAOE, Coordinacion de Optica, Mexico.* We report the first observation of classical Bloch-like oscillations and revivals of light in a new class of dynamic optical systems-the so-called Glauber-Fock oscillator lattices.

QM1E.7 • 09:45
Disorder-enhanced nonlinear delocalization in segmented photonic lattices, Matthias Heinrich[1], Yoav Lahini[2], Robert Keil[1], Uta Naether[3,1], Felix Dreisow[1], Andreas Tünnermann[1], Stefan Nolte[1], Alexander Szameit[1]; [1]*Institute of Applied Physics, Friedrich-Schiller-Universität Jena, Germany;* [2]*Department of Physics of Complex Systems, The Weizmann Institute of Science, Israel;* [3]*Departamento de Física, Faculdad de Ciencias, Universidad de Chile, Chile.* We investigate the impact of nonlinearity on the perfect imaging by segmentation in photonic lattices with disorder. We find the presence of strongly localized Anderson modes renders imaging significantly more susceptible to nonlinear perturbations.

Room A6

CLEO: Science & Innovations

CM1F • Combustion & Chemical Reaction Diagnostics—Continued

CM1F.5 • 09:00
Thermometry of Flames using Multiple Probe Single Beam CARS Spectroscopy, Orin Yue[1], Marshall T. Bremer[1], Dmitry Pestov[2], James R. Gord[3], Sukesh Roy[4], Marcos Dantus[1,2]; [1]*Chemistry, Michigan State University, USA;* [2]*Biophotonic Solutions Inc., USA;* [3]*Air Force Research Labratory, USA;* [4]*Spectral Energies LLC, USA.* We introduce a temperature measurement method using single beam CARS spectroscopy to create a time profile in the spectral domain. Analysis of signal decay provides temperature of multiple chemical species in a single laser shot.

CM1F.6 • 09:15
Fiber-Optic Measurement of High Temperatures with Sub-Millimeter Spatial Resolution, Markus P. Hehlen[1], Blaine W. Asay[1], Gary R. Parker[1], Laura B. Smilowitz[1], Bryan F. Henson[1]; [1]*Los Alamos National Laboratory, USA.* Two-band differential luminescence thermometry is enabled by a 760-µm long section of Yb3+,Er3+-codoped fiber in a fully integrated fiber-optic system. Temperature measurements up to 1100 oC with sensitivities of up to 1.4E-03 K^-1 are demonstrated.

CM1F.7 • 09:30
Simultaneous Measurement of Multiple Gas Species Using a Nd3+:YAG Laser Combined with Raman Scattering, Sulochana Karuppusamy[1], Simone C. Eichmann[3,4], Sascha R. Engel[2,3], Nilesh J. Vasa[1], Kumaravel Munusamy[1], Thomas Seeger[3,4], Alfred Leipertz[2,3]; [1]*Department of Engineering Design, Indian Institute of Technology Madras, India;* [2]*Lehrstuhl für Technische Thermodynamik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany;* [3]*Erlangen Graduate School in Advanced Optical Technologies, Universität Erlangen-Nürnberg, Germany;* [4]*Lehrstuhl für Technische Thermodynamik, Universität Siegen, Germany.* Coherent anti-Stokes Raman scattering technique combined with a single pulsed Nd3+:YAG laser is proposed and demonstrated for simultaneous measurement of CO2 and CH4. The technique can be used in combustion measurement consisting of gas mixture.

CM1F.8 • 09:45
A Compact First-order Bragg Grating in a Tapered Fiber Probe for High Temperature Sensing, Jun-long Kou[1], Sun-jie Qiu[1], Fei Xu[1], Yan-qing Lu[1]; [1]*College of Engineering and Applied Sciences, Nanjing University, China.* We demonstrate a first-order fiber Bragg grating for high temperature sensing machined by focused ion beam. This 61-period grating is compact with 200-nm-deep shallow grooves and shows a sensitivity of 20 pm/°C near 1550 nm.

Room A7

CLEO: QELS-Fundamental Science

QM1G • High Density, Electron-Hole Systems—Continued

QM1G.5 • 09:00 Invited
Direct Photoluminescence Observation of the Negative Bogoliubov Branch in an Exciton-polariton Condensate, Tomoyuki Horikiri[1,2], Tim Byrnes[1], Natsuko Ishida[1,3], Andreas Loffler[4], Sven Hofling[4], Alfred Forchel[4], Yoshihisa Yamamoto[1,2]; [1]*National Institute of Informatics, Japan;* [2]*Stanford, USA;* [3]*University of Tokyo, Japan;* [4]*Wurzburg University, Germany.* The negative Bogoliubov branch in exciton-polariton condensate is for the first time directly observed in photoluminescence measurement. We will give the result of the experiment and theoretical investigation for understanding the underlying physics.

QM1G.6 • 09:30
Evidence of non-vanishing excitonic correlation near the exciton Mott transition in Si revealed by THz time domain spectroscopy, Takeshi Suzuki[1], Ryo Shimano[1]; [1]*The Department of Physics, The University of Tokyo, Japan.* We investigate the Coulomb correlation in electron-and-hole system in Si using optical-pump-terahertz-probe spectroscopy. Excitonic correlation is observed even above the Mott density accompanied by coupled behavior of plasmon and exciton.

QM1G.7 • 09:45
Transport of Indirect Excitons in a Potential Energy Gradient, Jason Leonard[1], Mikas Remeika[1], Yuliya Y. Kuznetsova[1], Alexander A. High[1], Leonid V. Butov[1], Micah Hanson[2], Arthur Gossard[2]; [1]*Physics, University of California at San Diego, USA;* [2]*Materials Department, University of California at Santa Barbara, USA.* We create a potential energy gradient for indirect excitons using a shaped electrode and study exciton transport. We observe that indirect excitons are localized at low densities and travel along the ramp at high densities.

Monday, 7 May

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

Room A8

CLEO: QELS-Fundamental Science

QM1H • Spasers and Nanoemitters—Continued

QM1H.4 • 09:00
Hybrid Lasers Based on CdSe/CdS Core/Shell Colloidal Quantum Rods on Silica Microspheres, Christos Grivas[1], Peristera Andreakou[1], Pengfei Wang[2], Ming Ding[2], Gilberto Brambilla[2], Liberato Manna[3], Pavlos Lagoudakis[1]; [1]*School of Physics and Astronomy, University of Southampton, United Kingdom;* [2]*Optoelectronics Research Centre, University of Southampton, United Kingdom;* [3]*Istituto Italiano di Technologia, Italy.* Single-mode lasing at ~628 nm above an absorbed pump power threshold of 67.5 µW, tunable within a 2.1-nm range (30% of the free-spectral-range) was obtained from colloidal CdSe/CdS core/shell nanorods on whispering-gallery-mode silica microspheres.

QM1H.5 • 09:15
Coherent single-photon absorption by single emitters coupled to one-dimensional nanophotonic waveguides, Yuntian Chen[1], Martijn Wubs[1], Jesper Mørk[1], Femius Koenderink[2]; [1]*DTU Fotonik, Technical University of Denmark, Denmark;* [2]*FOM Institute for Atomic and Molecular Physics (AMOLF), Netherlands.* We have derived an efficient model that allows calculating the dynamical single-photon absorption of an emitter coupled to a waveguide. We suggest a novel and simple structure that leads to strong single-photon absorption.

QM1H.6 • 09:30
Plasmonic thermal emitter using perfect absorber made of metallic disk on SiO2, Mohammed N. Abbas[1]; [1]*Nano Science and Technology, Research Center for Applied Sciences, Taiwan.* It is shown that the metallic disk structure can be used as an efficient narrow-band thermal emitter in the IR region. The absorption spectra of such structure are investigated both theoretically and experimentally.

QM1H.7 • 09:45
Omnidirectional absorption enhancement in hybrid waveguide-plasmon system, Jing Zhang[1,2], Wenli Bai[2], Likang Cai[2], Guofeng Song[2], Qiaoqiang Gan[1]; [1]*EE, University at Buffalo, SUNY, USA;* [2]*Institute of Semiconductors, Chinese Academy of Sciences, China.* Omnidirectional absorption enhancements induced by localized surface plasmon resonances supported by gold nanowire arrays embedded in a slab waveguide are demonstrated, which could find applications on novel photovoltaic devices or photodetectors.

Room B2 & B3 / Room C1 & C2

CLEO: Science & Innovations

CM1I • Quantum Dot Lasers—Continued

CM1I.2 • 09:00
Temperature-Stable 25-Gbps Direct-Modulation in 1.3-µm InAs/GaAs Quantum Dot Lasers, Mitsuru Ishida[1], Manabu Matsuda[4,5], Yu Tanaka[4,5], Kan Takada[1], Mitsuru Ekawa[4,5], Tsuyoshi Yamamoto[3,6], Takeo Kageyama[6], Masaomi Yamaguchi[3], Kenichi Nishi[6], Mitsuru Sugawara[6], Yasuhiko Arakawa[1,2]; [1]*Institute of Nano Quantum Information Electronics, The University of Tokyo, Japan;* [2]*Institute of Industrial Science, The University of Tokyo, Japan;* [3]*Fujitsu Laboratories Limited, Japan;* [4]*Fujitsu Limited, Japan;* [5]*Photonics Electronics Technology Research Association, Japan;* [6]*QD Laser, Inc., Japan.* By clarifying the temperature and mirror-loss dependence of modulation bandwidth of 1.3-µm-wavelength InAs/GaAs quantum-dot lasers, temperature-stable 25-Gbps direct-modulation is achieved from 20 to 70°C with fixed bias and modulation currents.

CM1I.3 • 09:15
1.55 µm High-Speed Quantum Dot Lasers for Telecommunication Applications, David Gready[1], Christian Gilfert[2], Vitalii Ivanov[2], Johann Peter Reithmaier[2], Gadi Eisenstein[1]; [1]*Electrical engineering, Technion - Israel institute of technology, Israel;* [2]*Institute of Nanostructure Technology and Analytics, University of Kassel, Germany.* We present room temperature characteristics of 340µm long 1.55µm quantum dot lasers. Due to the high modal gain of 10cm-1 per dot layer, CW ground state lasing and record modulation rates of 15Gbit/sec were demonstrated.

CM1I.4 • 09:30
99-µm-long-cavity Laser Diode Using Highly Stacked InGaAs Quantum Dots, Fumihiko Tanoue[1,2], Hiroharu Sugawara[1], Kouichi Akahane[2], Naokatsu Yamamoto[2]; [1]*Graduate School of System Design, Tokyo Metropolitan University, Japan;* [2]*National Institute of Information and Communications Technology, Japan.* We fabricated a 99-µm-long-cavity broad-area laser diode involving 19 stacked InGaAs quantum dots, which lased at 1013 nm without any HR coating, and the threshold current density was 2.25 kA/cm2.

CM1L.5 • 09:45
QDash semiconductor mode-locked lasers as compact subchannel comb for optical OFDM superchannel systems, Regan Watts[1], Ricardo Rosales[2], Stuart Murdoch[3], Francois Lelarge[4], Abderrahim Ramdane[2], Liam Barry[1]; [1]*The Rince Institute, Dublin City University, Ireland;* [2]*CNRS LPN, France;* [3]*Physics Department, University of Auckland, New Zealand;* [4]*Alcatel-Thales III-V Lab, France.* Device characterizations of QDash semiconductor lasers as a subchannel comb generator are presented, including measurements of electric field, optical linewidth, and mode coherence out to 1.5THz spectral mode separation.

CM1J • Nonlinear Optical Phenomena—Continued

CM1J.4 • 09:00
Non-instantaneity of \chi^(3) nonlinear optical effects, Susanta K. Das[1], Martin Bock[1], Ruediger Grunwald[1], Bastian Borchers[1], Janne Hytti[2], Günter Steinmeyer[1,2], Detelf Ristau[3], T. Vockerodt[4], Uwe Morgner[3,4]; [1]*Max-Born-Institut, Germany;* [2]*Optoelectronics Research Centre, Finland;* [3]*Laserzentrum Hannover, Germany;* [4]*Institut für Quantenoptik, Universität Hannover, Germany.* We present direct experimental evidence for a non-instantaneous nonlinear response in TiO2. An asymmetry in interferometric FROG measurements indicates a relaxation time constant of about 5 fs.

CM1J.5 • 09:15
Interaction between Kerr and Ionization Induced Nonlinear Fiber Optics, Ka Fai Mak[1], John C. Travers[1], Philipp Hoelzer[1], Wonkeun Chang[1], Francesco Tani[1], Frederick Vinzent[2], Nicolas Joly[2,1], Philip S. Russell[1,2]; [1]*Division Russell, Max Planck Institute for the Science of Light, Germany;* [2]*Physics, University of Erlangen-Nuremberg, Germany.* Light-plasma interactions are explored in gas-filled photonic crystal fibers through self-compression of few-µJ pulses. Here we study the interaction between ionization-driven soliton dynamics and Kerr-based deep-UV generation.

CM1J.6 • 09:30
Quasi-Phase-Matched Terahertz Generation from Two-Color Laser-Produced Plasma, Yongsing You[1], Taek il Oh[1], Ki-Yong KIm[1]; [1]*University of Maryland, USA.* We observe quasi-phase-matched, super-broadband terahertz generation from two-color, laser-produced plasma filaments. The terahertz output increases linearly with the filament length and the far-field radiation is peaked at an off-axis angle.

CM1J.7 • 09:45
93% Conversion Efficiency from a Fiber Optical Parametric Oscillator, Yiqing Xu[1], Stuart Murdoch[1]; [1]*Physics Department, University of Auckland, New Zealand.* We experimentally demonstrate a χ(3) fiber optical parametric oscillator with a total internal conversion efficiency in excess of 93 % from the pump to the Stokes and anti-Stokes sidebands by introducing an intracavity filter.

Room C3 & C4

JOINT

JM1K • Optomechanics—Continued

JM1K.4 • 09:00
Suppression of extraneous thermal noise in cavity optomechanics, Yi Zhao[1], Dalziel Wilson[1], Kang-Kuen Ni[1], Jeff Kimble[1]; [1]*California Institute of Technology, USA.* Extraneous thermal motion can limit displacement sensitivity and radiation pressure effects, such as optical cooling, in a cavity-optomechanical system. Here we present an active noise suppression scheme and its experimental implementation.

JM1K.5 • 09:15
A Cavity Optomechanical System Exhibiting Optically Induced Tunable Mechanical Nonlinearity, Huan Li[1], Jong W. Noh[1], Yu Chen[1], Semere A. Tadesse[2], Mo Li[1]; [1]*Electrical and Computer Engineering, University of Minnesota, USA;* [2]*School of Physics and Astronomy, University of Minnesota, USA.* A novel multichannel cavity optomechanical system consisting of a micro-disk resonator and a nano-cantilever has been proposed and implemented, which subsequently led to the first demonstration of optically induced tunable mechanical nonlinearity.

JM1K.6 • 09:30 Invited
Optomechanics with Ultracold Atoms and SiN Membranes, Matthew T. Rakher[1], Andreas Jöckel[1,2], Maria Korppi[1,2], Stephan Camerer[2], David Hunger[2], Theodor Hänsch[2], Philipp Treutlein[1,2]; [1]*Physics, Universität Basel, Switzerland;* [2]*Fakultät für Physik, Ludwig-Maximilians-Universität, Germany.* An optical lattice formed by reflection from a SiN$_x$ membrane creates a bidirectional coupling of atomic and membrane motion. We measure the influence of the atoms on the membrane and explore causes of mechanical dissipation.

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

Marriott San Jose
Salon I & II

Marriott San Jose
Salon III

Marriott San Jose
Salon IV

CLEO: Science & Innovations

CM1L • Terahertz Spectroscopic Applications & Technology—Continued

CM1L.5 • 09:00
Continuous Wave Terahertz Spectrometer with kHz Sampling Speed, Thorsten Goebel[1], Dennis Stanze[1], Bernd Sartorius[1], Martin Schell[1]; [1]*Photonic Components, Fraunhofer Heinrich Hertz Institute, Germany.* Telecom technology based CW photomixing terahertz systems, operating at 1.5µm optical wavelength allow coherent spectroscopic measurements with sampling rates up to 25kHz. This is more than an order of magnitude faster than previously demonstrated.

CM1L.6 • 09:15
Sweeping of Terahertz Frequency Comb for High-Accuracy, High-Resolution, and Broadband Terahertz Spectroscopy, Takeshi Yasui[1,2], Yi-da Hsieh[1], Yuki Iyonaga[1], Hajime Inaba[3], Kaoru Minoshima[3], Shuko Yokoyama[1], Tsutomu Araki[1]; [1]*Osaka Univ., Japan;* [2]*Univ. Tokushima, Japan;* [3]*AIST, Japan.* We fully interpolated frequency gaps between THz-comb modes by their incremental sweeping at intervals of their linewidth, showing the possibility of enhancing the spectral resolution in THz spectroscopy to the linewidth of THz comb mode.

CM1L.7 • 09:30
Using Terahertz Time-Domain Spectroscopy to Determine the Glass Transition Temperature of Heavy Oils, Ayesheshim Ayesheshim[1], Lyubov Titova[1], Zhenyou Wang[1], Amin Kabir[1], Kentaro Indo[2], Patrice Abivin[2], Shawn Taylor[2], Yuesheng Cheng[2], Frank Hegmann[2]; [1]*University of Alberta, Canada;* [2]*Schlumberger DBR Technology Center, Canada.* Terahertz time-domain spectroscopy is used to measure the temperature-dependent refractive index of heavy oils down to 80 K. Evidence for a glass transition is observed, providing insight into the viscosity-temperature behavior of heavy oils.

CM1L.8 • 09:45
Terahertz Time Domain Spectroscopy of Branched Alkanes, Daniel V. Nickel[1], Daniel M. Mittleman[1]; [1]*Rice University, USA.* n(ν) and α(ν) for branched alkanes were measured using THz-TDS and compared to their linear structure counterparts. There is an overall decrease in n(ν) and an increase in α(ν), contrary to the predictions of the additive model for polarizibility.

CM1M • Microresonators I—Continued

CM1M.5 • 09:00
Optical Fiber Tips Functionalized with Semiconductor Photonic Crystal Cavities, Gary Shambat[1], J. Provine[1], Kelley Rivoire[1], Tomas Sarmiento[1], James Harris[1], Jelena Vuckovic[1]; [1]*Stanford University, USA.* We develop a new method to transfer photonic crystal resonators to the tips of optical fibers. High Q (2000-4000) cavities are coupled via transmission or PL emission to the fibers in both Si and GaAs.

CM1M.6 • 09:15
Fabrication of High-Q Microresonators using Femtosecond Laser Micromachining, Gregory A. Cohoon[1], Robert Norwood[1], Kazunari Tada[1], Khanh Kieu[1], Masud Mansuripur[1]; [1]*College of Optical Sciences, University of Arizona, USA.* Whispering gallery mode microresonators are fabricated using an amplified femtosecond laser turning process. An electric arc is used to improve surface quality and improve Q-factor. Q-factor as high 7.8x106 is seen using this technique.

CM1M.7 • 09:30
Single mode tunable optical microcavities, Zi Yun Di[1], Philip R. Dolan[1], Helene V. Jones[1], Gareth M. Hughes[1], Jason M. Smith[1]; [1]*Department of Materials, University of Oxford, United Kingdom.* We present tunable open-access optical microcavities with ~cubic wavelength mode volumes and Q factors ~10,000. Purcell enhancement of emission from semiconductor nanocrystals into single cavity modes at room temperature is demonstrated.

CM1M.8 • 09:45
Optical Microdiscus Resonators, Michalis N. Zervas[1], G. Senthil Murugan[1], James Wilkinson[1]; [1]*University of Southampton, Optoelectronics Research Centre, United Kingdom.* We present a new "soften-and-squash" method for turning microspheres into high quality, stand-alone microdiscus resonators. Due to annealing involved in the fabrication process, the Q factors are x10 better than the starting microspheres.

CM1N • Fiber I—Continued

CM1N.5 • 09:00 Invited
Metamaterials Fabricated by Drawing, Simon Fleming[1], Alessandro Tuniz[1], Alexander Argyros[1], Boris T. Kuhlmey[1]; [1]*School of Physics, University of Sydney, Australia.* Metamaterials offer extraordinary optical properties, however they are challenging to make. We apply fiber drawing to fabricate volume metamaterials in quantity. We demonstrate metamaterials with engineered permittivity and permeability at THz.

CM1N.6 • 09:30
One-step Multi-material Preform Extrusion for Robust Chalcogenide Glass Optical Fibers and Tapers, Guangming Tao[1], Soroush Shabahang[1], Esmaeil-Hooman Banaei[1], Joshua J. Kaufman[1], Ayman F. Abouraddy[1]; [1]*CREOL, The College of Optics & Photonics, University of Central Florida, CREOL, USA.* We demonstrate a novel process of one-step extrusion of multi-material fiber preforms containing chalcogenide glasses and polymers. The polymer lends mechanical robustness to the drawn chalcogenide infrared fibers and tapers.

CM1N.7 • 09:45
Characterization of Single-Mode Performance of Chirally-Coupled-Core Fibers with Cores Larger than 50µm, Xiuquan Ma[1], Alex Kaplan[1], I-Ning Hu[1], Almantas Galvanauskas[1]; [1]*University of Michigan, USA.* We demonstrate robust single-spatial mode performance in fabricated Ge-doped 50µm - 60µm core Chirally-Coupled-Core fibers using spatially and spectrally resolved (S2) measurements.

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

Monday, 7 May

Room A1

CLEO: Science & Innovations

10:30–12:30
CM2A • Interconnects & Signal Processing
Carl B. Poitras, Cornell University, USA, *Presider*

CM2A.1 • 10:30
Current-Controlled InP Monolithically Integrated DPSK Demodulator, Francesca Bontempi[1], Sergio Pinna[1], Nicola Andriolli[1], Claudio Porzi[1], Antonella Bogoni[2], Xaveer Leijtens[3], Jeroen Bolk[3], Giampiero Contestabile[1]; [1]*Scuola Superiore Sant'Anna, Italy;* [2]*CNIT, Italy;* [3]*COBRA Research Institute, Netherlands.* A monolithically integrated InP optical circuit performing current-controlled DPSK demodulation is reported. The circuit consists of an interferometric structure with a 1-bit delay SOA-amplified loop. Operation at 8 Gb/s in C-band is reported.

CM2A.2 • 10:45
40 Gb/s All-Optical Selective Wavelength Shifter, An Nguyen[1], Claudio Porzi[1], Sergio Pinna[1], Giampiero Contestabile[1], Antonella Bogoni[2]; [1]*Scuola Superiore Sant'Anna, Italy;* [2]*CNIT Consorzio Nazionale Interuniversitario per le Telecomunicazioni, Italy.* We demonstrate 40Gb/s operation without bit loss of an all-optical selective wavelength-shifter in a SOA-MZI enabling simultaneous wavelength-conversion and data erasing of data burst under a gate signal.

CM2A.3 • 11:00
Silicon Nanowire based Optical XOR Logic Gate at 40Gb/s for DPSK Data, Fangxin Li[1], Chad Husko[1], Mark Pelusi[1], Trung Vo[1], Dan-Xia Xu[2], Siegfried Janz[2], R. Ma[2], Benjamin J. Eggleton[1], David J. Moss[1]; [1]*Physics, University of Sydney, Australia;* [2]*Institute for Microstructural Sciences, National Research Council of Canada, Canada.* We demonstrate all-optical XOR logic function for 40Gb/s DPSK signals in the C-band, based on four-wave mixing (FWM) in a silicon nanowire. Error-free operation with a system penalty of ~ 4.3dB at 10-9 BER has been achieved.

CM2A.4 • 11:15
PDM RZ-to-NRZ Format Conversion Using Polarization-Maintaining-Fibers inside a Polarization-Diversified Loop, HengYun Jiang[1], Lianshan Yan[1], Zhiyu Chen[1], Jia Ye[1], Yinghui Guo[1], Anlin Yi[1]; [1]*Southwest Jiaotong University, China.* A polarization-division-multiplexing RZ-to-NRZ format conversion is proposed using polarization-maintaining-fibers inside a polarization-diversified loop.Both 2×12.5 and 2×10-Gb/s PDM experiments are demonstrated with <1-dB power penalty.

Room A2

10:30–12:30
CM2B • All-optical Processing
Takashi Kondo, University of Tokyo, Japan, *Presider*

CM2B.1 • 10:30 Invited
Nonlinear Optical Functions of Photonic Crystals for Ultralow-power Photonic Processing, Masaya Notomi[1]; [1]*NTT Basic Research Lab, Japan.* Photonic-crystal nanocavities have enabled various nanophotonic devices having nonlinear optical functions, which can operate with ultralow power and be densely integrated in a tiny chip. We discuss potential impacts of this technology for future ICT.

CM2B.2 • 11:00
A Broadband 1850-nm 40-Gb/s Receiver Based on Four-Wave Mixing in Silicon Waveguides, Noam Ophir[1], Kishore Padmaraju[1], Michael Menard[2], Ryan K. Lau[3], Yoshitomo Okawachi[3], Michal Lipson[2,4], Alexander Gaeta[3,4], Keren Bergman[1]; [1]*Electrical Engineering, Columbia University, USA;* [2]*Electrical and Computer Engineering, Cornell University, USA;* [3]*Applied and Engineering Physics, Cornell University, USA;* [4]*Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We experimentally demonstrate a FWM-based receiver operating at long wavelengths. The scheme successfully demultiplexes a 1866-nm 40-Gb/s NRZ signal into 10-Gb/s tributaries while simultaneously wavelength-converting it to 1320 nm for photodetection.

CM2B.3 • 11:15
All-Optical Sub-Channel Data Erasing and Updating for a 16-QAM Signal using a Single PPLN Waveguide. Hao Huang[1], Jeng-Yuan Yang[1], Xiaoxia Wu[1], Salman Khaleghi[1], Moshe Tur[2], Alan Willner[1]; [1]*University of Southern California, USA;* [2]*Tel-Aviv University, Israel.* We demonstrate all-optical sub-channel data erasing/updating based on cascaded sum- and difference-frequency generation in a single PPLN waveguide. OSNR penalty of 2-dB for RZ and 4-dB for NRZ at a BER of 2e-3 are achieved.

Room A3

CLEO: QELS-Fundamental Science

10:30–12:30
QM2C • Optical Polaritons
Roberto Morandotti, INRS-EMT, Canada, *Presider*

QM2C.1 • 10:30 Tutorial
Microcavity Polaritons: Quantum Fluid Phenomena and Optoelectronic Applications, Alberto Bramati[1]; [1]*Laboratoire Kastler Brossel, Université Pierre et Marie Curie, Ecole Normale Supérieure et CNRS, Paris, France.* Polaritons are composite bosons which behave as a new type of quantum fluid: its specific properties will be presented in detail. Moreover, the strong potential for the realization of polariton-based optoelectronic devices will be discussed.

Alberto Bramati received his PhD in physics from the University Pierre et Marie Curie (UPMC), Paris, France in 1998. In 2007 he was appointed professor at the UPMC where he is currently carrying out his research activity at the Laboratoire Kastler Brossel of the Ecole Normale Supérieure. His main research topics are in the framework of Quantum Optics, Quantum Information and Nano-Photonics. In the last years he concentrated on the study of polariton systems obtaining several pioneering results: among them are the first demonstration of polariton superfluidity, hydrodynamic vortices and dark solitons.

Room A4

CLEO: Science & Innovations

10:30–12:30
CM2D • Laser Materials and Ceramics
Takunori Taira; Institute for Molecular Science, Japan, *Presider*

CM2D.1 • 10:30 Invited
Applications and Performance of Epoxy-free Composite Laser Optics, Nick Traggis[1], Neil Claussen[1]; [1]*Precision Photonics Corp, USA.* Epoxy-free assembly techniques such as Chemically Activated Direct Bonding have become widely utilized for the fabrication of high power composite laser optics. Recent performance data and application examples will be discussed.

CM2D.2 • 11:00
Diode Pumped Laser Oscillation and Spectroscopy of Pr^{3+}:LaF_3, Fabian Reichert[1], Francesca Moglia[1], Matthias Fechner[1], Nils-Owe Hansen[1], Daniel-Timo Marzahl[1], Günter Huber[1]; [1]*Institute of Laser Physics, University of Hamburg, Germany.* In this paper, we present spectroscopic investigations and first diode pumped quasi continuous wave (qcw) laser oscillation of Pr3+:LaF3 in the visible spectral range.

CM2D.3 • 11:15
Efficient, Resonantly Diode-Pumped, Eye-safe Laser Based on Er3+:GdVO4, Nikolay Ter-Gabrielyan[1], Viktor Fromzel[1], Witold Ryba-Romanowski[2], Tadeusz Lukasiewicz[3], Mark Dubinskii[1]; [1]*US Army Res. Lab, USA;* [2]*2Institute of Low Temperature and Structure Research, Poland;* [3]*3Institute of Electronic Materials Technology, Poland.* We report what is believed to be the first resonantly-pumped demonstration of Er3+:GdVO4 laser. Slope efficiency of ~53% has been achieved at 1598.5 nm with laser diode bar stack pumping at 1529 nm.

Room A5

CLEO: QELS-Fundamental Science

10:30–12:30
QM2E • New Directions in Metamaterials
Igal Brener, Sandia National Labs, USA, *Presider*

QM2E.1 • 10:30
Beyond Stefan-Boltzmann Law: Thermal Hyper-Conductivity, Evgenii Narimanov[1], Igor Smolyaninov[2]; [1]*Purdue University, USA;* [2]*University of Maryland, USA.* We demonstrate that the broadband divergence of the photonic density of states in hyperbolic metamaterials leads to giant increase in radiative heat transfer, beyond the limit set by the Stefan-Boltzmann law.

QM2E.2 • 10:45
Hyperbolic Metamaterial Interfaces: Hawking Radiation from Rindler Horizons and the "End of Time", Igor Smolyaninov[1], Ehren Hwang[1], Evgenii Narimanov[2]; [1]*University of Maryland, USA;* [2]*Purdue University, USA.*Extraordinary rays in a hyperbolic metamaterial behave as particle world lines in a three dimensional Minkowski spacetime. We analyze electromagnetic field behavior at the boundaries of this effective spacetime depending on the boundary orientation.

QM2E.3 • 11:00
Negative Radiation Pressure via Dielectric Birefringence, Jonathan Nemirovsky[1], Mikael Rechtsman[1], Mordechai Segev[1]; [1]*Physics Department, Technion, Israel.* We show how to achieve negative radiation pressure in a vacuum gap inside 1D waveguides, made of ordinary dielectric birefringent layered materials. The negative radiation pressure arises from modes with opposite group and phase velocities.

QM2E.4 • 11:15
Tapered Gold Helices as High-Extinction-Ratio, Broadband Circular Polarizer, Justyna K. Gansel[1], Michael Latzel[1], Andreas Frölich[1], Johannes Kaschke[1], Michael Thiel[2], Martin Wegener[1,3]; [1]*Institute of Applied Physics and DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology (KIT), Germany;* [2]*Nanoscribe GmbH, Germany;* [3]*Institute of Nanotechnology, Karlsruhe Institute of Technology (KIT), Germany.* Tapering is shown to further extend the bandwidth of three-dimensional gold-helix metamaterials as broadband circular polarizers to about 1.5 octaves. Furthermore, the extinction ratio is improved. Theory and experiment show good agreement.

Room A6

CLEO: Science & Innovations

10:30–12:30
CM2F • Remote Optical Sensing
Thomas Reichardt, Sandia National Labs, USA, *Presider*

CM2F.1 • 10:30
Remote open-path sensing of nitrous oxide using Chirped Laser Dispersion Spectroscopy, Michal Nikodem[1], Gerard Wysocki[1]; [1]*Electrical Engineering, Princeton University, USA.* A chirped laser dispersion spectroscopy system based on quantum cascade laser is presented. We demonstrate its application to remote open-path monitoring of atmospheric N2O.

CM2F.2 • 10:45
Standoff Detection of Chemical Traces with High Specificity Using Mode-Selective CARS, Marshall T. Bremer[1], Vadim V. Lozovoy[1], Marcos Dantus[1]; [1]*Chemistry, Michigan State University, USA.* A shaped femtosecond laser can selectively excite a coherence in a particular Raman mode. This concept is used to produce chemical images of an explosive simulant in a polymer background in a standoff configuration.

CM2F.3 • 11:00
Non-adiabatic Atomic Coherence at Work in the Oxygen Laser Source for Atmospheric Remote Sensing, Alexei V. Sokolov[1], Luqi Yuan[1], Andrew J. Traverso[1], Rodrigo Sanchez-Gonzalez[1], Michael P. Grubb[1], Kai Wang[1], Dmitri V. Voronin[1], Aleksei Zheltikov[1,3], Arthur Dogariu[2], James Michael[2], Richard B. Miles[2], Yuri Rostovtsev[4], Vladimir A. Sautenkov[1], Simon W. North[1], Marlan O. Scully[1,2]; [1]*Texas A&M University, USA;* [2]*Princeton University, USA;* [3]*Moscow State University, Russian Federation;* [4]*University of North Texas, USA.* We pump ambient air by loosely-focused ultraviolet pulses and generate a backward laser-like beam for use in remote sensing. We find that this efficient emission is likely linked to non-adiabatic coherence effects in atomic oxygen.

CM2F.4 • 11:15
Forward-backward pulse correlation in air laser emission for atmospheric remote sensing, Arthur Dogariu[1], James Michael[1], Alexei V. Sokolov[2], Marlan O. Scully[1,2], Richard B. Miles[1]; [1]*Princeton University, USA;* [2]*Texas A&M, USA.* We examine the correlations between the forward and backward emitted pulses from the amplified spontaneous emission oxygen air laser. We show a high degree of correlation and regular 0.8 ns pulse spiking intervals.

Room A7

CLEO: QELS-Fundamental Science

10:30–12:30
QM2G • Excitons in Semiconductors and Organic Materials
Denis Seletskiy, University of New Mexico, USA, *Presider*

QM2G.1 • 10:30
Ultrafast Charge Separation in Low Band-Gap Polymer Blend for Photovoltaics, Margherita Maiuri[1], Giulia Grancini[1], Daniele Fazzi[2], Hans-J. Egelhaaf[3], Daniele Brida[1], Guglielmo Lanzani[1,2], Giulio Cerullo[1]; [1]*Fisica, Politecnico di Milano, Italy;* [2]*Center for Nano Science and Technology, Istituto Italiano di Tecnologia, Italy;* [3]*Konarka Technologies GmbH, Germany.* We observe ultrafast charge dissociation in a promising low-band-gap-polymer:fullerene blend for organic photovoltaics. An hot charge transfer state, precursor of free carriers, is formed in ~30 fs upon impulsive photoexcitation with excess energy.

QM2G.2 • 10:45
Ultrafast supercontinuum spectroscopy of multiple exciton states in lead chalcogenide nanorods and nanocrystals, Felice Gesuele[1], Chee Wei Wong[1], Matt Sfeir[2], Weon-kyu Koh[3], Chris B. Murray[3,4], Tony Heinz[5]; [1]*SEAS, Columbia University, USA;* [2]*Center for Functional Nanomaterials, Brookhaven National Laboratory, USA;*[3]*Department of Chemistry, University of Pennsylvania, USA;* [4]*Department of Materials Science and Engineering, University of Pennsylvania, USA;* [5]*Departments of Physics and Electrical Engineering, Columbia University, USA.* We examine the multiple exciton population dynamics in lead chalcogenide nanostructures by ultrafast supercontinuum transient absorption. Carrier multiplication is revealed in the limit of low absorbed photon number, along with biexciton dynamics.

QM2G.3 • 11:00
Carrier multiplication in lead selenide nanorods probed with a superconducting nanowire single photon detector, Richard L. Sandberg[1,2], Lazaro A. Padilha[2], Mumtaz M. Qazilbash[3], Wan Ki Bae[2], Jeffrey M. Pietryga[2], Martin J. Stevens[4], Burm Baek[4], Sae Woo Nam[4], Victor I. Klimov[2]; [1]*Center for Integrated Nanotechnology, Materials Physics and Applications Division, Los Alamos National Laboratory, USA;* [2]*Center for Advanced Solar Photophysics, Los Alamos National Laboratory, USA;* [3]*Physics Department, College of William and Mary, USA;*[4]*Optoelectronics Division, National Institute of Standards and Technology, USA.* We study carrier multiplication in colloidal nanocrystals with novel superconducting nanowire single photon detectors. The PbSe nanorods show a ~80% increase in the multiexciton yield compared to spherical nanocrystals of the same band-gap energy.

QM2G.4 • 11:15
Tracking charge carriers through space and time in single silicon core-shell nanowires, Minah Seo[1], J. Yoo[1], Shadi A. Dayeh[1], S. T. Picraux[1], A. J. Taylor[1], Rohit P. Prasankumar[1]; [1]*LANL, USA.* We map space-and-time-dependent carrier dynamics in single silicon nanowires firstly, using ultrafast optical microscopy. This enables us to directly measure acoustic phonon oscillations and carrier velocities in Si and Si/SiO2 core-shell nanowires.

Room A8

CLEO: QELS-Fundamental Science

10:30–12:30
QM2H • Optical Quantum Devices
Nicholas Peters, Telcordia Technologies, USA, *Presider*

QM2H.1 • 10:30 Invited
All-optical quantum switching, Prem Kumar[1]; [1]*Center for Photonic Communication and Computing, Northwestern University, USA.* I will present progress in ultrafast all-optical quantum switching. χ(3)-based devices can route entangled single photons without disturbing their quantum state, whereas χ(2)-based devices can, in principle, lead to dissipation-free quantum-optical Fredkin gates.

QM2H.2 • 11:00
Picosecond N-photon autocorrelator based on superconducting nanodetectors, Zili Zhou[1], Giulia Frucci[1], Saeedeh Jahanmirinejad[1], Francesco Mattioli[2], Alessandro Gaggero[2], Roberto Leoni[2], Andrea Fiore[1]; [1]*COBRA Research Institute, Eindhoven University of Technology, Netherlands;* [2]*Istituto di Fotonica e Nanotecnologie (IFN), CNR, Italy.* We present a novel approach to an ultrafast N-photon autocorrelator with single-photon sensitivity based on superconducting nanodetectors. The hotspot relaxation time which determines the autocorrelator's temporal resolution was measured to be ~20ps.

QM2H.3 • 11:15
Beam Profiler for Single-Photon Applications based on Compressive Sampling Techniques, Warren Grice[1,3], Duncan Earl[1], Philip Evans[1], Dong-Sheng Guo[4], Travis Humble[2], Eric Martin[3], Raphael Pooser[1]; [1]*Computational Sciences and Engineering, Oak Ridge National Lab, USA;* [2]*Computer Science and Mathematics, Oak Ridge National Lab, USA;* [3]*Physics and Astronomy, University of Tennessee, USA;* [4]*Physics, Southern University and A&M College, USA.* We report the development of a low-cost beam characterization technique appropriate for extremely low light levels. The technique makes use of compressive sampling strategies that have been developed recently for imaging applications.

Room B2 & B3

JOINT

10:30–12:30
JM2I • Symposium on the 50th Anniversary of the Semiconductor Laser I
Thomas Koch, University of Arizona, USA, *Presider*

JM2I.1 • 10:30 Invited
Invention of the Semiconductor Laser, Marshall Nathan[1]; *NY, USA.* The semiconductor laser was realized at four institutions within a period of five weeks in 1962. The research leading up to this will be discussed. Events before and immediately after this at IBM will be described.

JM2I.2 • 11:00 Invited
The Double Heterostructure Concept, Herbert Kroemer[1]; [1]*Elec and Computer Engr. Dept, University of California at Santa Barbara, USA.* The talk will present the initial evolution of the heterostructure idea in the years 1954-1963. Originally proposed for improving bipolar transistors, heterostructures made it possible to achieve cw laser at room temperature.

Room C1 & C2

CLEO: Science & Innovations

10:30–12:30
CM2J • Ultrafast Sources
Henry Kapteyn, Kapteyn-Murnane Laboratories, USA, *Presider*

CM2J.1 • 10:30 Tutorial
Ultrashort Coherent Light Sources: From Femtosecond to Attosecond, Chang Hee Nam[1]; [1]*Dept of Physics & Coherent X-ray Research Center, KAIST, Republic of Korea.* Recent advances in femtosecond laser technology have revolutionized ultrafast science. Techniques to produce high-power sub-2-cycle laser pulses with CEP-stabilization and methods to obtain sub-100-as high-harmonic pulses are explained, along with applications to attosecond science.

Chang Hee Nam received his Ph. D. in plasma physics from Princeton University in 1988. After working at Princeton Plasma Physics Laboratory as a staff research physicist until 1989, he joined KAIST as a faculty member and became a full professor in 1998. He launched the Coherent X-ray Research Center in 1999 and has worked on the development of attosecond high-harmonic light sources along with advanced femtosecond laser technology and on attosecond science. He is a fellow of the American Physical Society and of the Optical Society of America.

Room C3 & C4

CLEO: QELS-Fundamental Science

10:30–12:30
QM2K • Plasmonic Waveguides & Circuits
Jacob Khurgin, Johns Hopkins University, USA, *Presider*

QM2K.1 • 10:30
Bragg grating filters in plasmonic V-groove waveguides, Cameron L. Smith[1], Boris Desiatov[2], Ilya Goykhmann[2], Irene Fernandez-Cuesta[1], Uriel Levy[2], Anders Kristensen[1]; [1]*DTU Nanotech, Denmark;* [2]*Department of Applied Physics, The Hebrew University of Jerusalem, Israel.* We demonstrate spectral filtering via Bragg gratings in plasmonic V-groove waveguides. Transmission spectra of wafer-scale fabricated devices exhibit 8.2 dB extinction ratio with 39.9 nm bandwidth. Near-field measurements verify spectral rejection.

QM2K.2 • 10:45
Polarization Based Plasmonic Splitter and Focusing Device, Gilad Lerman[1], Uriel Levy[1]; [1]*Applied physics, Hebrew university of Jerusalem, Israel.* A plasmonic "pin cushion" structure capable of splitting and focusing SPs depending on the illumination's polarization is demonstrated. It can serves as a plasmonic beam splitter, plasmonic lens and a plasmonic quadrant detector.

QM2K.3 • 11:00
Embedded plasmonic waveguides with Yagi-style antennas, Arian Kriesch[1,3], Stanley P. Burgos[3], Daniel Ploss[1,2], Jing Wen[1,2], Ulf Peschel[1,2], Harry A. Atwater[3]; [1]*Nonlinear Optics and Nanophotonics, Max Planck Institute for the Science of Light, Germany;* [2]*Institute of Optics, Information and Photonics, University of Erlangen-Nuremberg and Cluster of Excellence Engineering of Advanced Materials, Germany;* [3]*Thomas J. Watson Laboratory of Applied Physics, California Institute of Technology, USA.* High confinement in plasmonic waveguides usually comes along with high loss. We present experiments on a new approach, which allows to tune adiabatically between highly confining and low loss waveguides, connected to optical Yagi-style antennas.

QM2K.4 • 11:15
Widely wavelength tunable optical filters using characteristics of long-range surface plasmon polaritons, Jongwon Lee[1], Feng Lu[1], Mikhail A. Belkin[1]; [1]*University of Texas at Austin, USA.* We report widely tunable optical band-pass filters based on long-range surface plasmon polaritons. A 210nm of wavelength tuning is achieved with a 0.004 variation in the refractive index of the top filter cladding dielectric.

Marriott San Jose
Salon I & II

Marriott San Jose
Salon III

Marriott San Jose
Salon IV

CLEO: Science & Innovations

10:30–12:30
CM2L • Terahertz Time Domain Sources, Detectors, & Characterization
Rudolf Bratschitsch, Chemnitz University of Technology, Germany, *Presider*

CM2L.1 • 10:30
Two-Dimensional Photocurrent Control in Air Plasma for Optimized Terahertz Generation, Taek Il Oh[1], Yongsing You[1], Ki-Yong KIm[1]; [1]*Univeristy of Maryland, USA.* Two-dimensional transverse photocurrent generation is detailed for terahertz energy and polarization control in laser-produced air filaments. A full control of terahertz output is demonstrated and in good agreement with our 2D photocurrent model.

CM2L.2 • 10:45
Efficient Terahertz Generation from InGaN/GaN Dot-in-a-Wire Nanostructure, Guan Sun[1], Ruolin Chen[1], Pu Zhao[1], Yujie J. Ding[1], Hieu P. Nguyen[2], Zetian Mi[2]; [1]*Electrical & Computer Engineering, Lehigh University, USA;* [2]*Department of Electrical and Computer Engineering, McGill University, Canada.* InGaN/GaN dot-in-a-wire nanostructure grown on Si(111) is extremely efficient for terahertz generation. The highest output power is measured to be 300 nW just from ten vertically stacked quantum dots in each quantum wire.

CM2L.3 • 11:00
Generation of ultrabroadband coherent infrared wave with 200 THz bandwidth using air plasma driven by intense sub 10 fs pulses, Eiichi Matsubara[1], Masaya Nagai[1], Masaaki Ashida[1]; [1]*Osaka university, Japan.* We demonstrated the generation of infrared wave exceeding 200 THz through air plasma using sub-10-fs pulses produced by hollow fiber compression. Electro-optic sampling with 20-μm GaSe crystal assures the wave is coherent.

CM2L.4 • 11:15
Generation of Polarization Shaped Terahertz Waves, Jaewook Ahn[1], Kanghee Lee[1], Minwoo Yi[1], Jindong Song[2]; [1]*Physics, KAIST, Republic of Korea;* [2]*Nano-device Research Center, KIST, Republic of Korea.* Terahertz polarization shaping technique is developed. We have used the combination of wedge-type diffractive optical components in conjunction with a circular InAs pattern to produce various THz waves with temporally-evolving polarization states.

10:30–12:30
CM2M • Microresonators II
Hansuek Lee, California Institute of Technology, USA, *Presider*

CM2M.1 • 10:30
Automated Wavelength Recovery for Microring Resonators, Erman Timurdogan[1], Aleksandr Biberman[1], Douglas C. Trotter[2], Chen Sun[1], Michele Moresco[1], Vladimir Stojanovic[1], Michael R. Watts[1]; [1]*Research Laboratory of Electronics, Massachusetts Institute of Technology, USA;* [2]*Sandia National Laboratories,, USA.* We lock an adiabatic microring resonator to a laser line with a lock-in time of 200μs using a digital control loop, thereby experimentally demonstrating the first automated and scalable wavelength recovery approach for microring resonators.

CM2M.2 • 10:45
Self-locked low threshold OPO in a CMOS-compatible microring resonator, Lucia Caspani[1], Marco Peccianti[1,2], Alessia Pasquazi[1], Matteo Clerici[1], Razzari Luca[1,3], Brent Little[4], Sai T. Chu[4], David J. Moss[5], Roberto Morandotti[1]; [1]*INRS-EMT, Canada;* [2]*Institute for Complex Systems, CNR, UOS Montelibretti, Italy;* [3]*Fondazione Istituto Italiano di Tecnologia, Italy;* [4]*Infinera Ltd., USA;* [5]*Physics, University of Sydney, Australia.* We report a novel design for an integrated optical parametric oscillator (OPO) in a CMOS-compatible microring. It exploits self-sustained lasing of the pump tuned to a microcavity resonance, preventing the OPO from dimming with thermal fluctuations.

CM2M.3 • 11:00
Avoiding bandwidth collapse in hundreds of coupled silicon micro-resonators, Mark A. Schneider[1], Shayan Mookherjea[1]; [1]*Electrical and Computer Engineering, University of California San Diego, USA.* An important scaling relationship is derived and experimentally validated, estimating how many silicon microrings can be directly coupled to form a CROW, depending on the coupling and the disorder.

CM2M.4 • 11:15
Optical control of the quality factor using coupled photonic crystal cavities, Chaoyuan Jin[1], Milo Swinkels[1], Robert Johne[1], Thang Hoang[1], Leonardo Midolo[1], Peter van Veldhoven[1], Andrea Fiore[1]; [1]*Eindhoven University of Technology, Netherlands.* We have demonstrated optical control of the quality factor using coupled photonic crystal cavities. The corresponding modification of the local density of states enables the control of the spontaneous emission rate of the quantum emitters.

10:30–12:30
CM2N • Doped Fibers for Lasers
Michalis Zervas, University of Southampton, UK, *Presider*

CM2N.1 • 10:30
High-energy, in-band, cladding-pumped erbium doped pulsed fiber lasers, Ee Leong Lim[1], Shaiful Alam[1], David J. Richardson[1]; [1]*Optoelectronics Research Centre, United Kingdom.* We demonstrate a high-energy, in-band, cladding-pumped MOPA at 1563nm that is >1.5 times more efficient than the equivalent core pumped MOPA variant. A maximum pulse energy of 1.4mJ was obtained for 159ns pulses with M2≈1.5.

CM2N.2 • 10:45
5.4 W cladding-pumped Nd:YAG silica fiber laser, Jayanta Kumar Sahu[1], Seongwoo Yoo[2], Andrew Webb[1], Tim May Smith[1], Rob Standish[1]; [1]*Optoelectronics Research Centre, University of SOuthampton, United Kingdom;* [2]*School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore.* We report on the spectroscopy and laser characteristics of Nd-doped fiber, fabricated by rod-in-tube from Nd:YAG as a core material with silica cladding. A cladding-pumped CW laser operation at 1058nm with 52% slope-efficiency is demonstrated.

CM2N.3 • 11:00
A highly-efficient, 2.9 μm Q-switched Ho/Pr co-doped fiber laser, Tomonori Hu[1], Darren D. Hudson[1], Benjamin J. Eggleton[1], Stuart Jackson[1]; [1]*CUDOS, University of Sydney, Australia.* 100 ns, 40 W peak power, Q-switched pulses are produced from a holmium-praseodymium co-doped fiber laser with repetition rates from 100-200 kHz. A 20% slope efficiency was achieved with respect to the launched pump power.

CM2N.4 • 11:15
Watt-order output power at 638 nm in wavelength by direct oscillation with Pr-doped fiber laser, Jun Nakanishi[1], Tsuyoshi Yamada[1], Yasushi Fujimoto[2], Osamu Ishii[3], Masaaki Yamazaki[3]; [1]*Laser Development, NIDEK CO.,LTD., Japan;* [2]*ILE, Osaka Univ, Japan;* [3]*Sumita Optical Glass, Inc.,, Japan.* We have demonstrated a high power red fiber-laser with a Pr3+-doped waterproof fluoro-aluminate glass fiber. The maximum output power of the 638 nm laser beam was measured to be 1.24W.

Room A1 | Room A2 | Room A3 | Room A4

CLEO: Science & Innovations

CM2A • Interconnects & Signal Processing—Continued

CM2A.5 • 11:30
Multimode 90°-Crossings, Combiners and Splitters for a Polymer-Based On-Board Optical Bus, Aeffendi Hashim[1], Nikolaos Bamiedakis[1], Richard Penty[1], Ian White[1]; [1]*Electrical Engineering Division, University of Cambridge, United Kingdom.* The design and characterization of polymer-based multimode 90°-crossings, combiners and splitters exhibiting excess losses below 0.1 dB/crossing, 2 dB and 3 dB respectively are reported. The devices enable the realization of an on-board optical bus.

CM2A.6 • 11:45
4-Channel Polymeric Optical Bus Module for Board-Level Optical Interconnections. Nikolaos Bamiedakis[1], Aeffendi Hashim[1], Richard Penty[1], Ian White[1]; [1]*Engineering Department, University of Cambridge, United Kingdom.* A 4-channel polymeric optical bus module suitable for use in board-level interconnections is presented. Low-loss and low-crosstalk module performance is achieved, while −1 dB alignment tolerances better than ± 8 µm are demonstrated.

CM2A.7 • 12:00
All-Optical Token Technique for Contention Resolution in AWGR-based Optical Interconnects, Roberto Proietti[1], Runxiang Yu[1], Yawei Yin[1], Christopher Nitta[1], Yuhan Yao[1], Venkatesh Akella[1], S. J. Ben Yoo[1]; [1]*ECE, UC Davis, USA.* This paper shows an optical technique for contention resolution in AWGR-based optical interconnects. The technique exploits the saturation effect in SOAs and a polarization-diversity scheme to implement a fully-distributed optical control plane.

CM2A.8 • 12:15
Angular Sliced Laguerre-Gaussian (LG) Beams to Increase the Channel Number in Spatial-Mode Multiplexed System, Yan Yan[1], Hao Huang[1], Yang Yue[1], Yongxiong Ren[1], Nisar Ahmed[1], Alan Willner[1], Sam Dolinar[2]; [1]*university of southern california, USA;* [2]*Jet Propulsion Lab, USA.* An angular sliced LG beam rotates +90 or -90 degree and maintains the fan shape and spiral phase in the far field. It enables a new scheme of spatial-mode division system multiplexing in free space communication .

CM2B • All-optical Processing—Continued

CM2B.4 • 11:30
Experimental Characterization of Phase Tuning using Fine Wavelength Offset in a Complex-Coefficient Optical FIR Filter, Salman Khaleghi[1], Mohammad Reza Chitgarha[1], Omer F. Yilmaz[1], Moshe Tur[3], Michael W. Haney[2], Alan Willner[1]; [1]*Electircal Engineering, Univ. of Southern California, USA;* [2]*Department of Electrical & Computer Engineering, University of Delaware, USA;* [3]*Electrical Engineering, Tel Aviv University, Israel.* We characterize varying the tap-phases of the recently introduced complex-coefficient tunable conversion/dispersion-based FIR-filter by fine-tuning of pump lasers. Full tuning (-π to π) is achieved by detuning the frequency of laser pumps by <10GHz.

CM2B.5 • 11:45
Demonstration of Parallel Polychromatic Sampling based Analog-to-Digital Conversion at 8 GS/s, Andreas O. J. Wiberg[1], Zhi Tong[1], Lan Liu[1], Joseph L. Ponsetto[1], Vahid Ataie[1], Evgeny Myslivets[1], Nikola Alic[1], Stojan Radic[1]; [1]*Electrical and Computer Engineering, University of California San Diego, USA.* A scalable photonic sampled analog-to-digital conversion (ADC) is presented utilizing four-wave mixing processes to multicast and sample a signal. By expanding the architecture to multiple parallel gates, the effective sampling rate is increased.

CM2B.6 • 12:00
Dark Soliton Synthesis Using Optical Pulse Synthesizer and Soliton Transmission in Normal Dispersion Regime, Ken Kashiwagi[1], Kiyonobu Mozawa[1], Yosuke Tanaka[1], Takashi Kurokawa[1]; [1]*Tokyo University of Agriculture and Technology, Japan.* We generated dark solitons at a repetition rate of 25 GHz and experimentally investigated their soliton transmission in a normal dispersion fiber. The experimental result exhibited good agreement on the theory.

CM2B.7 • 12:15
An All-Optical Sample-and-Hold Architecture Incorporating Amplitude Jitter Suppression, Keith G. Petrillo[1], Jasper R. Stroud[1], Mark A. Foster[1]; [1]*Johns Hopkins University, USA.* We demonstrate an all-optical sample-and-hold architecture for photonically-assisted ADCs. Our scheme utilizes sub-ps sampling and dispersion to create >100-ps hold pulses and is additionally shown to reduce laser pulse amplitude jitter by 4.2 dB.

CLEO: QELS-Fundamental Science

QM2C • Optical Polaritons—Continued

QM2C.2 • 11:30
Photon and Polariton Condensates in Microcavities, Elena Kammann[1], Hamid Ohadi[1], Maria Maragkou[1], Konstantinos G. Lagoudakis[2], Timothy Liew[3], Alexey V. Kavokin[1], Pavlos Lagoudakis[1]; [1]*School of Physics and Astronomy, Southampton University, United Kingdom;* [2]*ICMP-LOEQ, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland;* [3]*Institute of Theoretical Physics, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland.* We study thermalisation coherence and spin dynamics of photon and polariton Bose-Einstein condensates (BECs). We observe a Bose Einstein distribution, buildup of long-range order and spontaneous symmetry breaking.

QM2C.3 • 11:45
Observation of Oblique Half-Solitons in polariton Superfluids, Romain Hivet[1], Hugo Flayac[2], Dimitrii Tanese[3], Thomas Boulier[1], Daria Andreoli[1], Jacqueline Bloch[3], Dmitry D. Solnyshkov[2], Guillaume Malpuech[2], Alberto Amo[3], Elisabeth Giacobino[1], Alberto Bramati[1]; [1]*Laboratoire Kastler Brossel, France;* [2]*LASMEA, France;* [3]*Laboratoire de Photonique et Nanostructures, France.* We report the observation of oblique dark half solitons in a polariton superfluid. These topological excitations exhibit specific phase and polarization properties and they behave as magnetic monopoles in an effective magnetic field.

QM2C.4 • 12:00
Efficient Generation of Far-Infrared Radiation in the Vicinity of Polariton Resonance, Lei Wang[1], Xiaomu Lin[1], Yujie J. Ding[1]; [1]*Electrical & Computer Engineering, Lehigh University, USA.* We demonstrate efficient generation of far-infrared radiation at the center wavelength of 20.8 µm in lithium niobate in the vicinity of one of the polariton resonances.

QM2C.5 • 12:15
Spontaneous symmetry breaking of cavity polariton solitons due to pseudospin dynamics, Albrecht Werner[1,2], Oleg Egorov[1,2], Falk Lederer[1,2]; [1]*Institute of Condensed Matter Theory and Solid State Optics, Germany;* [2]*Abbe Center of Photonics, Germany.* We study the influence of the exciton pseudospin dynamics on the existence and stability of polariton solitons in a semiconductor microcavity. We find the spontaneous symmetry breaking of polarization and formation of vector polariton solitons.

CLEO: Science & Innovations

CM2D • Laser Materials and Ceramics—Continued

CM2D.4 • 11:30
Efficient CW laser operation of Yb:LuAG ceramic laser, Hiroaki Nakao[1], Akira Shirakawa[1], Ken-ichi Ueda[1], Hideki Yagi[2], Takagimi Yanagitani[2]; [1]*Institute for Laser Science, University of Electro-Communications, Japan;* [2]*Takuma Works, Konoshima Chemical Co., Ltd., Japan.* Laser diode-pumped Yb3+-doped LuAG ceramic laser is reported. Maximum 2.14 W output power and 72% slope efficiency were obtained. Higher thermal conductivity and higher emission cross-section than Yb:YAG will be suitable for thin-disk laser.

CM2D.5 • 11:45
Efficient Laser Action in Yb:YAG Ceramic Structures Obtained by Reactive Sintering Method, Daniele Alderighi[1], Guido Toci[1], Jan Hostasa[2], Laura Esposito[2], Matteo Vannini[1]; [1]*Institute of Applied Physics "Nello Carrara", IFAC, National Research Council, CNR, Italy;* [2]*Institute of Science and Technology for Ceramics, ISTEC, National Research Council, CNR, Italy.* High quality Yb:YAG ceramics produced by reactive sintering show efficient laser action (up to 75% slope efficiency). Samples with Yb doping gradient, suitable for high power applications, were also prepared and tested.

CM2D.6 • 12:00
First laser oscillation of 1% at Yb:Sc2O3 and Yb:Lu2O3 ceramics, Angela Pirri[1], Guido Toci[1], Matteo Vannini[1]; [1]*Institute of Applied Physics "Nello Carrara", IFAC, National Research Council, CNR, Italy.* We present the first laser oscillation achieved on 1% at Yb:Sc2O3 and Yb:Lu2O3 ceramics pumped in QCW at 968 nm. Finally, we compare the obtained performance with results achieved pumping at 940 nm.

CM2D.7 • 12:15
Yb:CaF2 diode-pumped millijoule nanosecond laser tunable from 1030 to 1065nm, Antoine Courjaud[1], Vincent Clet[1], Jean-Louis Doualan[2], Patrice Camy[2], Richard Moncorgé[2], Eric Mottay[1]; [1]*Amplitude Systemes, France;* [2]*CIMAP, France.* We report a broadly tunable nanosecond diode-pumped laser source based on Yb:CaF2. The Q-switched cavity delivers pulses ranging from 1030 up to 1065 nm in the millijoule range at 300Hz repetition rate.

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

Room A5

CLEO: QELS-Fundamental Science

QM2E • New Directions in Metamaterials—Continued

QM2E.5 • 11:30
Toroidal photonic metamaterial, Vassili Savinov[1], Vassili A. Fedotov[1], Wei Ting Chen[3], Yao-Wei Huang[3], Din Ping Tsai[3], David B. Burckel[2], Igal Brener[2], Nikolay I. Zheludev[1]; [1]*Optoelectronics Research Centre & Centre for Nanostructured Photonic Metamaterials, University of Southampton, United Kingdom;* [2]*Sandia National Laboratories, USA;* [3]*Department of Physics, National Taiwan University, Taiwan.* We present the first design of a photonic metamaterial demonstrating dominant toroidal dipolar response in the infrared part of the spectrum.

QM2E.6 • 11:45
Topological Transitions in Metamaterials, Harish N. Krishnamoorthy[1,2], Zubin Jacob[3], Evgenii Narimanov[4], Ilona Kretzschmar[5], Vinod M. Menon[1,2]; [1]*Department of Physics, Queens College of the City University of New York (CUNY), USA;* [2]*Department of Physics, Graduate School and University Center of the City University of New York (CUNY), USA;* [3]*Department of Electrical and Computer Engineering, University of Alberta, Canada;* [4]*School of Electrical and Computer Engineering, Purdue University, USA;* [5]*Chemical Engineering, City College of the City University of New York (CUNY), USA.* We deomonstrate the existence of optical topological transition, the optical equivalent of Lifshitz transition in electronic systems, by controlling the topology of the optical isofrequency curve using metamaterials.

QM2E.7 • 12:00
Loss-Compensation in 3D Periodic Arrays of Nanoshells through Quantum Dots, and ε-Near-Zero Metamaterials, Salvatore Campione[1], Maria Antonietta Vincenti[2], Domenico de Ceglia[2], Filippo Capolino[1]; [1]*Electrical Engineering and Computer Science, UC Irvine, USA;* [2]*AEgis Technologies Inc, 410 Jan Davis Dr, USA.* We compensate for the losses in 3D arrays of nanoshells through quantum dots embedded in the nanoshells' cores, to achieve ε-near-zero metamaterials at optical frequencies. Results show loss-compensation or gain-capability in a narrow frequency band.

QM2E.8 • 12:15
A Photonic Free-Electron Laser, Thomas Denis[1], Marc W. van Dijk[1], Joan H. Lee[1], Peter J. van der Slot[1], Klaus Boller[1]; [1]*Mesa+ Institute for Nanotechnology, University of Twente, Netherlands.* Sending electrons through photonic crystals (PhC) is of high interest for generating widely tunable, coherent light. We present the novel concept of a tunable laser based on Cerenkov radiation from electrons in a PhC.

Room A6

CLEO: Science & Innovations

CM2F • Remote Optical Sensing —Continued

CM2F.5 • 11:30
Multibounce time-of-flight imaging for object reconstruction from indirect light, Andreas Velten[1], Amy Fritz[1], Moungi Bawendi[2], Ramesh Raskar[1]; [1]*Media Lab, MIT, USA;* [2]*Department of Chemistry, MIT, USA.* We demonstrate reconstruction methods that allow imaging 'around a corner' using time-of-flight data. We show an algorithm to reconstruct hidden objects from scattered light and ways to estimate the volume of hidden cavities.

CM2F.6 • 11:45
A Chirped Fiber Bragg Grating with Ripple Free Group Delay and its Application in Laser Ranging, Mohammad Umar Piracha[1], Dat Nguyen[1], Peter Delfyett[1]; [1]*CREOL, The College of Optics and Photonics, University of Central Florida, USA.* The group delay ripple (< +/-50ps) of a chirped fiber Bragg grating (dispersion = 1651ps/nm) is removed by spectral phase modulation to achieve twofold improvement in the range resolution (~320µm) of a chirped pulse lidar.

CM2F.7 • 12:00
Assessment of an Open Path Quantum Cascade Laser System for simultaneous retrieval of ambient methane and nitrous-oxide concentrations, Paulo C. Castillo[1], Ihor Sydoryk[1], Fred Moshary[1], Barry Gross[1], Carlos Padilla[1]; [1]*Electrical Engineering, The City College of New York, USA.* The development a field-deployable dual Methane-Nitrous-oxide open-path sensors using a chirped pulse tuned (1297.4-1298.8cm-1) Quantum Cascade Laser is discussed. Results using multipass gas cells are presented as well as preliminary field results.

CM2F.8 • 12:15
Directing Raman Signal to a Detector, Vladislav Yakovlev[1], Georgi I. Petrov[1], Gary Noojin[3], Leonid A. Golovan'[2], Hope Beier[4], Robert J. Thomas[4], Benjamin A. Rockwell[4]; [1]*Biomedical Engineering, Texas A&M University, USA;* [2]*Faculty of Physics, M.V. Lomonosov Moscow State University, Russian Federation;* [3]*TASC, Inc., USA;* [4]*711 HPW/RHDO, Air Force Research Laboratory, USA.* For the first time, we demonstrate traveling wave stimulated Raman scattering, which allows arbitrary direction of the generated signal towards the target.

Room A7

CLEO: QELS-Fundamental Science

QM2G • Excitons in Semiconductors and Organic Materials—Continued

QM2G.5 Invited • 11:30
Quantum coherence controls the charge separation in a prototypical artificial light harvesting system, Sarah M. Falke[1], Carlo Andrea Rozzi[2], Nicola Spallanzani[2], Angel Rubio[3], Elisa Molinari[2], Daniele Brida[4], Margherita Maiuri[4], Giulio Cerullo[4], Heiko Schramm[1], Jens Christoffers[1], Christoph Lienau[1]; [1]*Institute of Physics, University Oldenburg, Germany;* [2]*CRN, Italy;* [3]*Fritz-Haber-Institut der Max-Planck Gesellschaft,, Germany;* [4]*IFN-CNR, Politecnico di Milano, Italy.* Ultrafast spectroscopy and quantum-dynamics simulations of an artificial supramolecular light-harvesting system give strong evidence that the quantum-correlated wavelike motion of electrons and nuclei governs the ultrafast electronic charge transfer.

QM2G.6 • 12:00
Ultrafast Electron-Hole Scattering Monitored by Hole Cooling in Optically Excited Germanium Quantum Wells, Kolja Kolata[1], Niko S. Koester[1], Sangam Chatterjee[1], Daniel Chrastina[2], Giovanni Isella[2], John E. Sipe[3], Sebastian Imhoff[4], Angela Thränhardt[4]; [1]*Philipps-Universität Marburg, Germany;* [2]*L-NESS and Dipartimento di Fisica, Politecnico di Milano, Polo Territoriale di Como, Politecnico di Milano, Polo Territoriale di Como, Italy;* [3]*Department of Physics and Institute of Optical Sciences, University of Toronto, Canada;* [4]*Institut für Physik, Technische Universität Chemnitz, Germany.* The scattering and cooling dynamics in Ge quantum wells are investigated on a picosecond time scale. Time-resolved pump-probe experiments reveal an efficient scattering process between electrons in the L-valley and holes in the Γ-valley.

QM2G.7 • 12:15
Electrostatic Lattices for Indirect Excitons in Coupled Quantum Wells, Mikas Remeika[1], Michael M. Fogler[1], Leonid V. Butov[1], Micah Hanson[2], Arthur Gossard[2]; [1]*Physics, University of California San Diego, USA;* [2]*Materials Department, University of California at Santa Barbara, USA.* We report an implementation of a 2-dimensional electrostatic lattice potential for indirect excitons. We present electrode designs for square, triangular, and honeycomb lattices, and exciton photoluminescence measurements in a square lattice.

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

Room A8

CLEO: QELS-Fundamental Science

QM2H • Optical Quantum Devices—Continued

QM2H.4 • 11:30
Quantum random bit generation by stimulated Raman scattering, Philip J. Bustard[1], Doug Moffatt[1], Rune Lausten[1], Guorong Wu[1], Ian A. Walmsley[2], Ben J. Sussman[1]; *[1]Steacie Institute for Molecular Sciences, National Research Council, Canada, Canada; [2]Department of Physics, University of Oxford, United Kingdom.* We introduce a quantum random number generator based on the phase measurement of Stokes light generated by amplification of zero-point vacuum fluctuations using stimulated Raman scattering in bulk diamond.

QM2H.5 • 11:45
Multiplexed Classical and Quantum Transmission for High Bitrate Quantum Key Distribution Systems, Ketaki A. Patel[1,2], James F. Dynes[1], Iris Choi[1], Andrew W. Sharpe[1], Alex R. Dixon[1], Zhiliang Yuan[1], Richard Penty[2], Andrew J. Shields[1]; *[1]Toshiba Research Europe Ltd, United Kingdom; [2]Engineering Department, Cambridge University, United Kingdom.* We report the operation of a gigahertz clocked quantum key distribution system, with two classical data communication channels using coarse wavelength division multiplexing over a record fibre distance of 80km.

QM2H.6 • 12:00
Towards frequency-coded q-dit manipulation using coherent four-wave mixing, Stéphane Clemmen[1], Raphaël Van Laer[1], Alessandro Farsi[1], Jacob S. Levy[2], Michal Lipson[2,3], Alexander Gaeta[1]; *[1]School of Applied and Engineering Physics, Cornell University, USA; [2]School of Electrical and Computer Engineering, Cornell University, USA; [3]Kavli Institute at Cornell for Nanoscale Science, Cornell University, USA.* We demonstrate that the process of coherent four wave-mixing can be used to frequency shift on-demand single photon into several frequency bins.

QM2H.7 • 12:15
Implementing the Aharon-Vaidman quantum game with a Young type photonic qutrit, Piotr Kolenderski[1,2], Urbasi Sinha[1], Li Youning[3], Tong Zhao[1], Matthew Volpini[1], Adan Cabello[4,5], Raymond Laflamme[1], Thomas Jennewein[1]; *[1]Institute for Quantum Computing, University of Waterloo, Canada; [2]Institute of Physics, Nicolaus Copernicus University, Poland; [3]Department of Physics, Tsinghua University, China; [4]Departamento de Fisica Aplicada II, Universidad de Sevilla, Spain; [5]Department of Physics, Stockholm University, Sweden.* We implemented Aharon-Vaidman quantum game by using a qutrit encoded in a spatial mode of a single photon passing through three slits. We performed tomographic reconstructions of generalized qutrit states, and implement the game.

Room B2 & B3

JOINT

JM2I • Symposium on the 50th Anniversary of the Semiconductor Laser I—Continued

JM2I.3 • 11:30 Invited
Materials Development for Semiconductor Lasers, Russell D. Dupuis[1]; *[1]Materials Science and Engineering, Georgia Institute of Technology, USA.* We demonstrate 1.1W peak power from a monolithic broadband laser composed of four quantum cascade laser active regions distributed over two uncoupled optical waveguides. This work paves the way for high-brightness broadband mid-infrared sources.

JM2I.4 • 12:00 Invited
The Origin of the Quantum Well Laser, Charles Henry[1]; *[1]Bell Laboratories, retired, US,* The quantum well laser is designed to guide both the deBroglie waves of the injected carriers and the light waves of the generated photons, enabling very high efficiency lasers.

Room C1 & C2

CLEO: Science & Innovations

CM2J • Ultrafast Sources—Continued

CM2J.2 • 11:30
Direct Diode Pumped Kerr Lens Modelocked Ti:Sapphire Laser Oscillator, Charles G. Durfee[1], Tristan Storz[1], Jonathan Garlick[1,2], Steven Hill[1], Jeff A. Squier[1], Matthew Kirchner[2], Greg Taft[2], Kevin Shea[2], Henry C. Kapteyn[4,2], Margaret M. Murnane[4,2], Sterling Backus[2,3]; *[1]Dept of Physics, Colorado School of Mines, USA; [2]Research and Development Department, KMLabs Inc., USA; [3]Department of Electrical and Computer Engineering, Colorado State University, USA; [4]JILA/Dept. of Physics, University of Colorado, USA.* We describe a Ti:sapphire laser pumped directly with 445nm laser diodes. With 44 mW average power at 800 nm and bandwidth for <50 fs pulses, Kerr-lens-modelocked pulses are available with dramatically decreased pump cost.

CM2J.3 • 11:45
High-energy Soliton Pulse Generation in a Photonic Crystal Rod and its Application to Three-photon Microscopy, Ke Wang[1], Demirhan Kobat[1], Nicholas Horton[1], Chris Xu[1]; *[1]Applied&Engineering Physics, Cornell Univ., USA.* We demonstrate 67-nJ, 65-fs soliton pulse generation using a solid-core photonic crystal rod pumped by a compact fiber source, and its application to in vivo three-photon microscopy in mouse brain.

CM2J.4 • 12:00
High-resolution absolute distance measurement using a dual-wavelength, dual-comb, femtosecond fiber laser, Zheng Zheng[1], Xin Zhao[1], Ya Liu[1], Jingyi Guan[1], Lei Liu[1], Yu Sun[1]; *[1]BeiHang University, China.* A high-resolution laser ranging scheme using one dual-wavelength femtosecond fiber laser, which generates a dual-comb with their frequency difference inherently locked by the intracavity dispersion, is experimentally demonstrated for the first time.

CM2J.5 • 12:15
30-W Peak Power Generated from All-quantum-dot Master-oscillator Power-amplifier System for Nonlinear Bio-imaging Applications, Ying Ding[1], Maria Ana Cataluna[1], Daniil I. Nikitichev[1], Myke Ruiz[2], Michael Tran[2], Yannick Robert[2], Alexandros Kapsalis[4], Hercules Simos[4], Charis Mesaritakis[4], Tianhong Xu[3], Paolo Bardella[3], Mattia Rossetti[3], Igor L. Krestnikov[5], Daniil A. Livshits[5], Ivo Montrosset[3], Dimitris Syvridis[4], Michel Krakowski[2], Edik Rafailov[1]; *[1]Electronic Engineering, Physics & Renewable Energy, University of Dundee, United Kingdom; [2]III-V Lab, France; [3]Dipartimento di Elettronica, Politecnico di Torino, Italy; [4]Department of Informatics and Telecommunications, National and Kapodistrian University of Athens, Greece; [5]Innolume GmbH, Germany.* We present λ=1.26 μm all quantum-dot (QD) master-oscillator-power-amplifier (MOPA) system with a pulse energy of 321 pJ, and peak power of 30.3 W at a repetition rate of 648 MHz for nonlinear bio-imaging applications.

Room C3 & C4

CLEO: QELS-Fundamental Science

QM2K • Plasmonic Waveguides & Circuits—Continued

QM2K.5 • 11:30 Tutorial
Surface Plasmon Circuitry in Opto-Electronics, Alain Dereux[1], Jean-Claude Weeber[1], Sergey I. Bozhevolnyi[2], Emmanouil Kriezis[3], Nikos Pleros[4], Tolga Tekin[5], Matthias Baus[6], Hercules Avramopoulos[7]; *[1]Laboratoire Interdisciplinaire Carnot de Bourgogne UMR CNRS Universite de Bourgogne, France; [2]Institute of Sensors, Signals & Electrotechnics, University of Southern Denmark, Denmark; [3]Department of Electrical and Computer Engineering, Aristotle University, Greece; [4]Informatics and Telematics Institute, Center for Research and Technology Hellas, Aristotle University, Greece; [5]Fraunhofer Institut für Zuverlässigkeit & Mikrointegration, Germany; [6]AMO Gesellschaft für Angewandte Mikro- und Optoelektronik GmbH, Germany; [7]School of Electrical and Computer Engineering, National Technical University of Athens, Greece.* This tutorial reviews the physics of surface plasmon circuitry in order to bring to the fore recently demonstrated applications of surface plasmon in optoelectronics such as on-board optical interconnects or routing in datacom networks.

Prof. Alain Dereux, Belgian physicist born in 1963, PhD (1991) from the University of Namur (Belgium). In 1992, A. Dereux was post-doc researcher at the IBM Zurich Research Laboratory. In 1995, he was appointed Professor of Physics at the University of Burgundy (Dijon, France) where he later promoted to Distinguished Full Professor. His research activities, covering surface plasmon photonics (plasmonics), near-field optics and nanophotonics, aim at pushing applications in biology and in opto-electronics. Since 2004, they are integrated in successive European projects. In 2007, he chaired the "Third International Conference on Surface Plasmon Photonics (SPP3-Dijon)". Since 2012, he is director of the "Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB)" (> 250 personnels) jointly operated by French CNRS & University of Burgundy, Co-author of more than 150 publications (above 6700 citations, H-index = 35 by Dec 2011), A. Dereux has given more than 80 talks as conferences or invited seminars.

12:30–13:30 Lunch Break
(on your own)

CLEO: Science & Innovations

CM2L • Terahertz Time Domain Sources, Detectors, & Characterization—Continued

CM2L.5 • 11:30
Properties of Broadband Terahertz Generation in Birefringent ZnGeP2, Joseph D. Rowley[1], Peter G. Schunemann[2], Alan Bristow[1]; [1]*West Virginia Universtiy, USA;* [2]*BAE Systems, USA.* Generation of terahertz pulses by optical rectification is demonstrated in chalcopyrite ZnGeP2 (ZGP) as a function of pump intensity, wavelength and crystal orientation. For infrared excitation, ZGP emission exceeds that of GaAs and GaP.

CM2L.6 • 11:45
Enhanced Detection of Broadband Terahertz Fields via the Filamentation of Chirped Optical Pulses, Matteo Clerici[1], Marco Peccianti[1,2], Mostafa Shalaby[1], Lucia Caspani[1], Antonio Lotti[3], Arnaud Couairon[4], David G. Cooke[5], Tsuneyuki Ozaki[1], Daniele Faccio[1,6], Roberto Morandotti[1]; [1]*INRS-EMT University of Quebec, Canada;* [2]*Institute for Complex Systems, CNR, UOS Montelibretti, Italy;* [3]*Dipartimento di Scienza e Alta Tecnologia, Università dell'Insubria, Italy;* [4]*Centre de Physique Theorique, CNRS and Ecole Polytechnique, France;* [5]*Dept. of Physics, McGill University, Canada;* [6]*School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom.* We show that by employing positively chirped optical probe pulses above a critical power it is possible to enhance the detection bandwidth and signal obtained by Air Biased Coherent Detection scheme for broadband terahertz fields.

CM2L.7 • 12:00
Coherent Detection of Multiband Terahertz Radiation Using a Surface Plasmon-Polariton Based Photoconductive Antenna, Shuchang Liu[1], Xiang Shou[1], Ajay Nahata[1]; [1]*Electrical and Computer Engineering, University of Utah, USA.* We demonstrate a dipole antenna utilizing surface plasmons for enhanced sensitivity of narrowband coherent terahertz detection. We also describe properties of a multiband dipole detector that allows for enhanced sensitivity at multiple frequencies.

CM2L.8 • 12:15
Broad-bandwidth THz pulse characterization through electro-optic sampling with narrow-bandwidth probe pulses, Jeroen van Tilborg[1], Daniel J. Bakker[1], Nicholas H. Matlis[1], Wim P. Leemans[1]; [1]*Lawrence Berkeley National Laboratory, USA.*A novel electro-optic THz pulse diagnostic is presented. Experiments are conducted with 0.11-THz-bandwidth optical probes on a broadband THz source (0-8 THz detection bandwidth) rich in spectral features. Technical details are discussed.

CM2M • Microresonators II—Continued

CM2M.5 • 11:30
Robust Mode-Selection in Optical Bottle Microresonators, Ming Ding[1], G. Senthil Murugan[1], Gilberto Brambilla[1], James Wilkinson[1], Michalis N. Zervas[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* We have demonstrated a robust and accurate method of selecting whispering gallery modes in optical bottle microresonators (BMR) by inscribing scars on BMR's surface by focused ion beam. A "cleaned-up" transmission spectrum was obtained.

CM2M.6 • 11:45
Grating Couplers and Ring Resonator in Aluminum Nitride, Siddhartha Ghosh[1], Gianluca Piazza[2,1]; [1]*Electrical and Systems Engineering, University of Pennsylvania, USA;* [2]*Electrical and Computer Engineering, Carnegie Mellon University, USA.* We report on the use of aluminum nitride (AlN) as an integrated photonic material. One-dimensional grating couplers, waveguides and rings are fabricated in 400 nm polycrystalline AlN films. Single couplers exhibit -6.6 dB peak insertion loss.

CM2M.7 • 12:00
Realization of a two-stage microring ladder filter in SOI, Ashok Prabhu Masilamani[1], Vien Van[1]; [1]*Electrical and Computer Engineering, University of Alberta, Canada.* We report the design and fabrication of a two-stage microring ladder filter in the SOI material. Using thermo-optic tuning, we achieved a 4th-order filter response with flat top passband and a 100GHz bandwidth.

CM2M.8 • 12:15
Rigorous analysis of bistable memory in silica toroid microcavity, Wataru Yoshiki[1], Takasumi Tanabe[1]; [1]*Department of Electronics and Electrical Engineering, Faculty of Science and Technology, Keio University, Japan.* We modeled nonlinear behavior in a silica toroid microcavity using coupling mode theory and the finite element method, and obtained Kerr bistability that did not suffer from the thermo-optic effect by optimizing the fiber-cavity coupling.

CM2N • Doped Fibers for Lasers—Continued

CM2N.5 • 11:30
53.6 W, 1178 nm Yb-doped Photonic Bandgap Fiber Oscillator, Xinyan Fan[1], Meishin Chen[1], Akira Shirakawa[1], Ken-ichi Ueda[1], Christina B. Olausson[2], Jes Broeng[2]; [1]*Institute for Laser Science, University of Electro-Communications, 1-5-1 Chofugaoka, Chofu, 182-8585, Japan;* [2]*NKT Photonics A/S, Blokken 84, DK-3460, Denmark.* We report an 1178nm fiber oscillator using Yb-doped solid-core photonic bandgap fiber in an all-fiber format. 53.6W output power is achieved with 53% slope efficiency. ASE and parasitic lasing in high-gain wavelength is effectively suppressed.

CM2N.6 • 11:45
Highly Efficient Double-Clad Yb-free Er-Doped All-Fiber Laser and Amplifier Pumped at 976 nm, Leonid Kotov[1], Mikhail Likhachev[1], Mikhail Bubnov[1], Oleg I. Medvedkov[1], Denis Lipatov[2], Nikolaj Vechkanov[2], Alexej Guryanov[2]; [1]*FORC RAS, Russian Federation;* [2]*ICHPS RAS, Russian Federation.* Double-clad Yb-free Er-doped all-fiber laser and amplifier schemes based on novel P2O5-Al2O3-SiO2 glass matrix are demonstrated. A record slope efficiency of 40% with respect to the absorbed pump power at 976 nm was obtained.

CM2N.7 • 12:00
Suppression of Q-Switching in a Yb-doped Fiber Laser, James R. Leger[1], Johan Nilsson[2], Junhua Ji[2]; [1]*Electrical and Computer Engineering, Univ. of Minnesota, USA;* [2]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* Q-switching in a Yb-doped fiber laser is quenched by providing an alternative lasing wavelength to prevent inversion build-up. 98 % of the non Q-switched power is preserved while completely eliminating the Q-switched pulse.

CM2N.8 • 12:15
Continuous wave Erbium-doped fiber laser with output power of >100 W at 1550 nm in-band core-pumped by a 1480nm Raman fiber laser, V.r. Supradeepa[1], Jeffrey W. Nicholson[1], Ken Feder[1]; [1]*OFS Laboratories, USA.* A CW Erbium-doped fiber laser with >100W at 1554nm is demonstrated. The laser is core-pumped in-band by a Raman fiber laser with record power of >140W at 1480nm. The total conversion efficiency is ~75%.

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

Room A1 — CLEO: Science & Innovations

13:30–15:30 CM3A • Silicon Photonic Integration

Patrick (Guo-Qiang) Lo; Institute of Microelectronics, ASTAR, Singapore, *Presider*

CM3A.1 • 13:30
Electric Field Sensors based on Hybrid Silicon and Lithium Niobate Microring Resonators, Li Chen[1], Ronald M. Reano[1]; [1]*Electrical and Computer Engineering, Ohio State University, USA.* We present electric field sensors based on the indirect bonding of thin films of lithium niobate to silicon microring resonators using benzocyclobutene as a bonding layer. The demonstrated sensitivity is 4.5 V m-1 Hz-1/2.

CM3A.2 • 13:45
Feasibility of Multimode Polycrystalline Waveguides/Devices: Record Low Propagation Loss and Uniform 1x12 MMI Fanout, David Kwong[1], John Covey[1], Amir Hosseini[2], Yang Zhang[1], Ray T. Chen[1]; [1]*Electrical and Computer Engineering, University of Texas at Austin, USA;* [2]*Omega Optics, USA.* We investigate the loss dependence of multimode polysilicon waveguide widths, achieving a record low propagation loss of 3 dB/cm as well as demonstrating a low loss and high uniformity 1x12 multimode interference (MMI) beam splitter.

CM3A.3 • 14:00 Invited
Silicon Photonic Integrated Circuits, Subal Sahni[1], Adit Narasimha[2], Attila Mekis[1], Brian Welch[1], Colin Bradbury[2], Chang Sohn[1], Dan Song[1], Dany Martinez[2], Dennis Foltz[1], Drew Guckenberger[2], Gianlorenzo Masini[1], James Eicher[2], James Dong[2], Jeff Schramm[1], Joe White[1], John Redman[2], Kosei Yokoyama[1], Marek Tlalka[1], Mark Harrison[2], Mark Peterson[1], Mehrdad Saberi[2], Michael Mack[1], Michael Sharp[1], Peter De Dobbelaere[1], Rocky LeBlanc[1], Sal Leap[2], Sherif Abdalla[1], Steffen Gloeckner[1], Steve Hovey[1], Steve Jackson[1], Shuhuan Yu[1], Thierry Pinguet[1], Wei Xu[2], Yi Liang[1]; [1]*Luxtera Inc, USA;* [2]*Molex Inc, USA.* This paper reviews the CMOS photonics technology developed and commercialized by Luxtera. IC design and CMOS integration methodologies are highlighted and the performance of Luxtera's newest 4x14Gbps and 4x25Gbps transceiver chips is discussed.

Room A2 — CLEO: Science & Innovations

13:30–15:30 CM3B • Guided-Wave Sensing

Thomas Seeger, Universität Siegen, Germany, *Presider*

CM3B.1 • 13:30 Invited
Photochemical Microreactors in Photonic Crystal Fibers, Ana Cubillas[1], Michael Scharrer[1], Tijmen G. Euser[1], Matthias Schmidt[2], Bastian J. Etzold[2], Nicola Taccardi[2], Peter Wasserscheid[2], Philip S. Russell[1]; [1]*Russell division, Max Planck Institute for the Science of Light, Germany;* [2]*Lehrstuhl für Chemische Reaktionstechnik, Universität Erlangen-Nürnberg, Germany.* Photonic crystal fiber (PCF) offers new possibilities for sensing and photochemistry applications. In this paper we review our recent achievements on liquid-phase photochemical microreactors using PCF and discuss our future prospects in this field.

CM3B.2 • 14:00
Plasmonic Nanogap-enhanced Raman Scattering Using a Resonant Nanodome Array, Hsin-Yu Wu[1], Charles J. Choi[1], Brian T. Cunningham[1,2]; [1]*Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, USA;* [2]*Bioengineering, University of Illinois at Urbana-Champaign, USA.* We investigate the optical properties and surface-enhanced Raman scattering (SERS) of plasmonic nanodome array substrates that are demonstrated to provide a reproducible SERS enhancement factor of 1.18×10^10 for detection of a urinary metabolite.

Room A3 — CLEO: QELS-Fundamental Science

13:30–15:30 QM3C • Diamond

Lily Childress, Yale University, USA, *Presider*

QM3C.1 • 13:30 Invited
Diamond in Glass, a New Platform for Quantum Photonics, Andrew D. Greentree[1], Matthew R. Henderson[2], Brant C. Gibson[1], Heike Ebendorff-Heidepriem[2], Kevin Kuan[2], Shahraam Afshar[2], Julius O. Orwa[3], Igor Aharonovich[4], Timothy J. Karle[1], Snjezana Tomljenovic-Hanic[1], Steven Prawer[1], Tanya M. Monro[2]; [1]*School of Physics, University of Melbourne, Australia;* [2]*Institute for Photonics & Advanced Sensing, School of Chemistry & Physics, University of Adelaide, Australia;* [3]*Department of Physics, Latrobe University, Australia;* [4]*School of Engineering & Applied Science, Harvard University, USA.*, Diamond color centers are an important frontier for room-temperature solid-state quantum devices. Here we show incorporation of diamond nanoparticles into tellurite glass optical fibers, offering a platform for quantum sensing and single photons.

QM3C.2 • 14:00
High-Resolution Photoluminescence Spectroscopy of Near-Surface Nitrogen-Vacancy Centers in Diamond, Charles Santori[1], Andrei Faraon[1], Zhihong Huang[1], Victor Acosta[1], Kai-Mei C. Fu[2], Raymond Beausoleil[1], Matthew Markham[3], Daniel Twitchen[3]; [1]*Hewlett-Packard Laboratories, USA;* [2]*Department of Physics, University of Washington, USA;* [3]*Element Six, Ltd., United Kingdom.* Spectral diffusion is a critical problem affecting quantum devices based on nitrogen-vacancy centers in diamond. Here we report sub-GHz photoluminescence emission spectroscopy of near-surface nitrogen-vacancy centers in several types of samples.

Room A4 — CLEO: Science & Innovations

13:30–15:30 CM3D • Cryogenic Lasers

Gregory Wagner, Lockheed Martin Coherent Technologies, USA, *Presider*

CM3D.1 • 13:30
An efficient high pulse energy and high average power cryogenic gas cooled multi-slab Yb:YAG amplifier, Paul Mason[1], Klaus Ertel[1], Saumyabrata Banerjee[1], Paul J. Phillips[1], Cristina Hernandez-Gomez[1], John Collier[1]; [1]*Central Laser Facility, STFC, United Kingdom.* We present recent amplification results for DiPOLE, a cryogenic gas cooled multi-slab Yb:YAG amplifier, demonstrating efficient operation with pulse energies of 10.1 J at 1 Hz and 6.4 J at 10 Hz.

CM3D.2 • 13:45
High-average-power Yb:YLF cryogenic laser amplifier for sub-picosecond pulses, Daniel E. Miller[1], T. Y. Fan[1], Daniel J. Ripin[1]; [1]*MIT Lincoln Laboratory, USA.* We have demonstrated a cryogenic Yb:YLF amplifier at 100-W average power and 10-kHz pulse repetition frequency (PRF). At 4.5 mJ, the pulses have a 2.2-nm bandwidth and have been compressed to 700 fs in duration.

CM3D.3 • 14:00
High Energy 4.1-4.6 µm Fe:ZnSe laser, Vladimir Fedorov[1], Dmitri V. Martyshkin[1], Mike Mirov[1], Igor Moskalev[1], Sergey Vasyliev[1], Sergey B. Mirov[1]; [1]*Mid-IR Lasers, IPG Photonics Corporation, USA.* We report to the best of our knowledge the highest output energy (0.42J) of Fe:ZnSe operating at 4.14 µm. The lasing wavelength varied from 4.14 µm at 77K to 4.65 µm at 220K.

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

13:30–15:30
QM3E • Novel Temporal Phenomena & Airy Beams
Eugenio DelRe, University of L'Aquila, Italy, *Presider*

QM3E.1 • 13:30
Self-Accelerating Beams in Quadratic Nonlinear Media, Ido Dolev[1], Ido Kaminer[2], Asia Shapira[1], Ady Arie[1], Mordechai Segev[2]; *[1]Department of Physical Electronics, Tel Aviv University, Israel; [2]Physics Department and Solid State Institute, Technion, Israel.* We present experimental observations of self-accelerating beams in quadratic media. Joint acceleration in the nonlinear medium, asynchronous intensity peaks of the harmonic waves and self-healing effects on the jointly-accelerating beams are shown.

QM3E.2 • 13:45
Observation of accelerating Wannier-Stark beams in optically induced photonic lattices, Xinyuan Qi[1,2], Ramy El-Ganainy[3], Peng Zhang[1], Kostis Makris[4,5], Demetrios N. Christodoulides[6], Zhigang Chen[1,7]; *[1]Department of Physics and Astronomy, San Francisco State Univ, USA; [2]Department of Physics, Northwest University, China; [3]Department of Physics, University of Toronto, Canada; [4]Materials Science and Technology Department, University of Crete, Greece; [5]Institute for Theoretical Physics, Vienna University of Technology, Austria; [6]College of Optics-CREOL, University of Central Florida, USA; [7]TEDA Applied Physics School,, Nankai Univ., China.* We generate Wannier-Stark beams and observe shape-invariant propagation and acceleration in photonic lattices. In the absence of a lattice, such Wannier-Stark states diffract and deteriorate asymmetrically, in agreement with theoretical predictions.

QM3E.3 • 14:00
Non-Paraxial Accelerating Beams, Ido Kaminer[1], Rivka Bekenstein[1], Mordechai Segev[1]; *[1]Physics Department and Solid State Institute, Technion, Israel.* We present the spatially accelerating solutions of the Maxwell equations. Such beams accelerate along a circular trajectory extending beyond the paraxial regime, thus generalizing the concept of accelerating Airy beams.

13:30–15:30
QM3F • Meta Interfaces and Surfaces I
Gennady Shvets, The University of Texas at Austin, USA, *Presider*

QM3F.1 • 13:30
Symmetry-Breaking Plasmonic Metasurfaces for Broadband Light Bending, Xingjie Ni[1], Naresh K. Emani[1], Alexander Kildishev[1], Alexandra Boltasseva[1,2], Vladimir Shalaev[1]; *[1]Birck Nanotechnology Center, School of Electrical and Computer Engineering, Purdue University, USA; [2]DTU Fotonik, Department of Photonics Engineering, Technical University of Denmark, Denmark.* We experimentally demonstrate unparalleled wave-front control in a broadband, optical wavelength range from 1.0 µm to 1.9 µm, using a thin plasmonic layer (metasurface) consisting of a nanoantenna array that breaks the symmetry along the interface.

QM3F.2 • 13:45
Plasmonic Metasurfaces: Manipulating Light on a Surface, Yang Zhao[1], Andrea Alù[1]; *[1]Electrical and Computer Engineering, The University of Texas at Austin, USA.* We discuss theoretically and experimentally how ultrathin plasmonic metasurfaces can largely control and manipulate the polarization state of light, by which circular polarization conversion and filtering is achieved over subwavelength distances.

QM3F.3 • 14:00
Pulse shaping using optical metamaterials with naturally anisotropic structural elements, Ludmila J. Prokopeva[1,2], Dean P. Brown[3], Xingjie Ni[1], Vladimir P. Drachev[1], Augustine Urbas[4], Alexander Kildishev[1]; *[1]Birck Nanotechnology Center, School of Electrical and Computer Engineering, Purdue University, USA;[2]Institute of Computational Technologies, Siberian Branch of the Russian Academy of Sciences, Russian Federation; [3]UES, Inc., USA; [4]Materials and Manufacturing Directorate, Air Force Research Laboratories, USA.* We numerically investigate a sub-class of metamaterials with anisotropic structural elements. We show such a metamaterial allows for placing electric and magnetic resonance bands close together hence providing flexible manipulation of optical pulses.

13:30–15:30
QM3G • Coherent Phenomena and Control in Semiconductors
Daniele Brida; Politecnicodi Milano, Italy, *Presider*

QM3G.1 • 13:30
Coherent optical control a single hole spin in a quantum dot, Timothy M. Godden[1], John H. Quilter[1], Andrew J. Ramsay[1], Stephen J. Boyle[1], Isaac J. Luxmoore[1], Jorge Puebla-Nunez[1], Mark Fox[1], Maurice S. Skolnick[1]; *[1]Physics & Astronomy, University of Sheffield, United Kingdom.* We report full coherent optical control of a single hole spin in an InAs/GaAs quantum dot by using a picosecond laser pulse and a Voigt-geometry magnetic field.

QM3G.2 • 13:45
Optimal quantum control for conditional rotation of exciton qubits in semiconductor quantum dots, Reuble Mathew[1], Angela Gamouras[1], Kimberley C. Hall[1], Michael Flatté[2], Craig Pryor[2]; *[1]Department of Physics and Atmospheric Science, Dalhousie University, Canada; [2]Department of Physics and Astronomy and Optical Science and Technology Center, University of Iowa, USA.* Pulse-shaping protocols are developed for a controlled-rotation gate in an InAs quantum dot with electronic structure calculated using k.p theory. The shaped pulses show a dramatic improvement in fidelity over transform-limited pulses.

QM3G.3 • 14:00
Excitons, Biexcitons, and Trions in an InAs Quantum Dot Ensemble Studied with 2D Fourier-Transform Spectroscopy, Galan Moody[1,2], Rohan Singh[1,2], Hebin Li[1], Ilya Akimov[3,4], Manfred Bayer[3], Dirk Reuter[5], Andreas Wieck[5], Steven T. Cundiff[1,2]; *[1]JILA/NIST/University of Colorado-Boulder, USA; [2]Department of Physics, University of Colorado, USA; [3]Experimentelle Physik 2, Technische Universität Dortmund, Germany; [4]A. F. Ioffe Physical-Technical Institute, Russian Academy of Sciences, Russian Federation; [5]Lehrstuhl fuer Angewandte Festkoerperphysik, Ruhr-Universitaet Bochum, Germany.* Multi-particle correlations are studied in an InAs quantum dot ensemble using 2D Fourier-transform spectroscopy. Signatures of trions and a fifth-order contribution from biexcitons are observed by varying the excitation polarization and density.

Concurrent sessions are grouped across four pages. Please review all four pages for complete session information.

Room A8

CLEO: QELS-Fundamental Science

13:30–15:30
QM3H • Novel Plasmonic Sensors
Hatice Altug, Boston University, USA, *Presider*

QM3H.1 • 13:30
Single molecule surface enhanced Raman spectroscopy with an optical antenna chip, Dongxing Wang[1], Wenqi Zhu[1], Yizhuo Chu[1], Michael D. Best[2], Jon P. Camden[2], Kenneth B. Crozier[1]; [1]*School of Engineering and Applied Sciences, Harvard University, USA;* [2]*Chemistry, University of Tennessee, USA.* We propose and fabricate a chip containing optical antennas for single molecule Surface-Enhanced Raman Spectroscopy (SMSERS). We verify that SMSERS is achieved using experiments with Rhodamine 6G (R6G) isotopologues.

QM3H.2 • 13:45
Ultra Sensitive Surface-Enhanced Raman Scattering Detection Using Uniform Sub-5 nm Gap Optical Antennas, Tae Joon Seok[1], Michael Eggleston[1], Amit Lakhani[1], Myung-Ki Kim[1], Ming C. Wu[1]; [1]*Electrical Engineering and Computer Sciences, University of California, Berkeley, USA.* Arch-dipole optical antennas with uniform 5nm gaps have been fabricated on Si substrate using deep-UV "spacer" lithography. Strong surface-enhanced Raman scattering (SERS) signals with an enhancement factor of 1.1×108 have been measured.

QM3H.3 • 14:00
Large Area Periodic Nanogap Arrays for Raman and Fluorescence Enhancement: Modeling and Performance, Thomas Siegfried[1], Yasin Ekinci[1,2], Harun Solak[3], Olivier Martin[4]; [1]*Paul Scherrer Institute, Switzerland;* [2]*ETH Zurich, Switzerland;* [3]*Eulitha AG, Switzerland;* [4]*Nanophotonics and Metrology Laboratory, EPFL, Switzerland.* A high-throughput fabrication process will be presented, that yields nanogap arrays with periodicities above 150 nm, and with accurately controlled gap widths of ±1.5 nm over mm2 large areas.

Room B2 & B3

JOINT

13:30–15:30
JM3I • Symposium on the 50th Anniversary of the Semiconductor Laser II
Seth Bank, University of Texas at Austin, USA, *Presider*

JM3I.1 • 13:30 Invited
Past and Next Generation Semiconductor DFB lasers and The Beginnings of Optoelectronic Integrated CIrcuits (OEICs), Amnon Yariv[1]; [1]*Electrical Engr. and Applied Physics, Caltech, USA.* No abstract available

JM3I.2 • 14:00 Invited
The History of High Power Laser Diodes at Xerox PARC and SDL, Inc., Don Scifres[1]; [1]*SDL Ventures, LLC, USA.* The development of high power laser diodes at Xerox PARC and SDL, Inc. was not the primary initial goal of either company. Instead, a winding road led to the powerful, efficient reliable lasers of today.

Room C1 & C2

CLEO: Science & Innovations

13:30–15:30
CM3J • High Power Terahertz Sources & Applications
David Cooke, McGill University, Canada, *Presider*

CM3J.1 • 13:30 Invited
High Field THz Pulse Generation and Nonlinear THz Dynamics, Frank Hegmann[1]; [1]*University of Alberta, Canada.* The generation of intense single-cycle THz pulses and their application to the study of ultrafast nonlinear THz dynamics in semiconductors, such as terahertz-pulse-induced intervalley scattering and hot electron effective mass anisotropy, are described.

CM3J.2 • 14:00
Highly efficient generation of single-cycle MV/cm THz pulses in organic crystals, Clemens Ruchert[1], Carlo Vicario[1], Fernando Ardana[1], Christoph P. Hauri[1]; [1]*Paul Scherrer Institute, Switzerland.* We present the generation of high-power single-cycle THz pulses in organic salt crystals. Broadband THz radiation with MV/cm electric field strength is produced by optical rectification driven with a powerful femtosecond optical parametric amplifier.

Room C3 & C4

13:30–15:30
CM3K • Filaments and Related Phenomena
Benjamin Eggleton, University of Sydney, Australia, *Presider*

CM3K.1 • 13:30 Tutorial
Light Filaments: An Intricate Case of Light Matter --- Matter-light Interaction, Jean-Claude Diels[1,3], Ladan Arissian[2,1]; [1]*CHTM, University of New Mexico, USA;* [2]*Electrical and Computer Engineering, University of New Mexico, USA;* [3]*Physics and Astronomy, University of New Mexico, USA.* Filamentation of high power pulses in air is reviewed. An attempt is made to reconcile the various conflicting theories and experimental results that have been published over the last 15 years on this topic.

Jean-Claude Diels is Professor of Physics and ECE at the University of New Mexico since 1987. Previous appointments include the Universities of North Texas, Southern California, Bordeaux, the CEA Saclay, the Max Planck Institute, the University of California Berkeley, and Philips Research Laboratories. He is co-author of the Graduate textbook "Ultrafast Phenomena", and of the popular book "The power and Precision of Light", a tribute to the 50th anniversary of the laser. He was given the 51st Annual Research Lecture Award of the University of New Mexico, and the 2006 Excellence in Engineering Award of The Optical Society.

Marriott San Jose
Salon I & II

CLEO: Science & Innovations

13:30–15:30
CM3L • Dynamics of Laser-Matter Interactions
Emmanuel Haro Poniatowski, Universidad Autonoma Metropolitana Iztapalapa, Mexico, *Presider*

CM3L.1 • 13:30 Invited
Energy Transfer during Ultrafast Laser-matter Interactions, Xianfan Xu[1]; *[1]Purdue Univ., USA.* We investigate energy transfer during ultrafast laser-matter interactions. We show that when coherent phonons are generated by ultrafast laser pulses, additional energy transfer pathways exist which can influence energy transfer and phase change.

CM3L.2 • 14:00
Measuring the Sphere-Surface Interaction in Optical Trap Assisted Nanopatterning, Romain Fardel[1], Yu-Cheng Tsai[1], Craig Arnold[1]; *[1]Department of Mechanical and Aerospace Engineering, Princeton University, USA.* Near-field methods rely on a precise positioning of the optical element above the surface. In this work, we measure the interaction potential of a trapped microsphere near a sample surface by high-speed microscopy.

Marriott San Jose
Salon III

13:30–15:30
CM3M • Waveguides and Passive Components
Vasily Astratov, University of North Carolina at Charlotte, USA, *Presider*

CM3M.1 • 13:30 Invited
Hollow-core Photonics for Optofluidics and Atom Photonics, Holger Schmidt[1], Aaron Hawkins[2]; *[1]UC Santa Cruz, USA; [2]Brigham Young University, USA.* We review the state of the art of planar hollow-core waveguide devices using for applications in optofluidics and atom photonics.

CM3M.2 • 14:00
Demonstration of Coupled High Q-factor Surface Nanoscale Axial Photonics (SNAP) Microresonators, Misha Sumetsky[1], Kazi Abedin[1], Yury Dulashko[1], John Fini[1], Eric Monberg[1]; *[1]OFS Labs, USA.* We report the first experimental demonstration of coupled identical super-high Q-factor bottle microresonators formed by periodic nanoscale variation of the optical fiber radius. The Q-factor of the fabricated microresonator series exceeds 10^7.

Marriott San Jose
Salon IV

13:30–15:30
CM3N • Photonic Crystal Fibers
Siddharth Ramachandran, Boston University, USA, *Presider*

CM3N.1 • 13:30
Optical properties of low loss (70dB/km) Kagome hollow core photonic crystal fiber for Rb and Cs based optical applications, Thomas D. Bradley[1,2], Meshaal Alharbi[1,2], Yingying Wang[1,2], Coralie F. Dutin[1], Fetah Benabid[1,2]; *[1]Physics, University of Bath, United Kingdom; [2]Physics, XLIM, France.* We report on hollow-core Kagome fiber with a record loss of 70dB/km and operating at ~800nm. We show experimentally that the bending-loss is limited by coupling between the guiding core mode and the modes in the cladding holes.

CM3N.2 • 13:45
Efficient Mid-IR Lasing in Gas-Filled Hollow Waveguides, Andrew M. Jones[1], Bastian Baumgart[2], Chenchen Mao[2], A. V. Vasudevan Nampoothiri[2], Neil Campbell[2], Coralie F. Dutin[3], Yingying Wang[3], Fetah Benabid[3,4], Wolfgang Rudolph[2], Brian R. Washburn[1], Kristan L. Corwin[1]; *[1]Department of Physics, Kansas State University, USA; [2]Department of Physics, University of New Mexico, USA; [3]Centre for Photonics and Photonic Materials, Department of Physics, University of Bath, United Kingdom; [4]Xlim Research Institute, Université de Limoges, France.* Mid-IR lasers operating at 3 - 3.2 µm and 4.3 - 4.4 µm with efficiencies near 20% have been demonstrated from 12C2H2 and HCN-filled low-loss (< 5 dB/m) kagome-structure HC-PCF and from CO2-filled silver coated capillaries.

CM3N.3 • 14:00
Experimental and numerical investigation of effective area of all-solid photonic bandgap fiber for high power delivery, Masahiro Kashiwagi[1], Kunimasa Saitoh[2], Katsuhiro Takenaga[1], Shoji Tanigawa[1], Shoichiro Matsuo[1], Munehisa Fujimaki[1]; *[1]Fujikura Ltd., Japan; [2]Hokkaido university, Japan.* The effective area of a large-mode-area all-solid photonic bandgap fiber for high-power delivery is investigated numerically and experimentally. The new evaluation method of the effective area is proposed and discussed.

Room A1 — CLEO: Science & Innovations

CM3A • Silicon Photonic Integration—Continued

CM3A.4 • 14:30
Backend monolithic integration of passive optical devices on 90nm bulk CMOS chip, Yoon Ho Daniel Lee[1], Michal Lipson[1,2]; [1]*ECE, Cornell University, USA;* [2]*Kavli Institue, Cornell University, USA.* We demonstrate optical resonators and waveguides monolithically integrated on a CMOS die through post-backend processing. Both CMOS process integrity and optical performance are verified and measured.

CM3A.5 • 14:45
3-D Integration of Silicon Nitride on Silicon-on-Insulator Platform, Qing Li[1], Ali A. Eftekhar[1], Amir H. Atabaki[1], Ali Adibi[1]; [1]*Georgia Institute of Technology, USA.* We propose to vertically integrate silicon nitride on silicon-on-insulator platform to achieve better device performances. Preliminary results on the silicon nitride growth, high-Q resonator fabrication, and vertical integration are presented.

CM3A.6 • 15:00
Monolithically Integrated Quantum Dot Laser and Silicon Nitride Waveguide for High Temperature Optical Interconnects, Chi-Sen Lee[1], Thomas Frost[1], Pallab Bhattacharya[1]; [1]*University of Michigan, USA.* The monolithic integration of quantum dot lasers with low loss silicon nitride single mode waveguides for high temperature operation is demonstrated. The losses in the coupled system have been measured and analyzed.

Room A2 — CLEO: Science & Innovations

CM3B • Guided-Wave Sensing—Continued

CM3B.3 • 14:15
Double resonance 1-D photonic crystal cavities for single-molecule mid-infrared photothermal spectroscopy, Juejun Hu[1], Hongtao Lin[1], Yi Zou[1]; [1]*Department of Materials Science and Engineering, University of Delaware, USA.* We propose a mid-infrared spectroscopic technique to detect a single molecule without using cryogenically cooled detectors. Such sensitivity is attained by leveraging dramatically amplified photothermal effects in a pump-probe doubly resonant cavity.

CM3B.4 • 14:30
On-chip integrated spectrometer using nanobeam photonic crystal cavities, Parag B. Deotare[1], Leonard Kogos[1], Qimin Quan[1], Rob Ilic[2], Marko Loncar[1]; [1]*Harvard University-SEAS, USA;* [2]*Cornell University, USA.* We demonstrate an integrated on-chip spectrometer employing photonic crystal nanobeam photonic crystal cavities for telecom wavelength. Acetylene absorption line was successfully measured by thermo-optic tuning of a single device.

CM3B.5 • 14:45
Evanescent-Field Intra-Cavity Sensing with a Dual-Wavelength Distributed-Feedback Laser, Edward H. Bernhardi[1], Kees van der Werf[2], Anton Hollink[1], Kerstin Wörhoff[1], Rene M. de Ridder[1], Vinod Subramaniam[2], Markus Pollnau[1]; [1]*Integrated Optical MicroSystems Group, University of Twente, Netherlands;* [2]*NanoBioPhysics Group, University of Twente, Netherlands.* We demonstrate an integrated optical particle sensor based on a dual-wavelength distributed-feedback waveguide laser. Micro-particles were detected down to a size of 1 µm, which represents the typical size of many fungal and bacterial pathogens.

CM3B.6 • 15:00
Side Opened Microstructured Optical Fiber based Surface Plasmon Resonance Biochip, Guanjun Wang[1], Jiansheng Liu[1], Zheng Zheng[1], Yi Yang[2], Jing Xiao[1], Yusheng Bian[1]; [1]*School of Electronic and Information Engineering, Beihang University, China;* [2]*College of Information Science and Technology, Donghua university, China.* A side-opened, metal film-coated microstructured optical fiber based SPR biochip for high sensitive point-of-care test is studied, which possesses the characteristics of integration, easy of fabrication and a minimal index resolution of 2.2x10-5 RIU.

Room A3 — CLEO: QELS-Fundamental Science

QM3C • Diamond—Continued

QM3C.3 • 14:15
Optical Adiabatic Spin Transfer in Diamond Nitrogen Vacancy Centers, David A. Golter[1], Hailin Wang[1]; [1]*University of Oregon, USA.* We develop control and measurement techniques for adiabatic population transfer of electron spins associated with nitrogen vacancy centers in diamond.

QM3C.4 • 14:30
Cavity QED of NV Centers with a Tunable Silica Resonator, Khodadad N. Dinyari[1], Russell Barbour[1], Andrew Golter[1], Hailin Wang[1]; [1]*Physics, University of Oregon, Oregon Center for Optics, USA.* We report experimental studies, in which NV centers in a diamond nanopillar at 10 K are coupled to a high-Q silica microsphere whose resonance frequency can be tuned over a 500 GHz range.

QM3C.5 • 14:45
Coupling of Nitrogen-Vacancy Centers to Photonic Crystal Resonators in Monocrystalline Diamond, Andrei Faraon[1,2], Zhihong Huang[1], Victor Acosta[1], Charles Santori[1], Raymond Beausoleil[1]; [1]*Hewlett Packard Laboratories, USA;* [2]*Applied Physics and Materials Science, California Institute of Technology, USA.* The zero-phonon transition rate for nitrogen-vacancy centers is enhanced by coupling to photonic crystal resonators fabricated in monocrystalline diamond. Autocorrelation measurements on the zero-phonon line demonstrate coupling of a single emitter.

QM3C.6 • 15:00 Invited
Entangling the Motion of Diamonds at Room Temperature, Michael R. Sprague[1], K. C. Lee[1], Ben J. Sussman[2], Josh Nunn[1], Nathan K. Langford[1], Xian-Min Jin[1,3], Tessa Champion[1], Patrick Michelberger[1], Klaus F. Reim[1], Duncan G. England[1], Dieter Jaksch[1,3], Ian A. Walmsley[1]; [1]*Physics, University of Oxford, United Kingdom;* [2]*National Research Council of Canada, Canada;* [3]*Centre for Quantum Technologies, National University of Singapore, Singapore.* We demonstrate entanglement between the vibrational mode of two macroscopic, spatially-separated diamonds at room temperature with ultrashort pulses and a far-off-resonant Raman interaction.

Room A4 — CLEO: Science & Innovations

CM3D • Cryogenic Lasers—Continued

CM3D.4 • 14:15
A composite Yb:YAG / Yb:GSAG cryogenically cooled amplifier for picosecond pulses, Darren Rand[1], Daniel J. Ripin[1], T. Y. Fan[1], Daniel E. Miller[1], Juan Ochoa[1], Kris Goldizen[1]; [1]*MIT Lincoln Lab, USA.*A laser amplifier using two cryogenically cooled materials, Gd3Sc2Al3O12 (GSAG) and YAG, demonstrates tens of millijoule pulse energy at kilohertz repetition rates. The near-diffraction-limited output was compressed to picosecond pulse duration.

CM3D.5 • 14:30
From 10 to 30 joules with the Lucia laser system: update on current performance and future cryogenic amplifier, Thierry GONCALVES-NOVO[1]; [1]*Laboratoire LULI - Ecole Polytechnique, France.* 10.2 J 7ns pulses were extracted at 2Hz in four passes from Lucia active mirror Yb3+: YAG diode pumped laser amplifier. A second amplifier head relying on cryogenic cooling will allow reaching the 30J level.

CM3D.6 • 14:45
160 mJ cryogenic Ho:YLF laser with unstable resonator, Helge Fonnum[1], Espen Lippert[1]; [1]*FFI, Norway.*We report 160 mJ from a Q-switched Ho:YLF oscillator pumped with 60W in 10 ms by a Tm-fiber laser. 20 ns FWHM pulses, threshold 244 mJ, slope 43 % and beam quality M2 < 2.

CM3D.7 • 15:00
Cryogenic, Conduction Cooled, End Pumped, Zigzag Slab Laser, Suitable For Power Scaling, Miftar Ganija[1], David J. Ottaway[1], Peter J. Veitch[1], Jesper Munch[1]; [1]*School of Chemistry and Physics, The University of Adelaide, Australia.* Thermo mechanical and thermo optical properties of Yb:YAG improve significantly at cryogenic temperatures. We present the first end pumped, zigzag slab Yb:YAG geometry, which is cryogenically conduction cooled, robust, and power scalable.

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

QM3E • Novel Temporal Phenomena & Airy Beams—Continued

QM3E.4 • 14:15
High-intensity self-accelerating Airy pulses and controllable spectral shifting in nonlinear Kerr mediam Yi Hu[1], Ming Li[1], Domenico Bongiovanni[1], Matteo Clerici[1], Zhigang Chen[2], José Azana[1], Roberto Morandotti[1]; [1]*Université du Quebec, Institute National de la Recherche Scientifique, Canada;* [2]*Department of Physics & Astronomy, San Francisco State University, USA.* We show that high-intensity Airy pulses propagating in Kerr-type nonlinear media can preserve their self-accelerating features under appropriate conditions. By engineering the input pulses, controllable spectral shifting and reshaping are achieved.

QM3E.5 • 14:30
Multi-core, tapered fiber for nonlinear pulse reshaping, Darren D. Hudson[1], Thomas Büttner[1], Eric C. Mägi[1], Alvaro Casas Bedoya[1], Thierry Taunay[2], Benjamin J. Eggleton[1]; [1]*School of Physics, University of Sydney, Australia;* [2]*OFS Laboratories, USA.* We present a new method to create a coupled waveguide array via tapering a multi-core telecommunications fiber. This device exhibits the novel physics associated with coupled waveguide arrays: discrete self-focusing and nonlinear pulse chopping.

QM3E.6 • 14:45
Self-accelerating optical beams in nonlocal nonlinear media, Rivka Bekenstein[1], Ran Schley[1], Mordechai Segev[1]; [1]*Physics Department and Solid State Institute, Technion, Israel.* We find self-accelerating beams in nonlocal nonlinear media and show that their propagation dynamics is affected by boundary conditions that increase their acceleration, or cause bending in a direction opposite to the initial trajectory.

QM3E.7 • 15:00 Invited
Bloch oscillations, Landau-Zener tunneling and fractal patterns in a discrete fiber network, Alois Regensburger[1,2], Bersch Christoph[1,2], Benjamin Hinrichs[1,2], Georgy Onishchukov[2], Andreas Schreiber[2], Christine Silberhorn[2,3], Ulf Peschel[1]; [1]*Inst. of Optics, Information and Photonics, University Erlangen-Nuremberg, Germany;* [2]*Max Planck Institute for the Science of Light, Germany;* [3]*Applied Physics, University of Paderborn, Germany.* Coherent light propagation in a discrete fiber network with similarities to quantum walks is considered. The controlled interplay of phase gradients and photon losses leads to Bloch oscillations, Landau-Zener tunneling and fractal patterns.

QM3F • Meta Interfaces and Surfaces I—Continued

QM3F.4 • 14:15
Metamaterial bolometers, Fabian B. Niesler[1], Martin Wegener[1]; [1]*Institute for Applied Physics, Institute for Nanotechnology, DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology, Germany.* We fabricate metamaterial bolometers using gold nanostructures on thin SiN membranes. The electrical and optical characterization around 1.5 µm wavelength shows spectral and polarization filter capabilities that can be tailored lithographically.

QM3F.5 • 14:30 Invited
Broadband Birefringent Metainterfaces, Nanfang Yu[1], Patrice Genevet[1], Francesco Aieta[1], Mikhail A. Kats[1], Zeno Gaburro[1], Federico Capasso[1]; [1]*School of Engineering and Applied Sciences, Harvard University, USA.* We report broadband birefringent metainterfaces comprising 2D arrays of phased optical antennas that can create light beams with arbitrary polarization states and arbitrary propagation directions over a wide spectral range (from λ5 to 14 µm).

QM3F.6 • 15:00
From Isolated Metaatoms to Photonic Metamaterials: Mapping of Collective Near-field Phenomena with EELS, Felix von Cube[1,2], Stephan Irsen[2], Stefan Linden[1,3]; [1]*Physikalisches Institut, University of Bonn, Germany;* [2]*Research center caesar, Germany;* [3]*Institut für Nanotechnologie, Karlsruher Institut für Technologie (KIT), Germany.* We investigate the evolution of plasmonic modes during the transition from metaatoms to photonic metamaterials by electron energy-loss spectroscopy. Interactions between metaatoms have a strong effect on the near-field distribution of metamaterials.

QM3G • Coherent Phenomena and Control in Semiconductors—Continued

QM3G.4 • 14:15
Evidence of Exciton-Trion Coherent Interactions in a CdTe/CdMgTe Quantum Well, Hebin Li[1], Galan Moody[1,2], Rohan Singh[1,2], Ilya Akimov[3,4], Dimitri Yakovlev[3,4], Manfred Bayer[3], Grzegorz Karczewski[5], Tomasz Wojtowicz[5], Steven T. Cundiff[1,2]; [1]*JILA, National Institute of Standards and Technology, and the University of Colorado, USA;* [2]*Department of Physics, University of Colorado, USA;* [3]*Experimentelle Physik 2, Technische Universität Dortmund, Germany;* [4]*A. F. Ioffe Physical-Technical Institute, Russian Academy of Sciences, Russian Federation;* [5]*Institute of Physics, Polish Academy of Sciences, Poland.* Many-body interactions in a doped CdTe/CdMgTe quantum well are investigated using optical 2D Fourier-transform spectroscopy. The nature of coherent exciton-trion correlations is examined by analyzing lineshapes in the 2D spectra.

QM3G.5 • 14:30
Electromagnetically Induced Transparency of Spin Ensembles in a Two-Dimensional Electron Gas, Thomas K. Baldwin[1], Shannon O'Leary[2], Hailin Wang[1]; [1]*Department of Physics, University of Oregon, USA;* [2]*Department of Physics, Lewis and Clark College, USA.* We report experimental studies of electromagnetically induced transparency (EIT) in a two-dimensional electron gas of a modulation-doped quantum well, with the aim of realizing an ideal EIT process in a solid state spin ensemble.

QM3G.6 • 14:45
Tailoring Quantum-Correlated Two-Photon Transitions to Excitons in Semiconductor Quantum Wells, David A. Guzmán[1,2], Luis J. Salazar[1], Ferney J. Rodríguez[1], Luis Quiroga[1]; [1]*Physics Department, Universidad de Los Andes, Colombia;* [2]*Quantum Optics Laboratory, Universidad de Los Andes, Colombia.* Dependence of excitonic two-photon absorption on the quantum correlations of exciting biphotons in a semiconductor quantum well is studied. We found that exciton oscillator strengths increase when photons arrive simultaneously in entangled states.

QM3G.7 • 15:00
Theory of Line Narrowing in Nonlinear Polarization Spectroscopy, Mario Schoth[1], Marten Richter[1], Andreas Knorr[1], Thomas Renger[2]; [1]*Institut für Theoretische Physik, Technische Universität Berlin, Germany;* [2]*Institut für Theoretische Physik, Johannes Kepler Universität, Austria.* Nonlinear Polarization Spectroscopy in the Frequency Domain (NLPF) can be used to reveal the homogeneous line width of excitonic transitions, that is otherwise hidden by inhomogeneous broadening.

Room A8

CLEO: QELS-Fundamental Science

QM3H • Novel Plasmonic Sensors—Continued

QM3H.4 • 14:15
Coupling between a Sub-wavelength Optical Cavity and a Plasmonic Nanostructure probed by coupling by SERS, Jérôme Plain[1], Anna Rumyantseva[1], David G. Gosztola[2], Sergeï Kostcheev[1], Jean Louis Bijeon[1], Renaud Bachelot[1], Gary Wiederrecht[2], Jérôme Plain[1]; [1]*Université de technologie de Troyes, France;* [2]*Center for Nanoscale Materials, Argonne National Laboratory, USA.* We report on the utilization of optical sub-wavelength Fabry-Perot cavity coupled with SERS to study the interaction between the localized surface plasmon resonance of gold nanoparticles and the surface plasmon resonance of a gold film.

QM3H.5 • 14:30
Plasmonic Composite Nanoparticles to Engineer the Optical Scattering Spectra, Christos Argyropoulos[1], Francesco Monticone[1], Andrea Alù[1]; [1]*Electrical and Computer Engineering, University of Texas at Austin, USA.* Plasmonic-dielectric nanoparticles are tailored to support rich scattering spectra, combining Fano-type features with cloaking and resonant peaks. A core-shell design is proposed as sensor, with tunable features when nonlinearities are introduced.

QM3H.6 • 14:45
Extraordinarily high spectral sensitivity in refractive index sensors using multiple optical modes, Zongfu Yu[1], Shanhui Fan[1]; [1]*Stanford University, USA.* We show that high spectral sensitivity in surface plasmon resonance sensor is due to the multi-mode nature of the sensing scheme. Multi-mode sensing can be applied to dielectric systems to achieve similar extraordinary spectral sensitivity.

QM3H.7 • 15:00
Minimizing Quenching of Plasmonic Sensors caused by Adhesion Layers, Thomas Siegfried[1], Yasin Ekinci[1,2], Harun Solak[3], Olivier Martin[4]; [1]*Paul Scherrer Institute, Switzerland;* [2]*Laboratory of Metal Physics and Technology,, ETH Zurich, Switzerland;* [3]*Eulitha AG, Switzerland;* [4]*Nanophotonics and Metrology Laboratory, EPFL, Switzerland.* Adhesion layers are commonly used at dimensions where the electric near-field intensity can be strongly quenched. We have found that by minimizing the layer thickness to roughly 0.5 nm, quenching can by reduced by a factor of up to 7.

Room B2 & B3

JOINT

JM3I • Symposium on the 50th Anniversary of the Semiconductor Laser II—Continued

JM3I.3 • 14:30 Invited
Semiconductor Lasers for Telecommunications, Thomas L. Koch[1]; [1]*University of Arizona, USA.* Semiconductor lasers have witnessed a remarkable evolution from multimode pulse sources to tunable precision waveform generators for coherent communications. This talk will recount major milestones in this progression with an eye towards the future.

JM3I.4 • 15:00 Invited
Vertical-Cavity Surface-Emitting Lasers (VCSELs): Optics, Risk, Collaborations, Jack Jewell[1]; [1] *Consultant, USA; 2Axel Scherer; 2Caltech; 3Sam McCall 3(deceased); 4Yong Lee; 4Department of Physics, KAIST, 5Kusung-dong, 5Yusung-gu, Daejon, 5Korea; 6Jim Harbison; 6Leigh Florez 6(unknown); 7Hyatt Gibbs, 7College of Optical Sciences, University of Arizona.* The 1989 VCSEL-advance by this group, which marked a turning point in VCSEL development efforts, was a curious culmination built upon outside publications, optical innovations from the group, risky-research funding, and resolute inter-company collaboration.

Room C1 & C2 / Room C3 & C4

CLEO: Science & Innovations

CM3J • High Power Terahertz Sources & Applications—Continued

CM3J.3 • 14:15
Towards Generation of mJ-Level Ultrashort THz Pulses by Optical Rectification, Jozsef A. Fülöp[1], Laszlo Pálfalvi[1], Zoltan Ollmann[1], Gabor Almási[1], Sandro Klingebiel[2], Ferenc Krausz[2,3], Stefan Karsch[2,3], János Hebling[1]; [1]*Department of Experimental Physics, University of Pecs, Hungary;* [2]*Max-Planck-Institut für Quantenoptik, Germany;* [3]*Department für Physik, Ludwig-Maximilians-Universität München, Germany.* The so far highest THz pulse energy (125 µJ) and efficiency (0.25%) were measured by optical rectification of 1.3 ps pulses in LiNbO3. The generation of mJ-level THz pulses is predicted by calculations.

CM3J.4 • 14:30
Direct Current Generation in Graphene by a Monocycle Terahertz Radiation Pulse, Kenichi L. Ishikawa[1]; [1]*Photon Science Center, Graduate School of Engineering, University of Tokyo, Japan.* Direct current is generated in graphene irradiated by a linearly polarized, normally incident, intense monocycle terahertz pulse. The generated current depends on carrier-envelope phase, pulse intensity, and Fermi energy in a complex manner.

CM3J.5 • 14:45
Electric-Field Induced Second-Harmonic FROG Characterization of Long-Wavelength, Few-Cycle Pulses, Matteo Clerici[1], Daniele Faccio[1,2], Mostafa Shalaby[1], Mathieu Giguère[1], Bruno E. Schmidt[1], Marco Peccianti[1,3], François Légaré[1], Tsuneyuki Ozaki[1], Roberto Morandotti[1]; [1]*INRS-EMT, University of Quebec, Canada;* [2]*School of Engineering and Physical Sciences, Heriot-Watt University, SUPA, United Kingdom;* [3]*Institute for Complex Systems, CNR, UOS Montelibretti, Italy.* We describe a method for electric-field characterization of few-cycles pulses with wavelengths from mid-infrared to the THz region, based on electric-field induced second harmonic spectrograms. The method is demonstrated with single cycle THz pulses.

CM3J.6 • 15:00 Invited
Controlling Superconductivity with Strong Terahertz Fields, Matthias Hoffmann[1,4], Andreas Dienst[2], Daniele Fausti[3], Stefan Kaiser[3], Andrea Cavalleri[2,4]; [1]*LCLS Laser Department, SLAC National Accelerator Laboratory, USA;* [2]*Department of Physics, Clarendon Laboratory, University of Oxford, United Kingdom;* [3]*University of Trieste, Italy;* [4]*Max Planck Department for Structural Dynamics, University of Hamburg, Germany.* Ultrafast mid-infrared and terahertz pulses open a new avenue to control complex solids by directly accessing their low-energy excitations. Here we discuss recent results in inducing and manipulating superconductivity using strong fields.

CM3K • Filaments and Related Phenomena—Continued

CM3K.2 • 14:30
Femtosecond Laser Filaments Allow Remote Imaging beyond Diffraction Limit, Kai Wang[1], Benjamin D. Strycker[1], Dmitri V. Voronin[1], Pankaj K. Jha[1], Marlan O. Scully[1,2], Ronald E. Meyers[3], Philip Hemmer[1], Alexei V. Sokolov[1]; [1]*Institute for Quantum Science and Engineering, Texas A&M University, USA;* [2]*Princeton University, USA;* [3]*U.S. Army Research Laboratory, USA.* We demonstrate a scheme which achieves sub-diffraction-limited imaging of remote objects by using femtosecond laser filaments.

CM3K.3 • 14:45
Rogue Waves in the Transverse Plane of Femtosecond Multifilaments, Simon Birkholz[1], Carsten Bree[3,1], Goëry Genty[2], Erik Nibbering[1], Günter Steinmeyer[1,2]; [1]*Max-Born-Institut, Germany;* [2]*Tampere University of Technology, Finland;* [3]*Weierstrass-Institut für Angewandte Analysis und Stochastik, Germany.* The appearance of extreme-value statistics is experimentally observed in the beam profiles of multifilaments. Rogue wave formation sets in together with multifilament formation, with the strongest L-shaped distributions above 20 critical powers.

CM3K.4 • 15:00
Towards light-matter interaction at extreme intensities using high-angle Bessel beams, Daniele Faccio[1], Eleonora Rubino[2], Antonio Lotti[2], Arnaud Couairon[3], Audrius Dubietis[4], Gintaras Tamosauskas[4], Mahboubeh Ghalandari[1], Dimitris Papazoglou[5], Stelios Tzortzakis[5]; [1]*School of Engineering and Physical Sciences, Heriot-Watt University, United Kingdom;* [2]*Dipartimento di Scienza e Alta Tecnologia, University of Insubria, Italy;* [3]*Centre de Physique Theorique, Ecole Polytechnique, France;* [4]*Department of Quantum Electronics, Vilnius University, Lithuania;* [5]*Institute of Electronic Structures and Laser, Foundation for Research and Technology Hellas, Greece.* High-angle Bessel beams significantly reduce nonlinear pulse distortion yet enhance plasma generation. Digital holographic reconstruction of Bessel beams in water show clamping at increased intensities and excess plasma heating in the pulse wake.

Marriott San Jose
Salon I & II

Marriott San Jose
Salon III

Marriott San Jose
Salon IV

CLEO: Science & Innovations

CM3L • Dynamics of Laser-Matter Interactions—Continued

CM3L.3 • 14:15
Nanoscale 3D composition imaging by soft x-ray laser ablation mass spectrometry, Ilya Kuznetsov[1,2], Jorge Filevich[1,2], Feng Dong[1,3], Weilun Chao[1,4], Erik Anderson[1,4], Elliot Bernstein[1,3], Dean Crick[5], Jorge Rocca[1,2], Carmen Menoni[1,2]; [1]*NSF Engineering Research Center for Extreme Ultraviolet Science and Technology, Colorado State University, USA;* [2]*Electrical & Computer Engineering, Colorado State University, USA;* [3]*Department of Chemistry, Colorado State University, USA;* [4]*Center for X-Ray Optics, Lawrence Berkeley Laboratory, USA;* [5]*Microbiology, Immunology, and Pathology, Colorado State University, USA.* We demonstrate a novel mass spectrometry nanoprobe that uses soft x-ray laser ablation to map chemical composition. Composition maps of metal/dielectric/polymer samples with 250nm surface and 50nm depth resolution were obtained.

CM3L.4 • 14:30
Filament Ablation of Opaque Solid Material, Anthony Valenzuela[1], Chase Munson[1], Andrew Porwitzky[1]; [1]*US Army Research Lab, USA.* Filamentation of femtosecond laser pulses defy diffraction and exist for many meters. The filament contains the concentrated laser pulse and a plasma column in its wake. We study filament ablation of metal and polymer surfaces.

CM3L.5 • 14:45
Optical limiting and femtosecond transient absorption measurements in a low bandgap quinoidal oligothiophene derivative, Hae-Young Shin[1,2], J. H. Woo[1,2], Boyoung Kang[1], Minji Kwon[1,2], Marie Barthelemy[3], Mircea Vomir[3], Tsuyoshi Muto[4], K. Takaishi[4], Tetsuya Aoyama[4], Dong-Wook Kim[1,2], Seokhyun Yoon[1,2], Jean-Yves Bigot[3], Jeong Weon Wu[1,2], Jean Charles Ribierre[1,2]; [1]*Physics, Ewha Womans University, Republic of Korea;* [2]*CNRS-Ewha Research Center, Ewha Womans University, Republic of Korea;* [3]*IPCMS, CNRS-Universite de Strasbourg, France;*[4]*Advanced Science Institute, RIKEN, Japan.* To study the photophysics of a quinoidal oligothiophene derivative, we measured the optical limiting and transient absorption properties in both solution and thin films using femtosecond laser and ultrafast pump probe experiment, respectively.

CM3L.6 • 15:00
Multi-ion diffusion in silica glass using femtosecond pulsed laser deposition, Gin Jose[1], Toney T. Fernandez[1], D. Steenson[2], Animesh Jha[1]; [1]*Institute for Materials Research, University of Leeds, United Kingdom;* [2]*University of Leeds, Institute of Microwaves and Photonics, United Kingdom.* We demonstrate simultaneous implantation of Tellurium, Zinc, Sodium and Erbium ions in Silica glass via fs-PLD. 1.3µm deep uniform diffusion with Δnmax of 0.169 was produced. Process is explained using existing models with experimental verification.

CM3M • Waveguides and Passive Components—Continued

CM3M.3 • 14:15
Coupled-Resonator Optical Waveguides (CROWs) Based on Tapered Grating-Defect Resonators, Hsi-Chun Liu[1], Christos Santis[1], Amnon Yariv[1]; [1]*Electrical Engineering, California Institute of Technology, USA.* We report experimental results of CROWs based on high-Q (Q~10^5) tapered grating-defect resonators in silicon waveguides. CROWs with 36 resonators and tailored coupling coefficients are demonstrated, showing group velocities of c/11.2 and c/23.6.

CM3M.4 • 14:30
Feedback in Coupled-Resonance Optical Waveguides, Matthew D. Weed[1], Charles Williams[1], Peter Delfyett[1], Winston V. Schoenfeld[1]; [1]*CREOL, the College of Optics & Photonics, University of Central Florida, USA.* Coupled Mode Theory analysis of a new architecture for coupled-resonance optical waveguide design is presented that enables a feedback mechanism in a photonic crystal scheme while also increasing resonant finesse from 2.77 to 10.15.

CM3M.5 • 14:45
Polymer-Embedded Arrays of Vertical Silicon Nanowires as Color Filters, Hyunsung Park[1], Kwanyong Seo[1], Kenneth B. Crozier[1]; [1]*School of Engineering and Applied Sciences, Harvard University, USA.* We demonstrate color filters comprising silicon nanowire arrays embedded in polymer. Each array's transmission spectrum contains one or more dips, whose positions can be tuned across the visible wavelength range by choice of nanowire radius.

CM3M.6 • 15:00
Submicrometer-width TiO2 waveguides, Christopher C. Evans[1], Jonathan Bradley[1], Jennifer Choy[1], Orad Reshef[1], Parag B. Deotare[1], Marko Loncar[1], Eric Mazur[1]; [1]*School of Engineering and Applied Sciences, Harvard University, USA.* We fabricate submicrometer-width TiO2 strip waveguides and measure optical losses at 633, 780, and 1550 nm. Losses of 30, 13, and 4 dB/cm (respectively) demonstrate that TiO2 is suitable for visible-to-infrared on-chip microphotonic devices.

CM3N • Photonic Crystal Fibers—Continued

CM3N.4 • 14:15
Milli-Joule laser pulse delivery for spark ignition through kagome fiber, Benoit Beaudou[1], Frederic Gerome[1], Yingying Wang[1,2], Meshaal Alharbi[1,2], Tom Bradley[1,2], Georges Humbert[1], Jean-Louis Auguste[1], Jean-Marc Blondy[1], Fetah Benabid[1,2]; [1]*Xlim research institute, France;* [2]*GPPM University of Bath, United Kingdom.* We demonstrate for the first time ns-laser spark ignition through kagome-type fibers in a friendly manner. The energy threshold damage is pushed over the 10mJ-level and the output power density is approaching TW/cm2 after focusing.

CM3N.5 • 14:30
Gas Absorption between 1.8 and 2.1 µm in Low Loss (5.2 dB/km) HC-PBGF, Natalie V. Wheeler[1], Marco N. Petrovich[1], Naveen K. Baddela[1], John R. Hayes[1], Eric N. Fokoua[1], Francesco Poletti[1], David J. Richardson[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* 19-cell defect HC-PBGF is fabricated with record low loss (5.2 dB/km) at 2 µm. Gas absorption lines present in the fiber post-fabrication are quantified with initial conclusions on the origin and removal of relevant species.

CM3N.6 • 14:45
Microwave resonator for generation of microplasmas in Hollow-Core Photonic Crystal Fibers, Benoît Debord[1], Frédéric Gérôme[1], Raphaël Jamier[1], Caroline Boisse-Laporte[2], Philippe Leprince[2], Olivier Leroy[2], Jean-Marc Blondy[1], Fetah Benabid[1]; [1]*Xlim research Institute, France;* [2]*LPGP Orsay, France.* We report on new class of microwave resonator enabling generation of a stable microplasma in 100 µm core-diameter kagome-latticed HCPCF without any structural damage. Blue Ar+ lines are successfully generated with low microwave power.

CM3N.7 • 15:00 Invited
Photonic Microcell: A Revival Tool for Gas Lasers, Fetah Benabid[1,2]; [1]*Xlim Research Institut, France;* [2]*Physics, University of Bath, United Kingdom.* We review the recent progress on hollow-core photonic crystal fibers and its integrated form of photonic microcells in both their design and fabrication and in their applications in different lasing mechanisms in gas-phase materials.

Room A1	Room A2	Room A3	Room A4
CLEO: Science & Innovations		CLEO: QELS-Fundamental Science	CLEO: Science & Innovations

CM3A • Silicon Photonic Integration—Continued

CM3A.7 • 15:15
Optical Routers with Ultra-Low Power Consumption for Photonic Networks-on-Chip, Lin Yang[1]; [1]*Institute of Semiconductors, Chinese Academy of Sciences, China.* We demonstrated a five-port optical router for photonic networks-on-chip. New topology design improves the performances in terms of power consumption, optical loss, crosstalk and channel uniformity of the optical router.

CM3B • Guided-Wave Sensing—Continued

CM3B.7 • 15:15
2×3 Photonic Crystal Series-Parallel Integrated Sensor Arrays Based on Monolithic Substrates Using Side-Coupled Resonator Arrays, Daquan Yang[1,2], Huiping Tian[1,2], Jiatian Huang[1,2], Yuefeng Ji[1,2]; [1]*State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications, China;* [2]*School of information and communication Engineering, Beijing University of Posts and Telecommunications, China.* We propose an alternative method to build nanoscale point and sensor array performing highly-parallel and multiplexing capability on monolithic photonic crystal slab, which is 2×3 monolithic photonic crystal series-parallel integrated sensor array.

QM3C • Diamond—Continued

CM3D • Cryogenic Lasers—Continued

CM3D.8 • 15:15
Cryogenic Faraday Isolator for Multikilowatt Average Laser Power, Dmitry Zheleznov[1]; [1]*Nonlinear and laser optics, Institute of Applied Physics RAS, Russian Federation.* Design of cryogenic Faraday isolator for multikilowatt laser power is described. Characteristics of device have been investigated experimentally at laser power above 1 kW and possibility of its use at power 6 kW is demonstrated.

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

NOTES

Room A5	Room A6	Room A7

CLEO: QELS-Fundamental Science

QM3E • Novel Temporal Phenomena & Airy Beams—Continued

QM3F • Meta Interfaces and Surfaces I—Continued

QM3F.7 • 15:15
Flux Exclusion Quantum Superconducting Metamaterial, Vassili Savinov[1], Anagnostis Tsiatmas[1], Anthony R. Buckingham[2], Vassili A. Fedotov[1], Peter A. de Groot[2], Nikolay I. Zheludev[1]; [1]*OptoelecOptoelectronics Research Centre & Centre for Photonic Metamaterials, University of Southampton, United Kingdom;* [2]*School of Physics and Astronomy & Centre for Photonic Metamaterials, University of Southampton, United Kingdom.* The new type of metamaterial exploits magnetic flux quantization as a source of its nonlinear response but does not require Josephson junctions. We fabricated metamaterial from a high-Tc superconductor and report its electromagnetic characterization.

QM3G • Coherent Phenomena and Control in Semiconductors—Continued

QM3G.8 • 15:15
Sub-Cycle Switching of Ultrastrong Light-Matter Interaction in a 1D Photonic Bandstructure, Jean-Michel Menard[1,2], Michael Porer[1,2], Alfred Leitenstorfer[1], Rupert Huber[1,2], Riccardo Degl'Innocenti[3], Simone Zanotto[3], Giorgio Biasiol[4], Lucia Sorba[3], Alessandro Tredicucci[3]; [1]*Physics, University of Konstanz, Germany;* [2]*Physics, University of Regensburg, Germany;* [3]*NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Italy;* [4]*Laboratorio TASC, CNR-IOM, Area Science Park, Italy.* Multi-terahertz transients map out the photonic bandstructure of a plasmonic crystal while ultrastrong coupling with quantized electronic transitions in semiconductor quantum wells is activated within less than a cycle of light.

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

NOTES

Room A8

CLEO: QELS-Fundamental Science

QM3H • Novel Plasmonic Sensors—Continued

QM3H.8 • 15:15
Analytical Comparison of Raman and Photoluminescence Enhancement by Metal Nanoparticles, Greg Sun[1], Jacob B. Khurgin[2]; [1]*Physics, University of Massachusetts Boston, USA;* [2]*ECE, Johns Hopkins University, USA.* We present a comparative study on the enhancement of photoluminescence and Raman processes by a single metal nanoparticle and show the physics behind the strikingly different orders of magnitude in enhancement between the two that have been observed.

Room B2 & B3

JOINT

JM3I • Symposium on the 50th Anniversary of the Semiconductor Laser II—Continued

Room C1 & C2

CLEO: Science & Innovations

CM3J • High Power Terahertz Sources & Applications—Continued

Room C3 & C4

CM3K • Filaments and Related Phenomena—Continued

CM3K.5 • 15:15
Dispersion-Induced Depletion Instabilities in Cavity-Enhanced Optical Parametric Chirped Pulse Amplification, Aleem Siddiqui[1], Jeffrey Moses[1], Kyung-Han Hong[1], Franz X. Kaertner[1,2]; [1]*Massachusetts Institute of Technology, USA;* [2]*University of Hamburg, Germany.* In a cavity-enhanced optical parametric chirped-pulse amplifier, natural instabilities arise due to the interplay of pump depletion and dispersion when pulse durations longer than the pump to signal/idler walk-off lengths are used.

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

NOTES

Marriott San Jose Salon I & II	Marriott San Jose Salon III	Marriott San Jose Salon IV

CLEO: Science & Innovations

CM3L • Dynamics of Laser-Matter Interactions—Continued

CM3L.7 • 15:15
Femtosecond laser-induced forward transfer of thin layers, Matthias Feinaeugle[1], Anne Patricia Alloncle[2], Philippe Delaporte[2], Collin L. Sones[1], Robert W. Eason[1]; [1]Optoelectronics Research Centre, University of Southampton; [2]Southampton, Hampshire, United Kingdom. We report the shadowgraph imaging of femtosecond laser-induced forward transfer of 0.5 – 1.8µm solid films. We observe intact transfer with velocities as low as 34m/s in the absence of any shock wave.

CM3M • Waveguides and Passive Components—Continued

CM3M.7 • 15:15
On-chip metal wire grid polarizer for CMOS image sensor based on 65-nm technology, Kiyotaka Sasagawa[1,2], Keisuke Ando[1], Hitoshi Matsuoka[1], Takuma Kobayashi[1,2], Toshihiko Noda[1,2], Takashi Tokuda[1,2], Ohta Jun[1,2]; *[1]Nara Insittute of Science and Techonlogy, Japan; [2]CREST, Japan Sceence and Technology Agency, Japan.* We demonstrate complementary metal-oxide-semiconductor (CMOS) image sensor pixels with on-chip polarizer fabricated by a standard 65-nm CMOS technology. The extinction ratio of 94 at a wavelength of 750 nm was achieved.

CM3N • Photonic Crystal Fibers—Continued

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

NOTES

Monday, 7 May

Room A1 | **Room A2**

CLEO: Science & Innovations

16:00–18:00
CM4A • Silicon Photonics I
Jessie Rosenberg, IBM, USA, *Presider*

CM4A.1 • 16:00
Modeling light transmission in silicon waveguides, Mark A. Schneider[1], Shayan Mookherjea[1]; [1]*Electrical and Computer Engineering, University of California San Diego, USA.* We propose and experimentally validate a detailed model for silicon nanophotonic waveguides which predicts the full spectral distribution function of propagation statistics including the role of interfaces and roughness.

CM4A.2 • 16:15
Large Dispersion of Silicon Waveguide Directional Couplers, Ryan Aguinaldo[1], Yiran Shen[1], Shayan Mookherjea[1]; [1]*Electrical and Computer Engineering, University of California San Diego, USA.* The wavelength variation (dispersion) of waveguide directional couplers can be much larger than the modal refractive index dispersion of typical single-mode silicon nanophotonic waveguides and we investigate approaches to lowering this variation.

CM4A.3 • 16:30 Invited
The Foundry Model for Silicon Photonics - Technology, Challenges, and Opportunities, Patrick (Guo-Qiang) Lo[1]; [1]*Nano Electronics & Photonics, Institute of Microelectronics, ASTAR, Singapore.* Silicon photonics demands an easily assessable fabrication foundry with flexibility for research and development of integrated photonics circuits and with manufacturing path required for volume production.

16:00–18:00
CM4B • Fiber-Based Sensing
Waruna Kulatilaka, Spectral Energies LLC., USA, *Presider*

CM4B.1 • 16:00 Invited
Realization of Nano-Strain-Resolution Fiber Optic Static Strain Sensor for Geo-Science Applications. Zuyuan He[1], Qingwen Liu[1], Tomochika Tokunaga[2]; [1]*Department of Electrical Engineering and Information Systems, The University of Tokyo, Japan;* [2]*Department of Environment Systems, The University of Tokyo, Japan.* The first realization of nano-strain-resolution fiber optic static strain sensor is introduced. With this sensor, crustal deformations induced by oceanic tide and by earthquake were clearly observed.

CM4B.2 • 16:30
Active Distributed Sensing using Self-heated Optical Fibers, Tong Chen[1], Qingqing Wang[1], Rongzhang Chen[1], Botao Zhang[1], Kevin Chen[1]; [1]*Dept. of Electrical and Computer Engineering, University of Pittsburgh, USA.* We report distributed sensing with active control using self-heated optical fibers. The heat loss profile along the fiber is spatially interrogated with OFDR Rayleigh backscattering signals to perform gas flow and liquid level sensing measurements.

Room A3

CLEO: QELS-Fundamental Science

16:00–18:00
QM4C • Continuous Variable Quantum Optics
Viv Kendon, University of Leeds, UK, *Presider*

QM4C.1 • 16:00 Tutorial
Toward Quantum Computing with Oscillators, Olivier Pfister[1]; [1]*Physics Department, University of Virginia, USA.* The theory of the physical implementation of universal quantum computing in the optical frequency comb will be detailed. Recent experimental progress by my group will then be presented, and future perspectives will finally be discussed.

Olivier Pfister received a B.S. in Physics from Université de Nice, France (1987), and an M.S. (1989) and a Ph.D. (1993) in Physics from Université Paris-Nord, France, where he studied the hyperfine structure of tetrahedral molecules by ultrahigh resolution laser spectroscopy. He was then a Research Associate with John L. Hall at JILA, University of Colorado (1994-7), working on laser stabilization, nonlinear optical frequency chains, and quantum optical interferometry. He then joined the group of Daniel J. Gauthier at Duke University (1997-9) and observed complex polarization dynamics in a novel two-photon laser. In 1999, he joined the faculty of the University of Virginia, where he is now a Professor of Physics. Olivier Pfister is a member of the American Physical Society and of the Optical Society of America. His current research interests include quantum computing with light, quantum measurements at the ultimate precision, and anything having to do with symmetry.

Room A4

CLEO: Science & Innovations

16:00–18:00
CM4D • Petawatt Lasers Technologies
Federico Canova, Amplitude Technologies, France, *Presider*

CM4D.1 • 16:00
Progress on the XG-III high-power laser facility with synchronized fs, ps and ns output pulses, Jingqin Su[1], Na Xie[1]; [1]*Research Center of Laser Fusion, CAEP, China.* The paper presents the technical design and progress on a high-power laser XG-III, which consists of three synchronized beams, i.e. the femtosecond, picosecond and nanosecond beams.

CM4D.2 • 16:15
High efficient amplification in a PW Ti:sapphire laser, Seong Ku Lee[1], Tae Jun Yu[1], Jae Hee Sung[1], Jin Woo Yoon[1], Tae Moon Jeong[1], Jongmin Lee[1]; [1]*APRI, GIST, Republic of Korea.* We report that 60-J output energy from a Ti:sapphire amplifier was achieved with 120-J pump energy under the condition of the strong transverse parasitic lasing.

CM4D.3 • 16:30
A negative-feedback-stabilization system for an all-fiber regenerative amplifier, Ran Xin[1,2], Jonathan D. Zuegel[1]; [1]*LLE, University of Rochester, USA;* [2]*Physics and Astronomy, University of Rochester, USA.* A negative-feedback system is employed in an all-fiber regenerative amplifier to control the cavity dynamics and stabilize the output pulse energy. The 100 round-trip output level is stabilized to within 7% rms.

Thank you for attending CLEO: 2012. Look for your post-conference survey via email and let us know your thoughts on the program.

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

16:00–18:00
QM4E • Supercontinuum and Few-Cycle Phenomena
Mark Foster, Johns Hopkins University, USA, *Presider*

QM4E.1 • 16:00
Broadband Coherent Multiple-order Raman Sidebands Controlled via a Pulse Shaper, Miaochan Zhi[1], Kai Wang[1], Hua Xia[1], Alexei V. Sokolov[1]; [1]*Physics and Astronomy, Texas A&M University, USA.* We use diamond to produce femtosecond broadband coherent Raman generation akin to molecular modulation. We achieve shape control of few-cycle pulses by combining coarse manual phase adjustment with fine tuning via a programmable pulse shaper.

QM4E.2 • 16:15
Few-cycle highly localized wavepackets on demand with superior temporal transfer, Martin Bock[1], Susanta K. Das[1], Ruediger Grunwald[1]; [1]*C2, Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy im Forschungsverbund Berlin e.V., Germany.* Strongly collimated and localized wavepackets of variable geometry were shaped from 6-fs pulses by reflective spatial light modulators. Space-time signatures indicate undistorted propagation and close approximation to perfect linear light bullets.

QM4E.3 • 16:30
High-energy Few-cycle Pulses Directly Generated from Strongly Phase-mismatched Lithium Niobate Crystal, Binbin Zhou[1], Andy Chong[2], Frank W. Wise[2], Morten Bache[1]; [1]*DTU Fotonik, Denmark;* [2]*Department of Applied and Engineering Physics, USA.* We show that effective soliton compression can be realized in strongly phase-mismatched quadratic media. Sub-15 fs pulses are experimentally generated directly from 10-mm-long bulk lithium niobate crystal by 120-fs input pulses at 1300 nm.

16:00–18:00
QM4F • Meta Interfaces and Surfaces II
Alexandra Boltasseva, Purdue University, USA, *Presider*

QM4F.1 • 16:00
Out of plane reflection and refraction of light by plasmonic interfaces with phase discontinuities, Francesco Aieta[1,2], Patrice Genevet[1], Nanfang Yu[1], Mikhail A. Kats[1], Zeno Gaburro[1], Federico Capasso[1]; [1]*SEAS, Harvard University, USA;* [2]*FIMET, Università Politecnica delle Marche, Italy.* 3-dimensional laws of reflection and refraction are derived and demonstrated for thin interfaces that impart to the incident wavefront a phase gradient.The tangential wavevector provided by the interface creates out-of-plane reflection and refraction.

QM4F.2 • 16:15
Infrared Metamaterial Hologram, Stéphane Larouche[1], Yu-Ju Tsai[1], Talmage Tyler[1], Nan M. Jokerst[1], David R. Smith[1]; [1]*Electrical and Computer Engineering, Duke University, USA.* We designed, fabricated, and characterized an infrared metamaterial hologram. The hologram correctly reproduces the design image. This work demonstrates that metamaterials can be used to fabricate devices with arbitrary 2D refractive index profiles.

QM4F.3 • 16:30
Low-Diffraction Modes in Plasmonic Crystals, Sandeep Inampudi[1], Igor Smolyaninov[2], Viktor A. Podolskiy[1]; [1]*Physics and Applied Physics, University of Massachusetts, USA;* [2]*Department of Electrical and Computer Engineering, University of Maryland, USA.* We present a numerical analysis of low diffracting states in plasmonic crystals formed by PMMA guides on Au substrate and develop an analytical description of this phenomenon.

16:00–18:00
QM4G • Strongly Correlated Electron Systems
Theodore Norris, University of Michigan, USA, *Presider*

QM4G.1 • 16:00
Dynamic decoupling of spin-lattice-charge excitations in iron pnictides using time-resolved laser ellipsometry. Tianqi Li[1], Aaron Patz[1], Ran Sheng[1], Sergey Bud'Ko[1], Paul Canfield[1], Jigang Wang[1]; [1]*Physics & Astronomy, Ameslab and Iowa State University, USA.* We report distinct dynamics of magnetic, electronic anisotropy and charge excitations in parent and weakly Co-doped BaFe2As2, which identify the manifestation of the Ising nematic symmetry and, its contribution to magneto-structural phase transition.

QM4G.2 • 16:15
Intense Terahertz Pulse-Induced Nonequilibrium BCS State in Superconducting NbN, Ryusuke Matsunaga[1], Ryo Shimano[1]; [1]*Department of Physics, The University of Tokyo, Japan.* We perform terahertz(THz)-pump-THz-probe spectroscopy to study ultrafast dynamics of BCS superconductor NbN. Resonant photo-injection of high density quasiparticles realized by the intense THz pump pulses results in a nonequilibrium BCS state.

QM4G.3 • 16:30
Quasiparticle Dynamics in YBCO and YBCO/LSMO Measured Using Femtosecond Optical Spectroscopy, Jinho Lee[1], D. Talbayev[1], J. Xiong[1], Jian-Xin Zhu[2], Stuart A. Trugman[1,2], Quanxi Jia[1], Dmitry A. Yarotski[1], A. J. Taylor[1], Rohit P. Prasankumar[1]; [1]*Center for intergrated nanotechnologies, Los Alamos national Laboratory, USA;* [2]*Theoretical division, Los Alamos national Laboratory, USA.* Terahertz time-domain spectroscopy and temperature dependent femtosecond optical pump-probe spectroscopy are used to track quasiparticle dynamics at the interface between superconducting and ferromagnetic oxide layers.

Room A8

CLEO: QELS-Fundamental Science

16:00–18:00
QM4H • Plasmonic Nanoantennas
Richard Taubert, University of Stuttgart, Germany, *Presider*

QM4H.1 • 16:00
Quantitative measurement of scattering and absorption cross-sections of individual metal nano-antennas, Martin Husnik[1], Stefan Linden[2,3], Richard Diehl[4], Jens Niegemann[4], Kurt Busch[4,5], Martin Wegener[1,3]; *[1]Institut für Angewandte Physik and DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology (KIT), Germany; [2]Physikalisches Institut, Universität Bonn, Germany; [3]Institut für Nanotechnologie, Karlsruhe Institute of Technology (KIT), Germany; [4]Institut für Theoretische Festkörperphysik and DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology (KIT), Germany; [5]Institut für Physik, AG Theoretische Optik, Humboldt-Universität zu Berlin and Max-Born-Institut, Germany.* Using a common-path interferometer combined with a spatial modulation technique, we simultaneously measure the absolute absorption and scattering cross-sections of individual metal nano-objects such as split-ring resonators or straight antennas.

QM4H.2 • 16:15
Phase elements for surface optics, Mikhail A. Kats[1], Patrice Genevet[1,2], Guillaume Aoust[1,3], Nanfang Yu[1], Romain Blanchard[1], Francesco Aieta[1,4], Zeno Gaburro[1,5], Federico Capasso[1]; *[1]School of Engineering and Applied Sciences, Harvard University, USA;[2]Institute for Quantum Studies and Department of Physics, Texas A&M University, USA; [3]Department of Physics, Ecole Polytechnique, France; [4]Dipartimento di Fisica e Ingegneria dei Materiali e del Territorio, Università Politecnica delle Marche, Italy; [5]Dipartimento di Fisica, Università degli Studi di Trento, Italy* We demonstrate that plasmonic two-oscillator elements such as V- and Y-shaped antennas can locally tailor the phase of light over 2π. A theoretical model and full-wave simulations explain the measured spectral response of these elements.

QM4H.3 • 16:30
Magnetic Response of a Resonant Nanoslot Antenna, Alberto G. Curto[1], Martin Kuttge[1], Niek Van Hulst[1,2]; *[1]ICFO - The Institute of Photonic Sciences, Spain; [2]ICREA - Institució Catalana de Recerca i Estudis Avançats, Spain.* We reveal the predominant magnetic dipole character of resonant slot nanoantennas. Upon excitation with local sources, the radiation differs strongly from off-resonant apertures, both in angular radiation pattern and polarization.

Room B2 & B3

JOINT

16:00–18:00
JM4I • Symposium on the 50th Anniversary of the Semiconductor Laser III
Dan Wasserman, University of Illinois, USA, *Presider*

JM4I.1 • 16:00 Invited
The Age of Photonic Integration, Dave Welch[1]; *[1]Infinera Corporation, USA.* The 50 year history of the semiconductor laser has moved from scientific discovery, through manufacturing materials development, through an application explosion and more recently into the era of Photonic Integration. In this paper we will discuss the market and technical drivers behind Photonic Integration.

JM4I.2 • 16:30 Invited
Quantum Cascade Lasers: Coming of Age, Jerome Faist[1]; *[1]Institute for Quantum Electronics, ETH Zürich, Switzerland.* The quantum cascade laser, first realized in 1994, has now demonstrated operation over an extremely wide wavelength range extending from the mid-infrared to the Terahertz with very high efficiency, output power and spectral agility.

Room C1 & C2

CLEO: Science & Innovations

16:00–18:00
CM4J • Terahertz Waveguides and Filters
Frank Hegmann, University of Alberta, Canada, *Presider*

CM4J.1 • 16:00
Phase-Matched Microstrip Waveguides for Generation and Coherent Detection of Broadband Terahertz Radiation, Shuchang Liu[1], Amit Agrawal[1], Xiang Shou[1], Ajay Nahata[1]; *[1]Electrical and Computer Engineering, University of Utah, USA.* We describe novel waveguide devices allowing for single-mode propagation of optical pump and probe beams and broadband THz radiation. We demonstrate generation and coherently detection of broadband THz radiation with <10 mW average optical power.

CM4J.2 • 16:15
Fiber Drawn 2D Polymeric Photonic Crystal THz Filters, Matthias Stecher[1,4], Christian Jansen[1], Mehdi Ahmadi-Boroujeni[1], Richard Lwin[2], Alessio Stefani[3], Ole Bang[3], Martin Koch[1], Graham E. Town[4]; *[1]AG Exp. Halbleiterphysik, Philipps-Universität Marburg, Germany; [2]Institute of Photonics and Optical Science (IPOS), School of Physics, The University of Sydney, Australia; [3]DTU Fotonik, Department of Photonics Engineering, Technical University of Denmark, Denmark; [4]Department of Electronic Engineering, Macquarie University, Australia.* We report on polymeric 2D photonic crystal filters for THz frequencies fabricated by a standard fiber drawing technique. The frequency and angle dependent transmission spectra were characterized in a pulsed terahertz (THz) time domain spectrometer.

CM4J.3 • 16:30
THz Near-Field Imaging Based On A Tapered Parallel-Plates, Jingbo Liu[1], Rajind Mendis[1], Daniel Mittleman[1], Naokazu Sakoda[2]; *[1]Rice University, USA; [2]Kobe Steel, Ltd, Japan.* A Broad-band low-loss no-cut-off THz near-field imaging technique has been demonstrated experimentally. Using a tapered parallel-plate waveguide as a probe this technique is able to resolve sub-wavelength (λ ~ 600 µm-6 mm) features of size ~100 µm.

Room C3 & C4

16:00–18:00
CM4K • Ultrafast Modification of Materials
Richard Haglund, Vanderbilt University, USA, *Presider*

CM4K.1 • 16:00 Invited
Theory of Ultrafast Laser-Matter Interactions, Baerbel Rethfeld[1]; *[1]Physics, University of Kaiserslautern, Germany.* High energy laser pulses of subpicosecond duration irradiating solids are primarily absorbed by electrons within the material. We study microscopic processes determining absorption, redistribution of the energy and its transfer to the lattice.

CM4K.2 • 16:30
Analysis and applications of femtosecond-laser-induced nanogratings from UV to telecom wavelength, Martynas Beresna[1], Mindaugas Gecevičius[1], Peter G. Kazansky[1]; *[1]Univ Southampton, United Kingdom.* Nanostructures induced by femtosecond laser beam are characterized over the visible. Permanent refractive index increase with subpicosecond pulses is achieved. Feasibility of using induced anisotropy for spatial mode conversion to 1.5 µm is shown.

Monday, 7 May

16:00–18:00
CM4L • Advances in Nanofabrication for Photonics
Anders Kristensen, Danmarks Tekniske Universitet, Denmark, *Presider*

CM4L.1 • 16:00
Depletion Mechanisms in STED-inspired Lithography, Joachim Fischer[1], Thomas J. Wolf[2], Andreas-Neil Unterreiner[2], Martin Wegener[1,3]; *[1]Institute of Applied Physics & DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology (KIT), Germany;[2]Institute of Physical Chemistry & DFG-Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology (KIT), Germany; [3]Institute of Nanotechnology (INT), Karlsruhe Institute of Technology (KIT), Germany.* Direct laser writing optical lithography using light-induced depletion allows for fabricating structures beyond the diffraction limit. We investigate the depletion mechanisms of the photoinitiator DETC aiming at optimizing future photoresists.

CM4L.2 • 16:15
Protein-Protein Imprinting (PPi): High Throughput Nanoscale Imprinting of Silk Fibroin Films for Photonics, Mark A. Brenckle[1], Hu Tao[1], Fiorenzo G. Omenetto[1]; *[1]Biomedical Engineering, Tufts University, USA.* We demonstrate high throughput imprinting of nanophotonic structures on silk films using a silk template, allowing for positive and negative pattern fabrication. Induced beta-sheet crystallinity increases their durability and biological applicability.

CM4L.3 • 16:30
Fixed Beam Moving Stage Electron Beam Lithography of Waveguide Coupling Device Structures, Jason E. Sanabia[1], Kevin E. Burcham[1], Joseph Klingfus[1], Guido Piaszenski[2], Michael Kahl[2], Ralf Jede[2]; *[1]Raith USA, Inc., USA; [2]Raith GmbH, Germany.* The Fixed Beam Moving Stage (FBMS) lithography mode is used toward the fabrication of waveguide coupling device structures. Scanning electron microscope metrology is used for the dimensional characterization of the resulting waveguide structures.

16:00–18:00
CM4M • Couplers and Mode Converters
Marcelo Davanco, NIST, USA, *Presider*

CM4M.1 • 16:00
Highly Efficient Strip-to-Slot Mode Converters, Robert Palmer[1,2], Luca Alloatti[1], Dietmar Korn[1], Wolfgang Heni[1], Philipp Schindler[1], Jens Bolten[3], Matthias Karl[3], Michael Waldow[3], Thorsten Wahlbrink[3], Wolfgang Freude[1,2], Christian Koos[1,2], Juerg Leuthold[1,2]; *[1]Institute of Photonics and Quantum Electronics, KIT, Germany; [2]Institute of Microstructure Technology, KIT, Germany; [3]AMO GmbH, Germany.* We demonstrate compact, highly efficient, broadband strip-to-slot mode converters in silicon with average losses as low as (0.02±0.04) dB and negligible reflections between 1480 nm and 1580 nm.

CM4M.2 • 16:15
Wideband and Group Index Independent Coupling to Slow Light Slotted Photonic Crystal Waveguides with Adiabatic Group Index Taper and Mode Matching, Che-Yun Lin[1], Alan Wang[2], Ray T. Chen[1]; *[1]Electrical and Computer Engineering, University of Texas at Austin, USA; [2]Electrical Engineering and Computer Science, Oregon State University, USA.* We experimentally demonstrate highly efficient coupling into a slotted-photonic crystal waveguide featuring a nearly flat transmission spectrum with lowest insertion loss ~2.4dB.

CM4M.3 • 16:30
Compact Silicon Strip Waveguide Cantilever Couplers for Low-Loss and Broadband Fiber-to-Chip Coupling, Michael Wood[1], Peng Sun[1], Ronald M. Reano[1]; *[1]Electrical and Computer Engineering, Ohio State University, USA.* We demonstrate low-loss fiber-to-chip coupling using 7.3 μm long silicon strip waveguide cantilever couplers. Average coupling losses are measured to be less than 0.62 dB per connection throughout the optical telecommunications C band.

16:00–18:00
CM4N • Amplifiers
Akira Shirakawa, University of Electro-Communications, Japan, *Presider*

CM4N.1 • 16:00
Enhancing the phase sensitivity of phase sensitive amplifiers for efficient phase regeneration, Mingyi Gao[1], Takashi Inoue[1], Takayuki Kurosu[1], Shu Namiki[1]; *[1]National Institute of Advanced Industrial Science and Technology, Japan.* We have clarified a mechanism sidebands entailed by phase sensitive amplification significantly increase gain extinction ratio, by scrutinizing the trajectories of the output signal vector in the complex plane with increasing nonlinear phase shift.

CM4N.2 • 16:15
Generation of 110 W Infrared Power and 65W Green Power from a 1.3-GHz Sub-picosecond Fiber Amplifier, Zhi Zhao[1], Bruce M. Dunham[1], Ivan Bazarov[1], Frank W. Wise[2]; *[1]Physics Department, Cornell University, USA; [2]School of Applied and Engineering Physics, Cornell University, USA.* A fiber amplifier that achieves sub-picosecond pulse duration and greater than 100 W average power at 1.3-GHz repetition rate is reported. Frequency-doubling of the amplified pulses yields 65 W green power.

CM4N.3 • 16:30
High-quality pulse-compression of pre-chirped pulses in fiber-amplifiers, Hung-Wen Chen[1], Guoqing Chang[1], Shu-Wei Huang[1], Damian N. Schimpf[1], Franz X. Kaertner[1,2]; *[1]EECS, MIT, USA; [2]Center for Free-Electron Laser Science, DESY and Dept. of Physics, University of Hamburg, DESY and University of Hamburg, Germany.* Combining steady-state propagation-rate equation and GNLSE to accurately model high-repetition rate femtosecond YDFA, such modeling reveals the nonlinear-evolution dynamics of amplified pulses and allows optimization of the compressed-pulse quality.

Room A1	Room A2	Room A3	Room A4
CLEO: Science & Innovations		CLEO: QELS-Fundamental Science	CLEO: Science & Innovations

CM4A • Silicon Photonics I—Continued

CM4A.4 • 17:00
Low-voltage, high-extinction-ratio, Mach-Zehnder silicon optical modulator for CMOS compatible integration, Ding Jianfeng[1]; [1]*Institute of Semiconductors, Chinese Academy of Sciences, China.* We demonstrate a carrier-depletion optical modulator with the driving voltage swing of 2 V and the extinction ratio of 12.79 dB at 12.5 Gbit/s. Even the driving voltage is reduced to 1 V, the the device still has an extinction ratio of 7.67 dB.

CM4A.5 • 17:15
Low-loss and High Contrast Silicon-on-Insulator (SOI) Arrayed Waveguide Grating, Stanley T. Cheung[1], Binbin Guan[1], Stevan S. Djordjevic[1], Katsunari Okamoto[2], S. J. Ben Yoo[1]; [1]*Electrical and Computer Engineering, University of California, Davis, USA;* [2]*AiDi Corporation, Japan.* We report high-extinction and low-loss 40-channel x 100-GHz arrayed waveguide grating (AWG) fabricated on silicon-on-insulator using high quality etching condition resulting in < 0.8 dB/cm loss and low phase errors.

CM4B • Fiber-Based Sensing—Continued

CM4B.3 • 16:45
Simulation and Experiment for Verifying Intensity Modulation Scheme in Brillouin Optical Correlation Domain Reflectometry, Sitthipong Manotham[1], Masato Kishi[1], Zuyuan He[1], Kazuo Hotate[1]; [1]*Electrical Engineering and Information Systems, The University of Tokyo, Japan.* Intensity modulation scheme in Brillouin optical correlation domain reflectometry is verified both by simulation and experiment.The simulations are in good agreement with the experiments.The optimized waveform modulation is clarified to be effective.

CM4B.4 • 17:00
Photonic bandgap fiber bundle spectrometer, Hang Qu[1], Maksim Skorobogatiy[1], Bora Ung[1]; [1]*Ecole Polytechnique de Montreal, Canada.* A solid-core Bragg fiber bundle spectrometer is proposed. The test spectrum can be reconstructed by interrogating the transmitted intensities of the Bragg fibers in the bundle and by applying a deconvolution algorithm to the intensities.

CM4B.5 • 17:15
Discriminative Distributed Measurement of Strain and Temperature Based on Brillouin Dynamic Grating by BOCDA with Time-Division Pump-Probe Generation Scheme, Tetsuro Ashida[1], Masato Kishi[1], Zuyuan He[1], Kazuo Hotate[1]; [1]*Tokyo university, Japan.* A system for distributed discriminative measurement of strain and temperature is proposed using fiber Brillouin dynamic grating, based on BOCDA with time-division pump-probe generation scheme. The discrimination is successfully demonstrated.

QM4C • Continuous Variable Quantum Optics—Continued

QM4C.2 • 17:00
Unconditional Conversion between a Single-Photon State and a Coherent-State Superposition via Squeezing Operation, Yoshichika Miwa[1], Jun-ichi Yoshikawa[1], Noriaki Iwata[1], Mamoru Endo[1], Petr Marek[2], Radim Filip[2], Peter van Loock[3,4], Akira Furusawa[1]; [1]*The University of Tokyo, Japan;* [2]*Palacký University, Czech Republic;* [3]*Max Planck Institute for the Science of Light, Germany;* [4]*Universität Erlangen-Nürnberg, Germany.* We experimentally demonstrate a conversion of a single-photon state into a superposition of two weak coherent states and its inverse, via squeezing operation based on offline-prepared squeezed states, measurement and feedforward.

QM4C.3 • 17:15
Conditional quantum teleportation of non-Gaussian states of light: improvement to output state non-classicality, Hugo Benichi[1], Shuntaro Takeda[1], Takahiro Mizuta[1], Akira Furusawa[1], Ladislav Mista[2], Radim Filip[2]; [1]*Applied Physics, The University of Tokyo, Japan;* [2]*Department of Optics, Palacky University, Czech Republic.* We experimentally demonstrate conditional teleportation of non-Gaussian nonclassical states of light. The nonclassicality of the Wigner function is proven to be enhanced: the negativity is stronger than what deterministic operations achieve.

CM4D • Petawatt Lasers Technologies—Continued

CM4D.4 • 16:45
A Cylindrical Offner Stretcher for Reduced Chromatic Aberrations and Improved Temporal Contrast, Jake Bromage[1], Matthew Millecchia[1], Jo Bunkenburg[1], Robert K. Jungquist[1], Christophe Dorrer[1], Jonathan D. Zuegel[1]; [1]*University of Rochester, LLE, USA.* A stretcher using cylindrical mirrors is evaluated for ultra-broadband lasers. Adding a grating reduces chromatic aberration, and replacing the spherical mirrors eliminates the intermediate foci, increasing energy throughput and improving contrast.

CM4D.5 • 17:00
High Dynamic Range Temporal Contrast Measurement and Characterization of Oscillators for Seeding High Energy Petawatt Laser Systems, David Alessi[1], Thomas Spinka[1], Shawn Betts[1], Vernon K. Kanz[1], Ron Sigurdsson[1], Brendan Riordan[1], John K. Crane[1], Constantin L. Haefner[1]; [1]*Lawrence Livermore National Laboratory, USA.* We have measured the temporal contrast and performance of oscillators to determine their feasibility for future ultra-high-contrast experiments on the Advanced Radiographic Capability at the National Ignition Facility.

CM4D.6 • 17:15
Real-time Two-dimensional Detection of Angular Dispersion of CPA Laser Beams, Adam Borzsonyi[1,2], Lucile Mangin-Thro[1,3], Gilles Cheriaux[4], Karoly Osvay[2]; [1]*CE Optics Kft., Hungary;* [2]*Department of Optics and Quantum Electronics, University of Szeged, Hungary;* [3]*Ecole Nationale Superieure de Physique de Strasbourg, University of Strasbourg, France;* [4]*Laboratoire d'Optique Appliquee, ENSTA Ecole Polytechnique CNRS, France.* A novel and robust technique for single shot measurement of angular dispersion across the entire laser beam is introduced. The capabilities are demonstrated with the alignment of the grating compressor of a CPA laser.

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

QM4E • Supercontinuum and Few-Cycle Phenomena—Continued

QM4E.4 • 16:45
Asymmetric Draw-Tower Tapers for Supercontinuum Generation and Verification of the Novel Concept of Group-Acceleration Matching, Simon T. Sørensen[1], Uffe Møller[1], Peter M. Moselund[2], Christian Jakobsen[2], Jeppe Johansen[2], Thomas Vestergaard Andersen[2], Carsten L. Thomsen[2], Ole Bang[1,2]; [1]*DTU Fotonik - Department of Photonics Engineering, Technical University of Denmark, Denmark;* [2]*NKT Photonics A/S, Denmark.* We present the first short asymmetrical draw-tower photonic crystal fiber taper for maximizing the power in the blue edge of a supercontinuum. The results clearly emphasize the importance of the taper shape on the spectrum.

QM4E.5 • 17:00
Modelling of supercontinuum generation in quadratic crystals, Matteo Conforti[1], Fabio Baronio[1], Costantino De Angelis[1]; [1]*Univerity of Brescia, Italy.* We present a comprehensive framework to study the evolution of ultrabroadband optical pulses in quadratic media. We exploit this model to simulate recently observed phenomena such as broadband parametric downconversion and supercontinuum generation

QM4E.6 • 17:15
A new approach to pulse propagation in nonlinear optical media, Yuzhe Xiao[1], Drew N. Maywar[2], Govind P. Agrawal[1]; [1]*The Institute of Optics, University of Rochester, USA;* [2]*Electrical, Computer, and Telecom. Eng. Technology, Rochester Institute of Technology, USA.* We propose a time-transformation approach to optical pulse propagation and apply it to a Kerr-type nonlinear medium. Our method maps directly the electric field without making the slowly varying envelop approximation.

QM4F • Meta Interfaces and Surfaces II—Continued

QM4F.4 • 16:45
Ultra-high field enhancement in single and coupled SRRs using inhomogeneous polarized illumination, Jacob Scheuer[1]; [1]*School of Electrical Engineering, Tel-Aviv University, Israel.* We show that the field enhancement in Au split-ring resonator structures can be increased by orders of magnitude by using azimuthally polarized illumination, rendering this scheme highly attractive for nonlinear optics, imaging and spectroscopy.

QM4F.5 • 17:00
Observation of optical k~0 high-Q Fano resonances in macroscopic photonic crystal slabs, Ofer Shapira[1]; [1]*MIT, USA.* In infinite periodic PhC slabs, due to symmetry considerations, Fano resonances at k=0 decouple from the external world and their quality factors become infinite. Here, we experimentally demonstrate the existence of such resonances at k~0.

QM4F.6 • 17:15
Fano-resonant Asymmetric Metamaterials for Sensing and Vibrational Fingerprinting of Protein Monolayers, Gennady Shvets[1], Chihhui Wu[1], Alexander B. Khanikaev[1], Kamil Alici[1], Nihal Arju[1], Ronen Adato[2], Ahmet A. Yanik[2], Hatice Altug[2]; [1]*Physics, The University of Texas at Austin, USA;* [2]*Department of Electrical Engineering and COmputer Science, Boston University, USA.* Precise information on structure of protein monolayers (thickness, bond orientation, dipole strength) is obtained using spectroscopy of functionalized Fano-resonant asymmetric metamaterials. Results for single and two-protein layers are presented.

QM4G • Strongly Correlated Electron Systems—Continued

QM4G.4 • 16:45
Ultrafast Dynamics of the Mid-infrared Pseudogap in Stripe-phase $La_{1.75}Sr_{0.25}NiO_4$, Giacomo Coslovich[1], Bernhard Huber[1], Wei-Sheng Lee[2], Yi-De Chuang[3], Yi Zhu[1], Takao Sasagawa[4], Zahid Hussain[3], Hans A. Bechtel[3], Micheal C. Martin[3], Robert W. Schoenlein[1], Zhi-Xun Shen[2], Robert A. Kaindl[1]; [1]*Materials Sciences Division, Lawrence Berkeley National Laboratory, USA;* [2]*SIMES, SLAC National Accelerator Laboratory and Stanford University, USA;* [3]*Advanced Light Source, Lawrence Berkeley National Laboratory, USA;* [4]*Materials and Structures Laboratory, Tokyo Institute of Technology, Japan.* We present the first ultrafast mid-infrared study of charge and spin-ordered nickelates. A multi-component dynamics is observed, evidencing the femtosecond decay and formation of the low-energy pseudogap in the optical conductivity.

QM4G.5 • 17:00
Observation of coherent spin precession in YFeO3 crystal triggered with magnetic component of terahertz wave, Guohong Ma[1]; [1]*Department of Physics, Shanghai University, China.* We report the observation of the magnetic dipole transition triggered with magnetic component of terahertz pulse in an antiferromagnetic YFeO3, which is manifested by sharp absorption at the frequency of the quasiferromagnetic mode of the crystal.

QM4G.6 • 17:15
Withdrawn

Room A8

CLEO: QELS-Fundamental Science

QM4H • Plasmonic Nanoantennas—Continued

QM4H.4 • 16:45
Magnetic Vector-field of Optical Antennas from Electromagnetic Duality, Robert L. Olmon[1,2], Xiaoji G. Xu[1], Kseniya S. Deryckx[1], Brian A. Lail[3], Markus B. Raschke[1]; [1]*Physics, Univ of Colorado, USA;* [2]*Electrical Engineering, University of Washington, USA;* [3]*Electrical and Computer Engineering, Florida Institute of Technology, USA.* Combining scattering-scanning near-field optical microscopy (s-SNOM) with infrared synchrotron micro-spectroscopy we determine the magnetic near-field modes of an infrared linear antenna by measuring the electric field of its electromagnetic dual.

QM4H.5 • 17:00
Arrayed Nanoantennas for Efficient Broadband Unidirectional Emission Enhancement, Ivan Maksymov[1], Isabelle Staude[1], Andrey M. Miroshnichenko[1], Manuel Decker[1], Hark Hoe Tan[2], Dragomir N. Neshev[1], Chennupati Jagadish[2], Yuri S. Kivshar[1]; [1]*Nonlinear Physics Centre, Research School of Physics and Engineering, Australian National University, Australia;* [2]*Department of Electronic Materials Engineering, Research School of Physics and Engineering, Australian National University, Australia.* Plasmonic Yagi-Uda nanoantennas are narrowband because their bandwidth is compromised by their unidirectionality. We propose and study arrayed nanoantennas offering broadband unidirectional emission enhancement with a high radiation efficiency.

QM4H.6 • 17:15
Ellipto-Hyperbolic Plasmonic Antennas and Their Radiation Patterns, Lior Gal[1], Nikolai Berkovitch[1], Meir Orenstein[1]; [1]*Electrical Engineering, Technion - Israel Institute of Technology, Israel.* Ellipto-Hyperbolic nano antennas are studied theoretically and experimentally. Self modes are derived in closed-form, and very high directivity is implied. Ellipto-hyperbolic antennas are under extensive study and only few results are shown here.

Room B2 & B3

JOINT

JM4I • Symposium on the 50th Anniversary of the Semiconductor Laser III—Continued

JM4I.3 • 17:00 Invited
Quantum Dot Lasers: From Science to Practical Implementation, Yasuhiko Arakawa[1]; [1]*The University of Tokyo, Japan.* 30 years have passed since the concept of quantum dots for application to lasers was proposed. We discuss recent advances in quantum dot lasers, including their commercialization and the challenge to single artificial atom lasers.

Room C1 & C2

CLEO: Science & Innovations

CM4J • Terahertz Waveguides and Filters—Continued

CM4J.4 • 16:45
Inhibiting the TE1-mode Diffraction Losses in Parallel-Plate Waveguides via Slightly Concave Plates, Marx Mbonye[1], Rajind Mendis[1], Daniel M. Mittleman[1]; [1]*ECE Dept, Rice University, USA.* We investigate how to inhibit the diffraction losses inherent to the TE1 mode of the parallel-plate waveguides via slightly concave plates. This would lead to the realization of an ultra-low-loss THz waveguide as predicted previously.

CM4J.5 • 17:00 Tutorial
Waveguides for Pulsed Terahertz Radiation, Daniel Mittleman[1]; [1]*ECE Department, Rice University, USA.* In this tutorial, we review basic ideas of waveguide physics, and discuss the state of the art in strategies for guiding broadband terahertz pulses. These include metallic, dielectric, and plasmonic waveguides.

Dr. Mittleman received his B.S. in physics from the Massachusetts Institute of Technology in 1988, and his M.S. in 1990 and Ph.D. in 1994, both in physics from the University of California, Berkeley. After two years at AT&T Bell Laboratories as a post-doctoral member of the technical staff, Dr. Mittleman joined the ECE Department at Rice University in September 1996. At Rice, his research interests involve various aspects of spectroscopy, sensing, and imaging using terahertz radiation. Dr. Mittleman is a Fellow of The Optical Society and IEEE.

Room C3 & C4

CM4K • Ultrafast Modification of Materials—Continued

CM4K.3 • 16:45
Ultrafast Laser Half-Beam Writing Paradox, Peter Kazansky[1], Andrei G. Kazansky[2], Martynas Beresna[1], Mindaugas Gecevicius[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom;* [2]*Physics, Lomonosov Moscow State University, Russian Federation.* Paradoxical asymmetric imprinting revealed as different modification thresholds for two-halves of Gaussian beam is demonstrated in a-silicon. The phenomenon is interpreted in terms of anisotropic transport produced by ultrashort light pulses.

CM4K.4 • 17:00
Evidence for Non-Mass-Transfer Mechanism in fs-Laser Formation of Sub-200 nm Structures on Sapphire, Susanta K. Das[1], Frank Guell[2], Hamza Messaoudi[1], Martin Bock[1], Ruediger Grunwald[1]; [1]*Max Born Institute, Germany;* [2]*Electronic Department, University Barcelona, Spain.* Femtosecond-laser induced generation of sub-200 nm structures in Al2O3 is reported. Comparison of experiment to theory favors periodical fluence variation while excluding self-organized mass transfer as responsible mechanism for structure formation.

CM4K.5 • 17:15
Ripples Induced By Continuous Ultraviolet Laser Exposure In Soda-lime Glass, Francois Goutaland[1], Jean Philippe Colombier[1]; [1]*Lab H. Curien, France.* Ripples of period about 150 nm, formed at the surface of a silica-based glass, are reported. Our glass behaves like a metallic glass due to the formation of highly concentrated silver nanoparticles.

Marriott San Jose
Salon I & II

Marriott San Jose
Salon III

Marriott San Jose
Salon IV

CLEO: Science & Innovations

CM4L • Advances in Nanofabrication for Photonics—Continued

CM4L.4 • 16:45
Single Pulse Multiphoton Fabrication of Photopolymerized Periodic Structures Using Vortex Beams, Benjamin Mills[1], Dmytro Kundys[1], Maria Farsari[2], Sakellaris Mailis[1], Robert W. Eason[1]; [1]*Optoelectronic Research Centre, University of Southampton, United Kingdom;* [2]*IELS-FORTH, Greece.* Single ultra-short pulses with a vortex phase profile have been used to fabricate periodically modulated hollow cylinders via multi-photon polymerization. Fabrication and spectral characterization of these objects are presented.

CM4L.5 • 17:00
Artificial compound eyes fabricated by femtosecond laser-enhanced chemical etching and soft replication, Feng Chen[1], Qing Yang[2], Hewei Liu[1], Pubo Qu[1]; [1]*Key Laboratory for Physical Electronics and Devices of the Ministry of Education School of Electronics & information Engineering, Xi'an Jiaotong University, China;* [2]*State Key Laboratory for Manufacturing Systems Engineering, Xi'an Jiaotong University, China.* Reported herein is a new method to produce artificial compound eyes, which involves a femtosecond laser fabrication and soft replication. A meso-scale hemispherical shell covered with 10,200 hexagonal-shaped and gapless microlenses is demonstrated.

CM4L.6 • 17:15
In-fiber fabrication of size-controllable structured particles, Joshua J. Kaufman[1], Guangming Tao[1], Soroush Shabahang[1], Esmaeil-Hooman Banaei[1], Daosheng S. Deng[2], Xiangdong Liang[3], Steven G. Johnson[3], Yoel Fink[4], Ayman F. Abouraddy[1]; [1]*CREOL, The College of Optics & Photonics, University of Central Florida, CREOL, USA;* [2]*Department of Chemical Engineering, Massachusetts Institute of Technology, USA;* [3]*Department of Mathematics, Massachusetts Institute of Technology, USA;* [4]*Department of Materials Science and Engineering, Massachusetts Institute of Technology, USA.* We present an approach for fabricating single-material and multi-material structured spherical particles in the size range 1 millimeter to 50 nanometers that makes use of the Plateau-Rayleigh capillary instability in a multi-material fiber.

CM4M • Couplers and Mode Converters—Continued

CM4M.4 • 16:45
Characterization of Mid-Infrared Interband Cascade Laser Coupling to a GeSbS Chalcogenide Glass Waveguide, David R. Scherer[1], J. M. Hensley[1], K. R. Parameswaran[1], B. D. Casse[1], V. Singh[2], P. T. Lin[2], A. Agarwal[2], L. C. Kimerling[2], J. Giammarco[3], J. Wilkinson[3], I. Luzinov[3], J. D. Musgraves[3], K. Richardson[3], Juejun Hu[4], C. S. Kim[5], W. W. Bewley[5], C. L. Canedy[5], I. Vurgaftman[5], J. Abell[5], J. R. Meyer[5], M. Kim[6]; [1]*Physical Sciences Inc., USA;* [2]*Microphotonics Center, Massachusetts Institute of Technology, USA;* [3]*School of Materials Science and Engineering, COMSET, Clemson University, USA;* [4]*Department of Materials Science and Engineering, University of Delaware, USA;* [5]*Code 5613, Naval Research Laboratory, USA;* [6]*Sotera Defense Solutions, USA.* We demonstrate butt-coupling of a 3.4 μm interband cascade laser into a 3.7 μm thick by 7 μm wide GeSbS chalcogenide ridge waveguide and measure a total insertion loss of −28 dB.

CM4M.5 • 17:00
Ultra-Compact Polarization Mode Converter Implemented in a Dual-Trench Silicon-On-Insulator Waveguide, Aitor V. Velasco[2], María Calvo[2], Pavel Cheben[1], Alejandro Ortega-Moñux[3], Jens H. Schmid[1], Carlos Alonso Ramos[3], Iñigo Molina-Fernández[3], Jean Lapointe[1], Martin Vachon[1], Siegfried Janz[1], Dan-Xia Xu[1]; [1]*Institute for microstructural science, National Research Council of Canada, Canada;* [2]*Dpto. Optica, Universidad Complutense de Madrid, Spain;* [3]*ETSI Telecomunicación, Universidad de Málaga, Spain.* We demonstrate an ultracompact polarization mode converter based on a silicon-on-insulator waveguide with two longitudinal subwavelength trenches. An extinction ratio of 16 dB at 1.5 μm is achieved for a device length of 10 μm.

CM4M.6 • 17:15
Single trench SiON waveguide TE-TM mode converter, Kenichi Nakayama[1], Yuya Shoji[1], Tetsuya Mizumoto[1]; [1]*Department of Electrical and Electronic Engineering, Tokyo Institute of Technology, Japan.* A TE-TM mode converter fabricated with a single trench SiON waveguide is described. The device has the advantage that only single mask and etching process is needed to fabricate. 80% TE-TM mode conversion is demonstrated.

CM4N • Amplifiers—Continued

CM4N.4 • 16:45
Poor Power Efficiency in Gain-Guided Index-Antiguided Fiber Amplifiers and Lasers, Arash Mafi[1], Parisa Gandomkar Yarandi[1]; [1]*University of Wisconsin-Milwaukee, USA.* We highlight the key reasons behind the low efficiency of ultra-large-core single-mode gain-guided index-antiguided fiber amplifiers and lasers and argue that it is possible to improve the efficiency with proper design.

CM4N.5 • 17:00
Gain optimization in fiber optical parametric amplifiers by combining standard and high-SBS threshold highly nonlinear fibers, Francesco Da Ros[1], Karsten Rottwitt[1], Christophe Peucheret[1]; [1]*Department of Photonics Engineering, Technical University of Denmark, Denmark.* Combining Al-doped and Ge-doped HNLFs as gain media in FOPAs is proposed and optimized, resulting in efficient SBS mitigation while circumventing the additional loss of the high SBS threshold Al-doped fiber.

CM4N.6 • 17:15
Optical Amplifier Based Power Stabilizer for Noise Suppression of Fiber Laser, Zhengqing Pan[1], Fei Yang[1], Qing Ye[1], Haiwen Cai[1], Ronghui Qu[1], Zujie Fang[1]; [1]*Shanghai institute of optics and fine mechanics, China.* Reflective EDFA and reflective SOA based power stabilizers are designed respectively to suppress the intensity noise of fiber laser. The feasibility of both methods is verified theoretically and experimentally.

Room A1 | Room A2 | Room A3 | Room A4

CLEO: Science & Innovations

CM4A • Silicon Photonics I—Continued

CM4A.6 • 17:30
Stochastic bistable switching in CMOS-processed PECVD silicon nitride ring resonators, Tingyi Gu[1], James McMillan[1], Mingbin Yu[2], Patrick (Guo-Qiang) Lo[2], Dim-Lee Kwong[2], Chee Wei Wong[1]; [1]*Optical nanostructure laboratory, Columbia University, USA;* [2]*The Institute of Microelectronics, Singapore.* Absorptive optical nonlinearity is demonstrated in silicon nitride rings with 244,000 intrinsic Q. Thermal induced optical nonlinearity leads to stochastic bistable switching, for CMOS-compatible photonic integrated circuits.

CM4A.7 • 17:45
Stamp Printing of Silicon Nanomembrane Based Flexible Photonic Devices, Xiaochuan Xu[1], Harish Subbaraman[2], Amir Hosseini[2], David Kwong[1], Che-Yun Lin[1], Ray T. Chen[1]; [1]*University of Texas at Austin, USA;* [2]*Omega Optics, Inc., USA.* We demonstrate for the first time stamp printing of silicon nanomembrane based photonic devices onto flexible substrate utilizing protection layer and suspended configuration. The propagation loss of the transferred waveguide is ~1.1dB/cm.

CM4B • Fiber-Based Sensing—Continued

CM4B.6 • 17:30
Highly sensitive all-fiber oxygen sensors, Hee-Dok Choi[1], Nam-Su Kang[1], Jae-Min Hong[1], Jung Ah Lim[1], Yong-Won Song[1]; [1]*Future Convergence Research Division, Korea Institute of Science and Technology, Republic of Korea.*We demonstrated an all-fiber, highly sensitive and reversible oxygen sensors incorporating fiber Fabry Perot interferometer coated with hemoglobin, oxygen-transport Fe-protein,as an indicator. Sensing limit as low as 10ppm was experimentally achieved.

CM4B.7 • 17:45
Asymmetric fiber Michelson interferometer with a spatial mode beating arm for moving direction determination, Nan-Kuang Chen[1,2], Kuan-Yi Lu[1], Chinlon Lin[3]; [1]*Department of Electro-Optical Engineering, National United University, Taiwan;* [2]*Optoelectronics Research Center, National United University, Taiwan;* [3]*Bell lab and Bellcore, USA.* We demonstrate asymmetric Michelson fiber interferometer with a spatial mode beating arm where its output end has a sphered-end hollow-core fiber as a sensing head. The multiple foci can offer the advantage for direction determination.

CLEO: QELS-Fundamental Science

QM4C • Continuous Variable Quantum Optics—Continued

QM4C.4 • 17:30
Entanglement Enhancement with cascaded non-degenerate optical parametric amplifier, Xiaojun Jia[1], Zhihui Yan[1], Zhiyuan Duan[1], Changde Xie[1], Kunchi Peng[1]; [1]*Shanxi University, Institute of Opto-Electronics, China.* We experimentally demonstrate the cascaded entanglement enhancement of continuous variables. The quantum correlations are successively enhanced by two nondegenerate optical parametric amplifiers from −5.3 dB to −8.1 dB below quantum noise limit.

QM4C.5 • 17:45
Demonstration of a Controlled-Phase Gate for Continuous-Variable Cluster Computation, Shota Yokoyama[1], Ryuji Ukai[1], Jun-ichi Yoshikawa[1], Peter van Loock[2,3], Akira Furusawa[1]; [1]*Department of Applied Physics, School of Engineering, The University of Tokyo, Japan;* [2]*Optical Quantum Information Theory Group, Max Planck Institute for the Science of Light, Germany;* [3]*Institute of Theoretical Physics I, Universität Erlangen-Nürnberg, Germany.* We demonstrate a controlled-phase gate for continuous variables using a cluster-state resource of four optical modes. Its nonclassicality is verified through the presence of entanglement at the output for product-state inputs of two coherent states.

CLEO: Science & Innovations

CM4D • Petawatt Lasers Technologies—Continued

CM4D.7 • 17:30
Reference-free focal spot optimization of a petawatt laser using adaptive optics, Udo Eisenbarth[1], Christian Brabetz[1], Christina Lempa[1], Thomas Stöhlker[1], Vincent Bagnoud[1]; [1]*PHELIX, GSI Helmholtz Centre for Heavy Ion Research GmbH, Germany.* A novel approach on wave-front correction using adaptive optics has been demonstrated at PHELIX. This reference-free method minimizes the focal spot size by taking advantage of the orthogonality of the underlying Zernike polynomials.

CM4D.8 • 17:45
Beam-homogenization and space-charge-broadening calibration for accurately measuring high-intensity laser pulses using a high-speed streak camera, Jie Qiao[1], Paul Jaanimagi[1], Robert Boni[1], Jake Bromage[1], Elizabeth Hill[1]; [1]*Laboratory for Laser Energetics, University of Rochester, USA.* An anamorphic diffuser-based beam-homogenizing system and a space-charge-broadening calibration method were developed to measure 8-to-250 picosecond pulses using a high speed optical streak camera on kilojoule, petawatt-class laser systems.

18:30–20:00 Dine and Discover Event

NOTES

Room A5 | Room A6 | Room A7

CLEO: QELS-Fundamental Science

QM4E • Supercontinuum and Few-Cycle Phenomena—Continued

QM4E.7 • 17:30
Multi-octave supercontinuum from bulk filamentation of a mid-IR pulse, Matthias Baudisch[1], Francisco Silva[1], Dane Austin[1], Alexandre Thai[1], Michael Hemmer[1], Arnaud Couairon[2], Jens Biegert[1,3]; [1]*ICFO - The Institute of Photonic Sciences, Spain;* [2]*Centre de Physique Theorique, Ecole Polytechnique, France;* [3]*ICREA-Institucio Catalana de Recerca i Estudis Avancats, Spain.* We have generated a supercontinuum spanning more than three octaves extending from 450 nm to 4500 nm. The supercontinuum emerges from filamentation of a femtosecond pulse in a thin YAG plate.

QM4E.8 • 17:45
Octave Spanning Amplification in Single Color Pumped OPCPA System at Megahertz Repetition Rate, Stefan Demmler[1], Steffen Hädrich[1,2], Jan Rothhardt[2,1], Jens Limpert[1,2], Andreas Tünnermann[1,2]; [1]*Institute of Applied Physics, Friedrich-Schiller University Jena, Germany;* [2]*Helmholtz Institute Jena, Germany.* A full-octave bandwidth is amplified in an OPA. CEP-stable 20µJ pulses at up to 1MHz repetition rate resulting in 20W of average power are compressed to 5fs, which should enable isolated attosecond pulse generation.

QM4F • Meta Interfaces and Surfaces II—Continued

QM4F.7 • 17:30
Metamaterial 'Gecko Toe': Optically-Controlled Adhesion to Any Surface, Jianfa Zhang[1], Hideki Yasuda[1,2], Kevin F. MacDonald[1], Nikolay I. Zheludev[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom;* [2]*Frontier Core Technology Laboratories, FUJIFILM Corporation, Japan.* A new optical near-field force between plasmonic metamaterials and dielectric/metallic surfaces is identified. It can exceed Casimir, radiation and gravitational forces to provide an optically-controlled adhesion mechanism mimicking the gecko toe.

QM4F.8 • 17:45
Nature's Nonlinear Optical Antennas, Mikko J. Huttunen[1], Matti Virkki[1], Godofredo Bautista[1], Elina Vuorimaa-Laukkanen[2], Helge Lemmetyinen[2], Andás Dér[3], Martti Kauranen[1]; [1]*Department of Physics, Tampere University of Technology, Finland;* [2]*Department of Chemistry and Bioengineering, Tampere University of Technology, Finland;* [3]*Institute of Biophysics, Biological Research Centre of the Hungarian Academy of Sciences, Hungary.* We demonstrate that the trimer structures of bacteriorhodopsin (bR) proteins can have directional emission properties. The directional properties are confirmed by measuring the transmitted and reflected second-harmonic emissions from bR thin films.

QM4G • Strongly Correlated Electron Systems—Continued

QM4G.7 • 17:30 Invited
Photoinduced Phase Transitions in Strongly Correlated Electron Systems, Shin-ya Koshihara[1], Shinichi Adachi[2], Yoichi Okimoto[1], Tadahiko Ishikawa[1], Ryo Fukaya[1], Keiki Fukumoto[1], Manabu Hoshino[1], Ken Onda[3]; [1]*JST, CREST and Department of Materials Science, Tokyo Institute of Technology, Japan;* [2]*Photon Factory, Institute of Materials Structure Science, High Energy Accelerator Research Organization, Japan;* [3]*Department of Environmental Chemistry and Engineering, Tokyo Institute of Technology, Japan.* My talk demonstrates that the dynamical x-ray technique combined with the ultrafast spectroscopy becomes powerful tool to identify a 'hidden phase' in strongly correlated systems which never appears under thermo-equilibrium condition.

Monday, 7 May

18:30–20:00 Dine and Discover Event

NOTES

Room A8

CLEO: QELS-Fundamental Science

QM4H • Plasmonic Nanoantennas—Continued

QM4H.7 • 17:30
Emission of electric and magnetic dipoles in plasmonic systems, Rabia Hussain[1], Natalia Noginova[1], Crystal M. Whitfield[1], Cristal Carroll[1], Jarrett Jarrett[2], Augustine Urbas[2]; [1]*Center for Materials Research, Norfolk State University, USA;* [2]*Wright-Patterson AFB. Air Force Research Laboratory, Materials and Manufacturing Directorate, USA.* Spontaneous emission of Eu3+ is significantly modified in close vicinity of metal and nanostructured metal systems. The effects are different than those predicted by the "image model", and ascribed to strong coupling with plasmonic modes.

QM4H.8 • 17:45
Anomalously-large Photo-induced Magnetic Response of Disperse Metallic Nanocolloids, Navindra D. Singh[2], Matthew Moocarme[1], Benjamin Edelstein[2], Luat T. Vuong[1]; [1]*Physics, CUNY Queens College / Graduate Center, USA;* [2]*Mathematics, CUNY Queens, USA.* We demonstrate for the first time a plasmon-assisted magnetic response that occurs with disperse gold nanoparticles in aqueous solution. We observe increased Fano-like resonances and show the nonlinear interaction that occurs with matrix vortices.

Room B2 & B3

JOINT

JM4I • Symposium on the 50th Anniversary of the Semiconductor Laser III—Continued

JM4I.4 • 17:30 Invited
Recent Advances in Semiconductor Nanolasers, Ming C. Wu[1], Amit Lakhani[1]; [1]*Dept. of Electrical Engineering & Computer Sciences, UC-Berkeley, USA.* Nanolasers that integrate metal into the cavity design have pushed laser volumes much below one cubic wavelength λ3 0. In this paper, we review this growing field and highlight recent work on the nanopatch laser.

Room C1 & C2 / Room C3 & C4

CLEO: Science & Innovations

CM4J • Terahertz Waveguides and Filters—Continued

CM4K • Ultrafast Modification of Materials—Continued

CM4K.6 • 17:30
Polarization Dependence of Area Scanning Ultrafast Laser Machining, Mindaugas Gecevičius[1]; [1]*University of Southampton, United Kingdom.* Polarization dependence of laser machining by area scanning is observed. This general phenomenon is explained by anisotropies of stress induced in material and spatio-temporal distortions in ulrashort pulse. The control of phenomenon is demonstrated.

CM4K.7 • 17:45
Micromachining with femtosecond laser written radial polarization converter, Martynas Beresna[1], Mindaugas Gecevičius[1], Peter G. Kazansky[1], Yves Bellouard[2], Audrey Champion[2]; [1]*Univ Southampton, United Kingdom;* [2]*Eindhoven University of Technology, Netherlands.* Structures for microfluidics are fabricated with radially polarized femtosecond laser beam. Radial polarization is produced using birefringent optical element. Omnidirectional etching can be achieved using cylindrically symmetric polarization.

18:30–20:00 Dine and Discover Event

NOTES

Marriott San Jose
Salon I & II

Marriott San Jose
Salon III

Marriott San Jose
Salon IV

CLEO: Science & Innovations

CM4L • Advances in Nanofabrication for Photonics—Continued

CM4L.7 • 17:30
Laser Induced Annealing Dynamics of Photo-Electron Spectra from Silicon Field Emitter Arrays, Phillip D. Keathley[1], William P. Putnam[1], Alexander Sell[1], Stephen Guerrera[2], Luis Velasquez-Garcia[2], Franz X. Kaertner[1,3]; [1]*EECS, MIT, USA;* [2]*Microsystems Technology Laboratories, MIT, USA;* [3]*Physics, University of Hamburg, and Center for Free-Electron Laser Science, DESY, Germany.* A marked increase in electron yield, an overall spectral red shift, and the formation of a higher energy peak from Si field emitter arrays (FEAs) are observed in photo-electron spectra throughout a laser annealing process.

CM4L.8 • 17:45
Fabrication of crystalline Bragg reflectors for high power and integrated optical applications by multi-beam Pulsed Laser , Deposition, Katherine Sloyan[1], Tim May Smith[1], Michalis N. Zervas[1], Robert W. Eason[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* Tunable crystalline Bragg reflectors for high temperature, high power and integrated optical applications were fabricated via multi-beam Pulsed Laser Deposition. Apodised, π phase-shifted and >99% reflective quarter-wave structures are presented.

CM4M • Couplers and Mode Converters—Continued

CM4M.7 • 17:30
Transition from “Magic Width” to “Anti-Magic Width” in Thin-ridge Silicon-on-Insulator Waveguides, Naser Dalvand[1], Thach G. Nguyen[1], Ravi Tummidi[2], Thomas L. Koch[2], Arnan Mitchell[1]; [1]*School of Electrical and Computer Engineering, RMIT University, Australia;* [2]*Center for Optical Technologies, Lehigh University, USA.* We analyse a thin-ridge silicon-on-insulator waveguide which tapers from low-loss “magic” width to strongly radiating “anti-magic width” using a vector eigenmode expansion method. The conditions to achieve highly directional radiation are identified.

CM4M.8 • 17:45
A high-T, high-Resolution Thermometer based on a Microfiber Coupler Tip, Ming Ding[1], Pengfei Wang[1], Gilberto Brambilla[1]; [1]*Optoelectronics Research Centre, University of Southampton, United Kingdom.* A compact high sensitivity thermometer based on a microfiber coupler tip is demonstrated. It can measure a broad temperature range from room temperature to 1283oC. This is the highest temperature measured with silica optical fiber device.

CM4N • Amplifiers—Continued

CM4N.7 • 17:30
Tandem-pumped Ytterbium-doped Aluminosilicate Fiber Amplifier with Low Quantum Defect, Tianfu Yao[1], Junhua Ji[1], Jayanta K. Sahu[1], Andrew Webb[1], Johan Nilsson[1]; [1]*Optoelectronics Research Centre, United Kingdom.*We show theoretically that a quantum-defect below 1% is possible in tandem-pumped Yb-doped aluminosilicate fibers operating off the gain peak. Experimentally, we reach a quantum defect of 2% and a slope efficiency of 90% or more.

CM4N.8 • 17:45
Synthesis of flat-top gain response in fiber phase sensitive amplifiers with improved phase noise regeneration tolerance, Ning Kang[1], Jorge Seoane[1], Karsten Rottwitt[1], Christophe Peucheret[1]; [1]*Department of Photonics Engineering, Technical University of Denmark, Denmark.* Flat-top gain responses can be obtained together with two-level flat phase responses in fiber phase sensitive amplifiers by introducing moderate saturation together with dispersion engineering, resulting in an improved phase regeneration performance.

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18:30–20:00 Dine and Discover Event

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