Coherent Optical Technologies and Applications (COTA)

Abstracts

• Sunday, July 13 •

Atrium Foyer
4:00 p.m.–6:00 p.m.
Registration Open

• Monday, July 14 •

Atrium Foyer
7:00 a.m.–6:00 p.m.
Registration Open

JMA • Joint Plenary Session I

Salon E
8:00 a.m.–10:00 a.m.
JMA • Joint Plenary Session I

8:00 a.m.
Opening Remarks, *Conference Chairs (COTA, Slow Light, and ICQI).*

8:15 a.m.
ICQI Plenary
Photonic Entanglement in Quantum Communication and Quantum Computation, *Anton Zeilinger; Univ. Wien, Austria.*

9:00 a.m.
Opening Remarks, *Conference Chair (IPNRA).*

9:05 a.m.
IPNRA Plenary
The Intimate Merger of Photonics and Computing, *Ashok V. Krishnamoorthy, SUN Microsystems, USA.*

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

CMA • Components I

Salons C/D
10:30 a.m.–12:30 p.m.
CMA • Components I
Steve Pappert; DARPA/MTO, USA, Presider

CMA1 • 10:30 a.m. Invited
Chip-Scale Frequency Combs and Their Stabilization, *Pascale Del'Haye, Olivier Arcizet, Albert Schliesser, Tobias Wilken, Ronald Holzwarth, Tobias J. Kippenberg; Max Planck Inst. of Quantum Optics, Germany.* It is shown that the optical sidebands generated via optical parametric oscillations in an on-chip microcavity are equidistant thus overcoming the intrinsic cavity dispersion. This leads to the generation of optical frequency combs at input powers < 10 mW with repetition rate in the 80 GHz range.

CMA2 • 11:00 a.m. Invited
High-Power, Low-Noise 1.5-μm Optical Sources Based on Slab-Couple Optical Waveguide Amplifiers (SCOWAs), *Paul Juodawlkis; MIT Lincoln Lab, USA.* We describe the performance of single-frequency external-cavity lasers (P > 330mW; Δν < 100kHz) and mode-locked lasers (P > 100mW; jitter = 0.38fs, 1Hz to 1MHz) based on a novel high-power, low-loss semiconductor quantum-well gain medium.

CMA3 • 11:30 a.m.
Phase Coherence of Ti:Sapphire Optical Frequency Combs across Hundreds of Nanometers, *Qudsia Quraishi, Scott Diddams, Leo Hollberg; NIST, USA.* We demonstrate the scaling of the relative phase noise across hundreds of nanometers of spectra from stabilized Ti:Sapphire frequency combs. We show good agreement between the predicted and measured phase noise.

CMA4 • 11:45 a.m.
Sub-10 fs Residual Timing Jitter on a 10 GHz Optical Frequency Comb Generator, *Shijun Xiao, Leo Hollberg, Nathan Newbury, Scott Diddams; NIST, USA.* With a narrow linewidth seed laser, residual timing jitter on a 10 GHz optical frequency comb generator is reduced to 6 fs. We present analysis connecting spectral phase and laser linewidth to the timing jitter.

CMA5 • 12:00 p.m.
Dual-Frequency Laser at 1.5 μm for the Generation of High-Purity Microwave Signals, *Gregoire Pillet[1], Loic Morvan[1], Marc Brunel[2], Fabien Bretenaker[3], Daniel Dolfi[1], Marc Vallet[2], Jean-Pierre Huignard[1], Albert Le Floch[2]; [1]Thales Res. and Technology, France, [2]Inst. de Physique de Rennes, France, [3]Lab Aimé Cotton, Univ. Paris Sud, France.* We describe the stabilization of a dual-frequency laser on an external reference and on fiber delay lines. Low phase noise (-107 dBrad²/Hz at 10 kHz) beatnotes tunable from 2 to 6 GHz are demonstrated.

CMA6 • 12:15 p.m.
20 GHz Ultrashort Dual Wavelength Actively Mode-Locked Erbium-Doped Fiber Ring Laser, *Zhe Chen, Hongzhi Sun, Shaozhen Ma, Niloy K. Dutta; Univ. of Connecticut, USA.* We demonstrate a stable dual-wavelength actively mode-

locked erbium-doped fiber laser operating at 20GHz. We use a highly nonlinear fiber in the optical cavity. Simultaneous dual wavelength pulse trains with pulse widths ~1ps are achieved.

12:30 p.m.–2:00 p.m.
Lunch Break

CMB • Waveform Synthesis

Salons C/D
2:00 p.m.–4:00 p.m.
CMB • Waveform Synthesis
Daniel Dolfi; Thales Res. and Technology, France, Presider

CMB1 • 2:00 p.m. Invited
Optical Waveform Generation for Coherent High-Resolution Imaging, *Kevin W. Holman, David G. Kocher, Sumanth Kaushik; MIT Lincoln Lab, USA.* We have developed a time-multiplexed technique for controlling the amplitude and phase of the individual frequency components of a mode-locked laser to generate a precisely linear chirped waveform. We have demonstrated a 20-GHz, 1-us chirp.

CMB2 • 2:30 p.m. Invited
Pulse Shaping and Control of Optical and RF Phase, *Andrew Weiner; Purdue Univ., USA.* Applications of pulse shaping for control of optical and RF phase, including PMD equalization, manipulation of optical frequency combs, generation of arbitrary ultrawideband RF waveforms, and RF dispersion compensation, are discussed.

CMB3 • 3:00 p.m. Invited
High Resolution Optical Waveform Analysis, *Peter Andrekson; Chalmers Univ. of Technology, Sweden.* Techniques to analyze optical waveforms with high resolution are discussed. Emphasis is on all-optical sampling that offers picosecond resolution with excellent sensitivity as well as optical phase-sensitive and real time (Nyquist-limited) waveform capture capability.

CMB4 • 3:30 p.m.
Low-Insertion-Loss, In-Fiber, Dynamic Arbitrary Waveform Generation, *Yu Yeung (Kenny) Ho, Li Qian; Univ. of Toronto, Canada.* We present a low-loss, high-repetition-rate, dynamic waveform generation technique by independent phase and amplitude control of spectral lines in a continuous fiber. Several distinct waveforms are experimentally demonstrated by manipulating 5 lines.

CMB5 • 3:45 p.m.
Multi-Channel Running-Code OCDMA, *Shawn X. Wang[1], Gregory S. Kanter[2], Prem Kumar[1]; [1]Northwestern Univ., USA, [2]NuCrypt LLC, USA.* We report on an experimental investigation of a multi-channel running-code OCDMA system. The system utilizes double-pass acousto-optic-modulator pulse shapers to perform microsecond-scale spectral phase encoding/decoding.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

CMC • Components II

Salons C/D
4:30 p.m.–6:30 p.m.
CMC • Components II
Juerg Leuthold; Univ. of Karlsruhe, Germany, Presider

CMC1 • 4:30 p.m. Invited
Electro-Optic Modulators and Modulation for Enhanced LIGO and Beyond, *Volker Quetschke; Univ. of Florida, USA.* The Laser Interferometer Gravitational-Wave Observatory (LIGO) is currently undergoing an upgrade to improve its sensitivity. The laser power will increase to 30W, leading to stronger requirements on the modulators for avoiding losses and thermal lensing.

CMC2 • 5:00 p.m.
Integrated Optical Modulator for a Spectral Coding of Optical Signals, *Alexander Shamray, Alexander Kozlov, Igor Ilichev, Mikhail Petrov; Ioffe Physico-Technical Inst., Russian Federation.* A novel integrated optical modulator based on the controllable Bragg grating was developed and fabricated. Modulator provides addition flexibility and possibility of using frequency modulation formats (FSK) in combination with spectral OCDMA encoding.

CMC3 • 5:15 p.m.
All-Optical Correlator for High-Speed OOK and DPSK Signals, *David F. Geraghty, Reza Salem, Mark A. Foster, Alex L. Gaeta; Cornell Univ., USA.* We describe a novel high-speed temporal correlator based on linear optical components. We demonstrate operation with 100-Gb/s OOK packets, and our modeling indicates that this system can also function with DPSK signals.

CMC4 • 5:30 p.m.
Frequency-Resolved Optical Gating on a Silicon Photonic Chip, *Mark A. Foster, Reza Salem, David F. Geraghty, Amy C. Turner, Michal Lipson, Alexander L. Gaeta; Cornell Univ., USA.* We implement frequency-resolved optical gating using four-wave mixing in CMOS-compatible silicon nanowaveguides and demonstrate sensitive characterization in the C-band for a 10-GHz train of 3.7-ps pulses.

CMC5 • 5:45 p.m.
Novel Phase Spectrum Measurement Method Based on Stimulated Brillouin Scattering, *Asier Villafranca[1], Javier*

Lasobras[1], Francisco Lopez[2], Rafael Alonso[1], Ignacio Garces[1]; [1]Univ. of Zaragoza, Spain, [2]Aragon Photonics SLU, Spain. A novel method to measure the phase spectrum of modulated optical signals based on stimulated Brillouin scattering is presented. Combined with power spectrum measurements, and through inverse Fourier transform, the time-domain information is recovered.

CMC6 • 6:00 p.m.
$\chi^{(2)}$ Evolution in Fiber during Prolonged Thermal Poling, *Jiawen Zhang, Li Qian; Univ. of Toronto, Canada.* We report a two-stage rise in the evolution of $\chi^{(2)}$ in a twin-hole fiber during thermal poling, suggesting a fast Na^+ migration and a slow H^+ injection, in accordance with our charge dynamics model.

CMC7 • 6:15 p.m.
80Gb/s XNOR Using a Four Wave Mixing Scheme in Highly Nonlinear Fibers, *Shaozhen Ma, Hongzhi Sun, Zhe Chen, Niloy K. Dutta; Univ. of Connecticut, USA.* 80 Gb/s All-optical XNOR has been demonstrated using four wave mixing scheme in highly nonlinear fibers. The nonlinear Schrodinger equations (NLS) describing the process in fibers has been simulate and solved using split-step Fourier method.

JMB • Joint Poster Session

Salon F
6:30 p.m.–8:00 p.m.
JMB • Joint Poster Session

JMB1
The Photoanisotropy and Photogirotropy in Compositions of Organic Dyes, *Valentina Shaverdova[1], Svetlana Petrova[1], Nino Obolashvili[2]; [1]Inst. of Cybernetics, Georgia, [2]Georgian Technical Univ., Georgia.* Several compositions of organic dyes, embedded in polymer matrix were created. Experimental results of investigation photoanisotropy and photogyrotropy in these compositions are presented. It was shown that they are polarize-sensitive in a wide spectral range.

JMB2
Polarization-Holographic Amplifier-Corrector of Optical Signals, *Vladimir Tarasashvili[1], Anna Purtseladze[1], Irakli Chaganava[2]; [1]Inst. of Cybernetis, Georgia, [2]Georgian Technical Univ., Georgia.* The possibility of applying the photoinduced anisotropy in dynamic polarization-sensitive media for the correction and amplifications of the laser radiation with a complex distribution of the polarization state over the wavefront is tested experimentally.

JMB3
Fundamentals of Spatial Coherence Modulation, *Rafael A. Betancur, Roman E. Castaneda; Univ. Nacional de Colombia, Colombia.* Fundamentals of phase and amplitude modulation of the coherence properties of an optical field have been stated from the standpoint of the second order theory. This methodology can be employed for designing arbitrary power distributions.

JMB4
A Full-Duplex Radio-over-Fiber Transport System, *Wen-I Lin, Ming-Huei Shyu, Chia Hsien Lee, Ardhendu Sekhar Patra, Hai-Han Lu; Natl. Taipei Univ. of Technology, Taiwan.* A full-duplex radio-over-fiber transport system based on two modes injection-locked Fabry-Perot laser diode is proposed and demonstrated. Good performance of BER was obtained over 40 km SMF transmission in our proposed systems.

JMB5
Radio-on-Hybrid WDM Transport Systems, *Wen-I Lin, Ming-Huei Shyu, Chia Hsien Lee, Ardhendu Sekhar Patra, Hai-Han Lu; Natl. Taipei Univ. of Technology, Taiwan.* A radio-on-hybrid wavelength-division-multiplexing transport system employing mutually injection-locked Fabry-Perot laser diodes is proposed and demonstrated. System performances evaluated by CNR, CSO, CTB, and BER for simultaneous transmission of CATV/LAN/ITS are improved.

JMB6
Optical Path Difference Determination by Means of Coherence Degree Measurement, *Maximino L. Arroyo Carrasco, Diana Rodríguez Méndez, Marcela M. Méndez Otero, Israel Severiano Carrillo; BUAP, Mexico.* We measure the optical path difference of two interfering beams by means of the coherence degree determination with Photo Electro-Motive Force based detectors. This technique makes possible profile, thickness and index of refraction measurements.

JMB7
Withdrawn

JMB8
Digital Post-Equalization of Intrachannel Nonlinearities in Coherent DQPSK Transmission Systems, *Yan Gao, Fan Zhang, Liang Dou, Zhangyuan Chen, Anshi Xu; Peking Univ., China.* Digital post-equalization of intrachannel nonlinearities in coherent DQPSK systems is numerically studied. The simulation results show that the simplified channel inversion method is efficient in simultaneous compensation of intrachannel nonlinearities and chromatic dispersion.

JMB9
Improved Receiver Sensitivity by Using an Injection-Locked Laser and Double-Pass EDFA Scheme, *Ricardo A. P. Gomes, Reginaldo Silva, Aldario C. Bordonalli; State Univ. of Campinas - UNICAMP, Brazil.* This work investigates a coherent receiver that uses a single-facet optical injection-

locked semiconductor laser embedded into a doubled-pass EDFA. Consequently, receiver sensitivity as low as -65 dBm is possible with this low noise combined scheme.

JMB10-JMB33 can be found in the Slow Light abstracts.
JMB34-JMB41, JMB81 can be found in the IPNRA abstracts.
JMB42-JMB80 can be found in the ICQI abstracts.

NOTES

• Tuesday, July 15 •

Atrium Foyer
7:30 a.m.–5:00 p.m.
Registration Open

JTuA • Joint Plenary Session II

Salon E
8:00 a.m.–10:00 a.m.
JTuA • Joint Plenary Session II

8:00 a.m.
Slow Light Plenary
Electro-Optic Modulation of Photons and Biphotons, *Stephen E. Harris; Stanford Univ., USA.*

8:40 a.m.
ICQI Plenary
Entanglement, Information Processing and Decoherence in Trapped Atomic Ions, *David J. Wineland; NIST, USA.*

9:20 a.m.
COTA Plenary
Coherence Cloning and Phase Controlled Apertures Using Optical Phase-Lock Loops, *Amnon Yariv; Caltech, USA.*

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

CTuA • Imaging I

Salons C/D
10:30 a.m.–12:30 p.m.
CTuA • Imaging I
Frank Hanson; SPAWAR Systems Ctr. San Diego, USA, Presider

CTuA1 • 10:30 a.m. **Invited**
Long Range ID Using Sub-Aperture Array Based Imaging, *Paul McManamon; Exciting Technology LLC, USA.* The Air Force needs decision quality long range ID, but radar does not provide this capability. Laser radar provides high quality ID, but conformal aperture approaches are needed for next generation Air Force aircraft.

CTuA2 • 11:00 a.m.
Laser Radar and Quantum States of Light, *Mark A. Rubin, Sumanth Kaushik; MIT Lincoln Lab, USA.* We examine proposals to employ squeezed states and NOON states, novel quantum states of light, in laser radar. We find that the use of these states does not yield enhanced performance.

CTuA3 • 11:15 a.m. **Invited**
Laser and Lidar Technology Development for Highly Accurate Vertical Profiles of Vector Wind Velocity from Earth Orbit, *Michael J. Kavaya; NASA Langley Res. Ctr., USA.* We report progress, challenges, plans and our wish list for enabling a coherent-detection, 2-micron, pulsed, Doppler lidar system to measure winds from space.

CTuA4 • 11:45 a.m. **Invited**
Digital Holography of Total Internal Reflection, *M. K. Kim, W. M. Ash; Univ. of South Florida, USA.* Phase front of light in TIR is modulated by presence of object on the surface. Digital holography reconstructs the modulated phase front, to image the interface between the TIR surface and biological cells on it.

CTuA5 • 12:15 p.m.
Mueller Matrix Microscopy, *Mircea Mujat, Nick Iftimia, Dan R. Ferguson, Dan X. Hammer; Physical Sciences Inc., USA.* We describe here a new imaging technique, Mueller matrix microscopy, for investigating the anisotropic properties of the refractive index in biological samples. The system's capabilities are demonstrated first on mica.

12:30 p.m.–2:00 p.m.
Lunch Break

CTuB • Imaging II

Salons C/D
2:00 p.m.–4:00 p.m.
CTuB • Imaging II
Zhongping Chen; Univ. of California at Irvine, USA, Presider

CTuB1 • 2:00 p.m. **Invited**
Guiding Laser Thermal Therapy with Optical Frequency Domain Imaging, *Ben Vakoc; Massachusetts General Hospital, Harvard Univ., USA.* Laser thermal therapy seeks to coagulate limited volumes of diseased tissue while leaving neighboring healthy tissue unharmed. The role of coherent imaging technologies in guiding and monitoring this coagulation process is described.

CTuB2 • 2:30 p.m. **Invited**
CARS Microscopy, *Sunney Xie; Harvard Univ., USA.* Coherent Anti-Stokes Raman Scattering microscopy is a label-free imaging technique using molecular vibration as a contrast mechanism. Recent advances have enabled orders of magnitude improvement in sensitivity, enabling a wide range of applications.

CTuB3 • 3:00 p.m. **Invited**
***In vivo* Three-Dimensional Optical Coherence Tomography Using Fourier Domain Mode-Locked Laser,** *Yu Chen; Univ. of Maryland, USA.* We have developed an endoscopic OCT system based on an FDML laser. *In vivo* three-dimensional imaging at 100 kHz with 9 × 7 μm

(transverse by axial) resolution is demonstrated in the rabbit gastrointestinal tract.

CTuB4 • 3:30 a.m. Invited

Applications of Highly Coherent Femtosecond Fiber Lasers, *Nathan R. Newbury; NIST, USA.* Coherent, broadband fiber lasers produce pulse trains with <1 femtosecond relative timing uncertainty and <1 mHz relative frequency uncertainty. These sources can advance many applications including optical frequency metrology, ranging LIDAR, and broadband molecular spectroscopy.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

CTuC • Analog Photonics

Salons C/D
4:30 p.m.–6:30 p.m.
CTuC • Analog Photonics
Y. K. Chen; Bell Labs, Alcatel-Lucent, USA, Presider

CTuC1 • 4:30 p.m. Invited

A High Dynamic Range Coherent Optical RF Digital Receiver, *Thomas Clark, Michael Dennis; Applied Physics Lab, Johns Hopkins Univ., USA.* Coherent optical techniques—capitalizing on linear electro-optic phase encoding, quadrature detection and DSP—are applied to analog signal transport with unprecedented linearity. Applications, results, and directions for future work will be discussed.

CTuC2 • 5:00 p.m.

Time-Sampled Linear Optical Phase Demodulation, *Leif A. Johansson, Colin Sheldon, Anand Ramaswamy, Mark Rodwell; Univ. of California at Santa Barbara, USA.* Time-sampled optical phase demodulation is proposed, based on heterodyne detection of a phase modulated signal, digital frequency division and measurement of the timing of zero-crossings using an XOR-gate. 30dB improvement in intermodulation terms is measured.

CTuC3 • 5:15 p.m.

Optical Phase Demodulation of a 10GHz RF Signal Using Optical Sampling, *Anand Ramaswamy, Leif A. Johansson, Jonathan Klamkin, Darko Zibar, Larry A. Coldren, Mark J. Rodwell, John E. Bowers; Univ. of California at Santa Barbara, USA.* For the first time we demonstrate sampling downconversion of a 10GHz phase modulated optical signal using an integrated coherent receiver with feedback. At a downconverted frequency of 100 MHz we measure 19dB improvement in SIR.

CTuC4 • 5:30 p.m.

En-Decoding in the Optical Phase Domain in the Design of ADC's, RF Amplifiers/Filters and Antenna Links, *Geert J. Wyntjes, John J. Atkinson, David Rall; Visidyne, Inc., USA.* Discuss the advantages of linear angle, phase encoding between pairs of optical carriers, beams, and its recovery through interferometry in the same domain for, in the design of RF amplifiers/filters, analog-to-digital converters, and antenna links.

CTuC5 • 5:45 p.m.

Improvement of CSO/CTB Performance Based on Fabry-Perot Etalon, *Wen-I Lin, Ming-Huei Shyu, Chia Hsien Lee, Ardhendu Sekhar Patra, Hai-Han Lu; Natl. Taipei Univ. of Technology, Taiwan.* We proposed and demonstrated an externally modulated NTSC 77-channel EDFA-repeated system employing Fabry-Perot etalon at the receiving site to improve system performance. Good performance of CNR, CSO, and CTB were achieved over 100-km SMF transmission.

CTuC6 • 6:00 p.m.

CATV/ROF Transport Systems Based on -1 Side Mode Injection-Locked and Optoelectronic Feedback Techniques, *Wen-I Lin, Ming-Huei Shyu, Chia Hsien Lee, Ardhendu Sekhar Patra, Hai-Han Lu; Natl. Taipei Univ. of Technology, Taiwan.* A CATV/ROF transport system with side mode injection-locked and optoelectronic feedback techniques is proposed and demonstrated. Good performances of CNR, CSO, and CTB were obtained for CATV band; BER values were achieved for ITS application.

CTuC7 • 6:15 p.m.

Coherent Optical Transponder at Femto-Watt Light Levels, *John Dick[1], Meirong Tu[1], Kevin M. Birnbaum[1], Dmitry V. Strekalov[1], Nan Yu[1], Ertan Salik[2]; [1]JPL, USA, [2]California State Polytechnic Univ., USA.* We investigated two schemes for coherent optical transponder at extremely low light levels. Optical phase locking at femtowatt levels has been demonstrated and characterized. We also discuss an alternative "injection seeded" approach, and ranging experiments.

Salon F
6:30 p.m.–8:00 p.m.
Conference Reception

• Wednesday, July 16 •

Atrium Foyer
7:30 a.m.–5:00 p.m.
Registration Open

CWA • Coherent Communications I

Salons C/D
8:00 a.m.–10:00 a.m.
CWA • Coherent Communications I
Hamid Hemmati; JPL, USA, Presider

CWA1 • 8:00 a.m. **Invited**
Coherent Communication in Optical Free-Space and Fiber Networks, *Vincent Chan; MIT, USA.* This paper addresses coherent optical detection in the context of free-space optical networks in the presence of atmospheric turbulence and multi-user interference. We discuss how many of these techniques can be applied to fiber networks.

CWA2 • 8:30 a.m. **Invited**
Multi-Carrier or Single-Carrier Transmission: An Optical Debate, *William Shieh, Xingwen Yi; Dept. of Electrical and Electronic Engineering, Univ. of Melbourne, Australia.* Coherent optical OFDM has promise for being an attractive modulation format for future 100 Gb/s transmission systems. In this presentation, we revisit the long-standing debate on the superiority between OFDM and single-carrier frequency-domain equalization.

CWA3 • 9:00 a.m. **Invited**
Performance of Synchronous or Nonsynchronous Receivers Using Atmospheric Compensation Techniques, *Aniceto Belmonte[1,2], Joseph M. Kahn[2]; [1]Dept. of Signal Theory and Communications, Technical Univ. of Catalonia, Spain, [2]Stanford Univ., USA.* We present recent studies on the impact of phase and amplitude fluctuations on free-space links using either synchronous or nonsynchronous detection. We compare options for atmospheric compensation, including conjugate and non-conjugate adaptive optics.

CWA4 • 9:30 a.m.
The FWM Impairment in Coherent OFDM Compounds on a Phased-Array Basis over Dispersive Multi-Span Links, *Moshe Nazarathy[1], Jacob Khurgin[2], Rakefet Weidenfeld[1], Yehuda Meiman[3], Pak Cho[3], Reinhold Noe[4], Isaac Shpantzer[3]; [1]Technion, Israel, [2]Johns Hopkins Univ., USA, [3]Celight Inc., USA, [4]Univ. Paderborn, EIM-E, Germany.* We develop a novel all-analytic model of FWM generation over dispersive coherent OFDM long-haul links, leading to a new multispan phased-array effect. The nonlinear FWM impairment may be mitigated by destructive interference of intermodulation products.

CWA5 • 9:45 a.m.
Withdrawn

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

CWB • Coherent Communications II

Salons C/D
10:30 a.m.–12:45 p.m.
CWB • Coherent Communications II
Kazuro Kikuchi; Dept. of Frontier Informatics, Univ. of Tokyo, Japan, Presider

CWB1 • 10:30 a.m. **Invited**
Digital Compensation of Linear and Nonlinear Impairments in Coherent Optical Receivers, *Ezra Ip, Alan P. T. Lau, Daniel J. F. Barros, Joseph M. Kahn; Stanford Univ., USA.* We study digital backpropagation for compensating linear and nonlinear impairments in single-mode fiber. We reduce computational complexity by increasing the spatial step size. We evaluate the effects of sampling rate and dispersion map on performance.

CWB2 • 11:00 a.m. **Invited**
Digital Self-Coherent Detection and Mitigation of Transmission Impairments, *Xiang Liu; Bell Labs, Alcatel-Lucent, USA.* We review the techniques used in digital self-coherent detection for improvement of receiver sensitivity, recovery of multi-level phase and amplitude modulated signals, and mitigation of transmission impairments. Comparisons with digital coherent detection are also discussed.

CWB3 • 11:30 a.m.
Experimental Demonstration of Distributed Impairment Compensation for High-Spectral Efficiency Transmission, *Gilad Goldfarb, Michael G. Taylor, Guifang Li; College of Optics and Photonics, CREOL and FPCE, Univ. of Central Florida, USA.* Distributed impairment compensation for dispersion and nonlinear effects is demonstrated experimentally in the OWDM (channel spacing equal to symbol rate) environment and for transmission distances over 1000 km.

CWB4 • 11:45 a.m.
Frequency Estimation and Compensation for Coherent QPSK Transmission with DFB Lasers, *Sebastian Hoffmann[1], Timo Pfau[1], Olaf Adamczyk[1], Christian Wördehoff[1], Ralf Peveling[1], Mario Porrmann[1], Reinhold Noé[1], Suhas Bhandare[2]; [1]Univ. of Paderborn, EIM-E, Germany, [2]Discovery Semiconductors, Inc., USA.* We present a hardware-efficient combined frequency and phase estimator. It is capable of tracking phase noise of 10 GBaud optical QPSK transmission systems with DFB lasers and frequency mismatch up to 0.8 GHz.

CWB5 • 12:00 p.m.
Self-Coherent Differential Transmission with Decision Feedback–Phase Noise Impairments, *Yuval Atzmon, Moshe Nazarathy; Technion, Israel.* The BER performance of self-coherent receivers is analytically evaluated for the first time, accounting for (i) linear (ii) non-linear (SPM/XPM) (iii) laser phase noises. Longer decision-feedback memory ameliorates the impact of (i),(ii) while enhancing (iii).

CWB6 • 12:15 p.m.
Fading Mitigation in Homodyne RZ-QPSK via Delay-Diversity Transmission, *Pak S. Cho, Yehuda Meiman, Geof Harston, Yaakov Achiam, Isaac Shpantzer; CeLight, Inc., USA.* Turbulence-induced fading in free-space transmission of optical RZ-QPSK can be mitigated in homodyne detection via delay-diversity. A SNR gain of 2.6 dB is obtained using orthogonal polarizations with delay comparable to the turbulence correlation time.

CWB7 • 12:30 p.m.
Coherent Detection of DQPSK for Tolerance to Coherent Crosstalk, *Anjali Agarwal, Paul Toliver, Tom Banwell, Ronald Menendez, Janet Jackel, Shahab Etemad; Telcordia Technologies, USA.* Coherent crosstalk is a significant challenge in OCDM/A systems especially for high spectral efficiency coherent implementations. We study its impact on DQPSK with coherent detection. An improvement in performance is seen over direct detection.

12:30 p.m.–2:00 p.m.
Lunch Break

CWC • Coherent Communications III

Salons C/D
2:00 p.m.–4:15 p.m.
CWC • Coherent Communications III
Keang-Po Ho; Inst. of Communication Engineering, Taiwan, Presider

CWC1 • 2:00 p.m. Invited
40 Gb/s Coherent WDM Modems, *Kim Roberts; Nortel Networks, Canada.* Continuous real-time measurements of coherent 46 Gb/s transmission with Dual Polarization QPSK. Digital compensation is used for dispersion and polarization effects, with little performance degradation created by 150 ps of rapidly varying 1st-order PMD.

CWC2 • 2:30 p.m. Invited
Beyond 100-Gb/s Optical Transmission Based on Coded Modulation and Coherent Detection, *Ivan B. Djordjevic; Univ. of Arizona, USA.* We present several two-dimensional and three-dimensional coded-modulation schemes enabling optical transmission well beyond 100-Gb/s, using commercial components operating at 40-Giga-symbols/s. The coded-modulation schemes include: bit-interleaved coded-modulation, multilevel-coding, and coded-OFDM; all three based on LDPC codes.

CWC3 • 3:00 p.m. Invited
Digital Coherent Communication Algorithms and Architectures, *Isaac Shpantzer; CeLight Inc., USA.* Digital coherent communications in fiber optic or free-space can be implemented in scalar time-domain or vectored frequency-domain. The key algorithms, architecture, VLSI design complexity and performance tradeoffs will be highlighted.

CWC4 • 3:30 p.m.
Dual-Threshold Receiver for 1550nm Homodyne QPSK Quantum Key Distribution System, *Qing Xu[1], Manuel Sabban[1], Philippe Gallion[1], Francisco Javier Mendieta[2]; [1]Ecole Natl. Supérieure des Télécommunications, France, [2]CICESE, Mexico.* We present a dual-threshold balanced homodyne receiver for QPSK QKD system in which the strong reference is time-multiplexed with the weak signal pulses in optical fiber, we also report its experimental BER and post-detection efficiency.

CWC5 • 3:45 p.m.
Coherent Performance Monitoring for Telecom Signals, *Jungmi Oh, Misha Brodsky, Lynn E. Nelson, G. Cadena, Mark D. Feuer; AT&T Labs, USA.* We show how interferograms of modulated telecom signals can be used to monitor signals degradation in real networks. In particular, reliable measurements of extinction ratio and OSNR are demonstrated for various modulation schemes.

CWC6 • 4:00 p.m.
Signal-Phase Variation Induced by an Amplitude Limiter Using Saturation of a Fiber-Optic Parametric Amplifier, *Masayuki Matsumoto; Osaka Univ., Japan.* Generation of phase variation in an amplitude limiter using saturation of parametric amplification in fiber is analyzed. Phase noise of output signals induced by input amplitude noise both of signal and pump is quantified.

Quantum Entanglement and Decoherence: 3rd International Conference on Quantum Information (ICQI)

Abstracts

• Sunday, July 13 •

Atrium Foyer
4:00 p.m.–6:00 p.m.
Registration Open

• Monday, July 14 •

Atrium Foyer
7:00 a.m.–6:00 p.m.
Registration Open

JMA • Joint Plenary Session I

Salon E
8:00 a.m.–10:00 a.m.
JMA • Joint Plenary Session I

8:00 a.m.
Opening Remarks, *Conference Chairs (COTA, Slow Light, and ICQI).*

8:15 a.m.
ICQI Plenary
Photonic Entanglement in Quantum Communication and Quantum Computation, *Anton Zeilinger; Univ. Wien, Austria.*

9:00 a.m.
Opening Remarks, *Conference Chair (IPNRA).*

9:05 a.m.
IPNRA Plenary
The Intimate Merger of Photonics and Computing, *Ashok V. Krishnamoorthy, SUN Microsystems, USA.*

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

QMA • Entanglement I

Salons H–J
10:30 a.m.–12:30 p.m.
QMA • Entanglement I
Bahaa Saleh; Boston Univ., USA, Presider

QMA1 • 10:30 a.m. Invited
Purity and Entanglement of Two-Photon States Generated by Parametric Down-Conversion, *Carlos H. Monken; Univ. Federal de Minas Gerais, Brazil.* We elucidate the dependence of purity and entanglement of two-photon states generated by parametric down-conversion on the parameters of the source, such as crystal length, pump beam spatial bandwidth and detectors angular apertures.

QMA2 • 11:00 a.m. Invited
Decoherence and Entanglement for Quantum Critical Baths, *Rosario Fazio; Intl. School for Advanced Studies (SISSA), Italy.* I introduce, and determine decoherence for, a wide class of non-trivial quantum critical baths coupled to a two-level system. I will describe the properties of decoherence and its relations with the entanglement in the bath.

QMA3 • 11:30 a.m. Invited
Control of Superposition States of Continuous Variables by Photon Counting and Filtering with cw Squeezed Light, *Masahide Sasaki; Natl. Inst. of Information and Communications Technology, Japan.* The two-photon subtraction from overlapping squeezed packets generates temporally multiplexed superposition states of continuous variables with a designated time separation. In an appropriate mode an amplified superposition state is produced due to bosonic quantum interference.

QMA4 • 12:00 p.m.
Entangled State Engineering in Single-Mode Fibers, *Joseph B. Altepeter, Jun Chen, Prem Kumar; Northwestern Univ., USA.* We present novel designs for fiber-based sources of entangled photon pairs, and investigate the increasing number of available options for quantum-state engineering in the telecom band using four-wave mixing in standard fibers.

QMA5 • 12:15 p.m.
Experimental Generation of Frequency-Degenerate Bright EPR Beams with a Self-Locked Optical Parametric Oscillator, *Virginia D'Auria[1], Gaelle Keller[1], Nicolas Treps[1], Thomas Coudreau[2], Julien Laurat[1], Claude Fabre[1]; [1]Lab Kastler Brossel, Univ. Pierre et Marie Curie, Ecole Normale Superiéure, CNRS, France, [2]Lab Matériaux et Phénomènes Quantiques, Univ. Denis Diderot, Lab Kastler Brossel, Univ. Pierre et Marie Curie, Ecole Normale Superiéure, CNRS, France.* We report the first experimental generation of bright frequency-degenerate EPR-beams with a type-II OPO. Degeneracy is obtained by introducing a birefringent plate inside the cavity, resulting in phase locking. EPR-correlation is characterized by homodyne detection.

12:30 p.m.–2:00 p.m.
Lunch Break

QMB • Entanglement II

Salons H–J
2:00 p.m.–4:00 p.m.
QMB • Entanglement II
Rosario Fazio; Intl. School for Advanced Studies (SISSA), Italy, Presider

QMB1 • 2:00 p.m. **Invited**
Engineering Multiparameter Entangled State with Adaptive Optics, *Alexander V. Sergienko[1], Cristian Bonato[2], Stefano Bonora[2], Paolo Villoresi[2]; [1]Dept. of ECE, Boston Univ., USA, [2]CNR-INFM LUXOR, Dept. of Information Engineering, Univ. of Padova, Italy.* We discuss the possibility of actively manipulating entangled states generated by type-II parametric down conversion. We study what effect active manipulation of wavevector using adaptive mirror will have on the behavior of polarization-temporal interference.

QMB2 • 2:30 p.m. **Invited**
Revealing Anyonic Statistics with Multiphoton Entanglement, *W. Wieczorek[1,2], Ch. Schmid[1,2], N. Kiesel[1,2], R. Pohlner[1,2], J. Pachos[3], Harald Weinfurter[1,2]; [1]Max-Planck-Inst. of Quantum Optics, Germany, [2]Dept. of Physics, Ludwig-Maximilians-Univ. Munich, Germany, [3]School of Physics and Astronomy, Univ. of Leeds, UK.* Anyons, manifested as quasiparticles in two-dimensional systems, exhibit fractional statistics that ranges continuously from bosonic to fermionic behavior. Here, we reveal anyonic features in a quantum simulation using multi-partite entangled state of polarized photons.

QMB3 • 3:00 p.m. **Invited**
Percolation Theory, Optical Quantum Computing, and Computational Phases of Matter, *Terry G. Rudolph; Imperial College, UK.* I review two results: robust methods for ballistic linear optical quantum computing, and phases of matter defined by their quantum computational universality, which make use of percolation theory–a fascinating phenomenon of classical statistical mechanics.

QMB4 • 3:30 p.m.
Long-Distance Entanglement between a Photon and a Single Trapped Atom, *Wenjamin Rosenfeld[1], Fredrik Hocke[1], Florian Henkel[1], Michael Krug[1], Andreas Deeg[1], Christian Jakob[1], Jürgen Volz[2], Markus Weber[1], Harald Weinfurter[1]; [1]Fakultat für Physik, Ludwig-Maximilians Univ. München, Germany, [2]Lab Kastler Brossel de l'ENS, France.* Atom-photon entanglement provides a powerful interface between atomic memories and photonic communication channels. As a first step towards long-distance quantum communication we demonstrate atom-photon entanglement over a 300 m long optical fiber.

QMB5 • 3:45 p.m.
Angular Dimensionality of Two-Photon Entanglement, *Eric R. Eliel, Bart-Jan Pors, Suman S. R. Oemrawsigh, Martin P. van Exter, Andrea Aiello, Gert W. 't Hooft, J. P. Woerdman; Leiden Univ., Netherlands.* We use rotatable angular phase plates to determine the angular dimensionality in twin-photon entanglement. We measure values between 2 and 6, depending on the shape of the phase plates; a value of 50 seems feasible.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

QMC • Optical and Other Implementations I

Salons H–J
4:30 p.m.–6:30 p.m.
QMC • Optical and Other Implementations I
Alexander Sergienko; Boston Univ., USA, Presider

QMC1 • 4:30 p.m. **Invited**
Polar Molecules and Circuit QED: Towards Hybrid Quantum Computing, *Peter Rabl[1,2], David DeMille[3], John M. Doyle[2], Mikhail D. Lukin[1,2], Robert J. Schoelkopf[4], Peter Zoller[5]; [1]Inst. for Theoretical Atomic, Molecular and Optical Physics, USA, [2]Dept. of Physics, Harvard Univ., USA, [3]Dept. of Physics, Yale Univ., USA, [4]Dept. of Applied Physics, Yale Univ., USA, [5]Inst. for Theoretical Physics, Univ. of Innsbruck, Austria.* Qubits encoded in longlived rotational states of polar molecules interact strongly with single photons of a superconducting stripline cavity. We discuss potential applications of such a hybrid device for quantum information processing.

QMC2 • 5:00 p.m.
Classical Logic Operations Using the Quantum Zeno Effect, *James D. Franson[1], B. C. Jacobs[2]; [1]Univ. of Maryland, Baltimore County, USA, [2]Applied Physics Lab, Johns Hopkins Univ., USA.* The quantum Zeno effect can be used to implement quantum logic operations using single photons as the qubits. It is shown here that similar effects can be used to implement classical logic and memory devices.

QMC3 • 5:15 p.m.
Tunable Setup for an Entire Family of Four-Photon Entangled States, *Witlef Wieczorek[1,2], Christian Schmid[1,2], Nikolai Kiesel[1,2], Roland Krischek[1,2], Harald Weinfurter[1,2]; [1]Max-Planck-Inst. for Quantum Optics, Germany, [2]Dept. of Physics, Ludwig-Maximilians-Univ. Munich, Germany.* We report on the experimental observation and analysis of an entire family of four-photon entangled states. We demonstrate how these states can be obtained with a single linear optics set-up and analyze particular entanglement properties.

QMC4 • 5:30 p.m.
Surface Polariton-Polariton Induced Transparency in Left-Handed Metamaterials, *Ali A. Kamli[1,2], Sergey A. Moiseev[1,3], Barry C. Sanders[1]; [1]Inst. for Quantum Information Science, Univ. of Calgary, Canada, [2]Dept. of Physics, King Khalid Univ., Saudi Arabia, [3]Kazan Physical-Technical Inst. of Russian Acad. of Sciences, Russian Federation.* We propose to control surface polariton (SP) propagation in left-handed materials. New spectral behavior of SP propagation is demonstrated due to the spatial properties of interaction between the SP modes and three level atoms.

QMC5 • 5:45 p.m.
Coherent Optical Spectroscopy of a Semiconductor Quantum Dot Cavity QED System in the Strong Coupling Regime, *Kartik Srinivasan[1], Oskar Painter[2]; [1]NIST, USA, [2]Caltech, USA.* Coherent optical spectroscopy of a strongly-coupled semiconductor microcavity-quantum dot system is performed using a fiber taper waveguide to efficiently access the system. Vacuum Rabi splitting under weak driving and saturation under strong driving are observed.

QMC6 • 6:00 p.m.
Weak Values and the Leggett-Garg Inequality in Solid-State Qubits, *Andrew N. Jordan, Nathan S. Williams; Dept. of Physics and Astronomy, Univ. of Rochester, USA.* An implementation of weak values is investigated in solid-state qubits. We demonstrate that a weak value can be non-classical if and only if a Leggett-Garg inequality can also be violated.

QMC7 • 6:15 p.m.
Toward Hyperentanglement via Semiconductor Two-Photon Emission, *Alex Hayat, Pavel Ginzburg, David Neiman, Serge Rosenblum, Meir Orenstein; Dept. of Electrical Engineering, Technion-Israel Inst. of Technology, Israel.* A novel phenomenon of semiconductor two-photon emission is presented experimentally. Based on this effect, we propose implementations of compact highly-efficient room-temperature sources of entangled photons (inter-band transitions in a microcavity) and hyperentangled photons (inter-subband transitions).

JMB • Joint Poster Session

Salon F
6:30 p.m.–8:00 p.m.
JMB • Joint Poster Session

JMB42
Coupling of N Qubits to Any Dicke State via Projective Measurements, *Christoph Thiel[1], Andreas Maser[1], Thierry Bastin[2], Enrique Solano[3], Joachim von Zanthier[1]; [1]Inst. for Optics, Information and Photonics, Univ. of Erlangen-Nuremberg, Germany, [2]Inst. de Physique Nucléaire, Atomique et de Spectroscopie, Univ. de Liège au Sart Tilman, Belgium, [3] Dept. of Physics, Arnold Sommerfeld Ctr. for Theoretical Physics and Ctr. for Nanoscience, Ludwig-Maximilians-Univ., Germany.* We propose a method mimicking the coupling of N qubits to a compound system using linear optics only. Our scheme employs N atoms with Λ-configuration and offers access to any of the 2^N Dicke states.

JMB43
Triple Quantum Correlations from an Above-Threshold Optical Parametric Oscillator, *Katiúscia N. Cassemiro, Alessandro S. Villar, Marcelo Martinelli, Paulo A. Nussenzveig; Inst. de Física, Univ. de Sao Paulo, Brazil.* We measured triple quantum correlations between the bright beams in an optical parametric oscillator, operating above threshold. Owing to extra noise in the system, still unaccounted for, tripartite entanglement is yet to be demonstrated.

JMB44
GHZ\W Type Tripartite Entanglement in Non-Interacting Fermi Gas, *Hessam Habibian[1], John W. Clark[2], Kurt Hingerl[3], Michael Bergmair[3]; [1]Christian Doppler Lab for Surface Optics, Inst. fur Halbleiter und Festkorperphysik, Johannes Kepler Univ. Linz, Austria, [2]Dept. of Physics, Washington Univ., USA, [3]Christian Doppler Lab for Surface Optics, Inst. für Halbleiter und Festkorperphysik, Austria.* We have considered GHZ\W entanglement in non-interacting Fermi gas. For this aim we have introduced new class of GHZ-Witnesses. We have shown that for tripartite Fermi systems GHZ\W entanglement as well as W-type exists.

JMB45
Topological Phase for Spin-Orbit Transformations on a Laser Beam, *Carlos Eduardo R. Souza[1], Jose Augusto O. Huguenin[1], Perola Milman[2], Antonio Z. Khoury[1]; [1]Inst. de Física, Univ. de Federal Fluminense, Brazil, [2]Lab de Materiaux et Phénomènes Quantiques, Univ. Paris Diderot, France.* We investigate the topological phase associated with the *SO*(3) representation in terms of maximally entangled states. An experimental demonstration of this topological phase is provided for polarization and spatial mode transformations of a laser beam.

JMB46
Operator Quantum Fault Tolerance, *Gerald Gilbert[1], Michael Hamrick[1], Yaakov S. Weinstein[1], Vaneet Aggarwal[2], Robert Calderbank[2]; [1]MITRE, USA, [2]Princeton Univ., USA.* We introduce a universal operator theoretic framework for quantum fault tolerance that incorporates a top-down approach based on specification of the full system dynamics. This approach leads to more accurate error thresholds.

JMB47
Microscopic Cascading Induced by Local-Field Effects as a Tool for Quantum Lithography, *Ksenia Dolgaleva[1], Heedeuk*

Shin[1], Robert W. Boyd[1], John E. Sipe[2]; [1]Inst. of Optics, Univ. of Rochester, USA, [2]Dept. of Physics, Univ. of Toronto, Canada. We show that there are cascaded contributions from the third-order microscopic hyperpolarizability to the fifth-order susceptibility induced by local-field effects which can be useful in creating novel quantum lithographic materials.

JMB48
Operational Monitoring of Multi-Qubit Entanglement Classes via Tuning of Local Operations, *Thierry Bastin[1], Christoph Thiel[2], Joachim von Zanthier[2], Lucas Lamata[3], Enrique Solano[4], Girish S. Agarwal[5]; [1]Inst. de Physique Nucléaire, Atomique et de Spectroscopie, Univ. de Liège au Sart Tilman, Belgium, [2]Inst. for Optics, Information and Photonics, Max Planck Res. Group, Univ. of Erlangen-Nuremberg, Germany, [3]Max Planck Inst. for Quantum Optics, Germany, [4]Physics Dept., Arnold Sommerfeld Ctr. for Theoretical Physics and Ctr. for Nanoscience, Ludwig-Maximilians-Univ., Germany, [5]Dept. of Physics, Oklahoma State Univ., USA.* We show that for a system of N emitters, incoherently radiating single photons it is possible to associate well-defined sets of experimental parameters with multiqubit entanglement classes, allowing their monitoring in an operational manner.

JMB49
Two-Color Ghost Imaging, *Kam Wai C. Chan, Malcolm N. O'Sullivan, Mehul Malik, Robert W. Boyd; Inst. of Optics, Univ. of Rochester, USA.* We study a quantum ghost imaging system that uses different wavelengths to illuminate the object and the reference detector. We found that the resolution is limited by the wavelength of light illuminating the object.

JMB50
Master Equation in the Presence of Initial Correlation with Reservoir, *Kazuya Yuasa; Waseda Univ., Japan.* We discuss the derivation of Markovian master equation via Nakajima-Zwanzig's projection operator method, when there exists initial correlation between the system and the reservoir.

JMB51
Experimental Test of Non-Local Realism Using a Fiber-Based Source of Polarization-Entangled Photon Pairs, *Matthew D. Eisaman, Elizabeth Goldschmidt, Jingyun Fan, Alan Migdall; NIST, USA.* We test local realistic and non-local realistic theories using a fiber-based source of polarization-entangled photons. Our measurements violate local (certain non-local) hidden-variable theories by 14 (3) standard deviations.

JMB52
Withdrawn

JMB53
Entanglement Stabilization via Quantum Feedback, *André R. R. Carvalho[1], Joseph J. Hope[2]; [1]Dept. of Physics, Australian Natl. Univ., Australia, [2]Australian Ctr. for Quantum-Atom Optics, Dept. of Physics, Faculty of Science, Australian Natl. Univ., Australia.* We describe how feedback methods can be implemented to produce and stabilize entangled states of two atoms inside a cavity. The scheme overcomes fundamental decoherence sources, and is mostly insensitive to practical imperfections.

JMB54
DLCZ Quantum Repeaters: Rate and Fidelity Analysis, *Jeyran Amirloo, Mohsen Razavi, A. Hamed Majedi; Univ. of Waterloo, Canada.* The fidelity and the rate of entanglement generation for the DLCZ entanglement-swapping protocol are evaluated. We find the distance beyond which DLCZ repeaters outperform single DLCZ links by accounting for loss, multiple-excitation, and self-purification effects.

JMB55
Recurrences in Quantum Walks, *Martin Stefanak[1], Igor Jex[1], Tamas Kiss[2]; [1]Czech Technical Univ., Czech Republic, [2]Res. Inst. for Solid State Physics and Optics, Hungarian Acad. of Sciences, Hungary.* We analyze the recurrence probabilities (Pólya numbers) of quantum walks. We show that one can achieve strikingly different recurrence behaviours for quantum walks by altering the coin and the initial state.

JMB56
BB84 Quantun Key Distribution without a Shared Reference Frame, *C. E. R. Souza[1], C. V. S. Borges[1], A. Z. Khoury[1], J. A. O. Huguenin[2], L. Aolita[3], S. P. Walborn[3]; [1]Inst. de Física, Univ. Federal Fluminense, Brazil, [2]Dept. de Ciências Exatas, Univ. Federal Fluminense, Brazil, [3]Inst. de Física, Univ. Federal do Rio de Janeiro, Brazil.* We report a simple quantum key distribution experiment in which a shared reference frame is not necessary. Logical qubits are encoded into non-separable states of polarization and first-order transverse spatial modes of the same photon.

JMB57
Effect of Dispersion on Fidelity of a Quantum Interferometer, *Thomas B. Bahder[1], Alexander V. Sergienko[2], David S. Simon[2]; [1]Charles M. Bowden Res. Facility, Aviation and Missile Res., Development and Engineering Ctr., US Army Res. Development Command, USA, [2]Dept. of Electrical and Computer Engineering, Boston Univ., USA.* We analyze the effect of frequency dispersion on the Shannon mutual information for high-resolution phase measurement with Mach-Zehnder interferometers, comparing input states of monochromatic photons to those of nonzero-bandwidth photons produced by parametric downconversion.

JMB58
Dynamics of Entangled Coherent States under Dissipation, *Freddy Antonio Peres Lastra[1], Guillermo E. S. Romero[1], Carlos E. Lopez[1], Nicim Zagury[2], Juan C. Retamal[1]; [1]Univ. de Santiago de*

Chile, Chile, [2]Univ. Federal do Rio de Janeiro, Brazil. We discuss the loss of entanglement under dissipation for a class of entangled coherent states of two modes of the electromagnetic field. Both asymptotic decays and finite disentanglement occur depending of the initial conditions.

JMB59
A Parametric Down-Conversion Source for Two-Photon Absorption Experiments, *Todd B. Pittman, Scott Hendrickson, Jim D. Franson; Univ. of Maryland, Baltimore County, USA.* We describe a Parametric Down-Conversion source based on a low-power (< 1mW), narrowband (<1 MHz) fiber-coupled pump laser. The source is designed for two-photon absorption experiments related to quantum Zeno gates.

JMB60
Photon Energy Entanglement Characterization by Electronic Transition Interference, *Alex Hayat, Pavel Ginzburg, Meir Orenstein; Dept. of Electrical Engineering, Technion-Israel Inst. of Technology, Israel.* Direct characterization of photon energy-entanglement, full Bell-state analysis and energy-qubit detection are proposed, based on a coherent-control concept of two-photon absorption interferometry of electronic transition amplitudes rather than of photons, within practical room-temperature semiconductor detectors.

JMB61
Entangling Schrödinger Cats: Methods, Measures and Statistics, *Mayer A. Landau, Carlos R. Stroud Jr.; Inst. of Optics, Univ. of Rochester, USA.* We study wavepacket entanglement using generalized Schrödinger cat states of collections of oscillators with time dependent interactions. Entanglement is characterized as a function of pulse area using a generalized entanglement measure, and generalized displacement operator.

JMB62
Entangled Coherent States, Heisenberg-Limited Metrology, and Related Issues, *Christopher C. Gerry, Adil Benmoussa; Dept. of Physics and Astronomy, Lehman College, CUNY, USA.* We discuss the generation of two mode maxinally entangled coherent states using a weak nonlinear medium. We then discuss their applications to quantum metrology (Heisenberg-limited interferometry), quantum lithography and violations of Bell-type inequalities.

JMB63
A New Scheme for Nuclear Spin Quantum Memory in an Isotope-Controlled Si Quantum Dot, *Ozgur Cakir[1,2], Toshihide Takagahara[1,2]; [1]Kyoto Inst. of Technology, Japan, [2]Core Res. for Evolutional Science and Technology, Japan Science and Technology Agency, Japan.* A new scheme for the nuclear spin quantum memory and the photon-electron quantum state transfer is proposed based on the singlet-triplet crossing of two electrons in a Si quantum dot with a single ^{29}Si isotope.

JMB64
Free Space Quantum Key Distribution System with Atmospheric Turbulence Mitigation by Active Deformable Mirror, *Ivan Capraro[1], Tommaso Occhipinti[1], Stefano Bonora[2], Paolo Villoresi[1]; [1]Univ. of Padova, Italy, [2]Univ. of Padova and Lab for Ultraviolet and X-Ray Optical Res., Inst. Natl. per la Fisica della Materia, Consiglio Natl. delle Ricerche, Italy.* Propagation through atmosphere is a major limitation in free space QKD implementations. Adaptive Optics can be a solution to this problem. This paper describes some results in this direction we obtained with our QKD setup.

JMB65
Coherent States Engineering with Linear Optics, *Bing He, János Bergou; Dept. of Physics and Astronomy, Hunter College, CUNY, USA.* We present a general linear optics based approach to implement contractive transformations that map products of N coherent states to products of M coherent states (M≤N) and apply it to nondestructive quantum database search.

JMB66
Separable Operations on Pure States, *Vlad Gheorghiu, Robert B. Griffiths; Carnegie Mellon Univ., USA.* Numerical evidence provides strong support for the conjecture that the ensemble resulting from a separable operation applied to a single bipartite pure state can be produced by some LOCC operation acting on the same state.

JMB67
Simulation of the Quantum Decoherence Effect for $^{79}Br^{85}Rb$, *R. A. Betancur; Univ. Natl. de Colombia, Colombia.* Decoherence effect on the density matrix of molecule $^{79}Br^{85}Rb$ using Brownian particle model in high temperature limit is simulated and the implied variables in this evolution are revealed which gives insight to avoid this limitation.

JMB68
Entanglement, Postselection and Precise Inferences in Joint Measurements of Incompatible Observables, *Alonso Botero; Univ. de los Andes, Colombia.* We discuss conditions under which joint outcomes of simultaneous measurements of non-commuting canonical observables can be inferred with arbitrary precision. The feat is possible for certain pre- and postselections involving entanglement with ancillary systems.

JMB69
Spin-Induced Non-Geodesic Motion, Wigner Rotation and Entanglement of Massive Spin-1/2 Particles in a Gravitational Field, *Paul M. Alsing[1], G.J. Stephenson[1], Patrick Kilian[2]; [1]Univ. of New Mexico, USA, [2]Bayrische Julius-Maximilians Univ. Würzburg, Germany.* We develop the

Wigner rotation for spin 1/2 particles moving in curved spacetimes, and include the spin-orbit coupling of the particle's motion to the gravitational curvature. We then investigate entanglement in curved spacetimes.

JMB70
Quantum Control of Entanglement by Phase Manipulation, *Vladimir S. Malinovsky; MagiQ Technologies Inc., USA.* A method of entangled states preparation of two-qubit systems is proposed. The method combines the techniques of coherent control by manipulation of the relative phase between pulses, and adiabatic control using time-delayed pulse sequences.

JMB71
Exact Results on Decoherence and Entanglement in a Cavity QED System of N Driven Atoms and One Dissipative Field Mode, *Matteo Bina, Federico Casagrande, Alfredo Lulli; Dept. di Fisica, Univ. di Milano, Italy.* The general solution allows investigating and monitoring decoherence, entanglement and purity of the system and the subsystems. Particular entangled atomic states can be frozen in de-coherence-free subspaces for quantum information purposes.

JMB72
Electromagnetically Induced Transparency on Semiconductor Quantum Well Structure, *Hoonsoo Kang, Jong Su Kim, Clare C. Byeon, Mun Seok Jeong, Do-Kyeong Ko, Jongmin Lee; Advanced Photonics Res. Inst., Gwangju Inst. of Science and Technology, Republic of Korea.* We observed electromagnetic-ally induced transparency on GaAs/AlGas quantum well structure. EIT signal was observed at various conditions including delay time, coupling beam intensity, polarization state of probe-coupling beam and temperature.

JMB73
Quantum Squeezing and Correlation of Slow-Light Self-Induced Transparency Solitons, *Ray-Kuang Lee[1], Yinchieh Lai[2,3]; [1]Inst. of Photonics Technologies, Natl. Tsing-Hua Univ., Taiwan, [2]Dept. of Photonics, Natl. Chiao-Tung Univ., Taiwan, [3]Res. Ctr. for Applied Sciences, Academic Sinica, Taiwan.* A quantum theory of self induced transparency solitons is developed with quantum effects of ensemble atoms taken into account. Suggestions for experimental SIT soliton squeezing detection and intersoliton correlation generation are given.

JMB74
Conditions to Preserve Quantum Entanglement of Quadrature Fields through an Eletctromagnetally Induced Transparency Medium, *Yu-Lin Chuang[1], Ray-Kuang Lee[1,2]; [1]Dept. of Photonics, Natl. Chiao-Tung Univ., Taiwan, [2]Inst. of Photonics Technologies, Natl. Tsing-Hua Univ., Taiwan.* We study the entanglements among three quadrature fields, two of them interacting through an electromagnetically induced transparency medium while two are generated by a two-mode squeezer. We show the conditions to preserve non-separation criteria.

JMB75
Quantum Key Distribution Using Magnetostatic Wave-Optical Interactions, *Anil Prabhakar, Pradeep Kumar; Indian Inst. of Technology, Madras, India.* We propose quantum key distribution using magnetostatic wave optical interactions in garnet films at telecommunication wavelengths. The simultaneous change in optical frequency and polarization is advantageous in an implementation of the B92 protocol.

JMB76
Continuous-Variable Teleportation: A New Look, *Paulina Marian, Tudor A. Marian; Univ. of Bucharest, Romania.* We show that the amount of noise distorting the properties of the input field state in the continuous-variable teleportation rigorously equals the EPR–uncertainty of the resource state.

JMB77
Security Evaluation of Dual-Threshold Homodyne Quantum Cryptographic Systems, *Manuel Sabban[1], Qing Xu[1], Philippe Gallion[1], Francisco Mendieta[1,2]; [1]Ecole Natl. Supérieure des Télécommunications (Télécom ParisTech), France, [2] Center for Scientific Investigation and Higher Education (CICESE), Mexico.* In this work we present a quantitative security analysis of a dual-threshold homodyne quantum cryptography with two types of possible eavesdropping attacks in terms of the differential of mutual information.

JMB78
Vortex-Antivortex Labyrinth Wavefunction, *Alexey Y. Okulov; A.M. Prokhorov General Physics Inst., Russian Acad. of Sciences, Russian Federation.* The vortex-antivortex optical trapping arrays are shown to transfer angular orbital momentum to support "antiferromagnet-like" matter waves. The wavefunction's phase gradient field associated with the field of classical velocities via Madelung transformation forms labyrinth-like structure.

JMB79
Entanglement Dynamics and Geometry of Quantum States: Calculations and Simulations, *Marcelo F. Santos; Univ. Federal de Minas Gerais, Brazil.* We analyze the dynamical behavior of entangled systems under the action of decoherence and its relation to the geometry of quantum states. Physical examples and an experimental simulation are also presented.

JMB80
Hyperfine Interaction Induced Decoherence and Quantum Information Processing with Quantum Dots, *Yechao Zhu[1], Siqing Yu[1], Ye Yeo[2]; [1]Hwa Chong Inst., Singapore, [2]Dept. of Physics, Natl. Univ. of Singapore, Singapore.* Employing a

realistic model of the nuclear spin bath, we derive exact dynamical mappings that describe the basic operations in quantum information processing with electron spin qubits in quantum dots.

JMB1-JMB9 can be found in the COTA abstracts.
JMB10-JMB33 can be found in the Slow Light abstracts.
JMB34-JMB41, JMB81 can be found in the IPNRA abstracts.

NOTES

• Tuesday, July 15 •

Atrium Foyer
7:30 a.m.–5:00 p.m.
Registration Open

JTuA • Joint Plenary Session II

Salon E
8:00 a.m.–10:00 a.m.
JTuA • Joint Plenary Session II

8:00 a.m.
Slow Light Plenary
Electro-Optic Modulation of Photons and Biphotons, *Stephen E. Harris; Stanford Univ., USA.*

8:40 a.m.
ICQI Plenary
Entanglement, Information Processing and Decoherence in Trapped Atomic Ions, *David J. Wineland; NIST, USA.*

9:20 a.m.
COTA Plenary
Coherence Cloning and Phase Controlled Apertures Using Optical Phase-Lock Loops, *Amnon Yariv; Caltech, USA.*

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

QTuA • Entanglement III

Salons H–J
10:30 a.m.–12:30 p.m.
QTuA • Entanglement III
Saverio Pascazio; Univ. di Bari, Italy, Presider

QTuA1 • 10:30 a.m. Invited
The Quantum Cost of a Nonlocal Measurement, *Somshubhro Bandyopadhyay[1], Shelby Kimmel[2], William K. Wootters[2]; [1]Univ. de Montréal, Canada, [2]Williams College, USA.* For any measurement on two spatially separated objects, one can ask how much quantum communication the measurement requires. Here we place upper and lower bounds on this quantity for a simple two-qubit measurement.

QTuA2 • 11:00 a.m. Invited
Phase Transitions in the Statistics of Bipartite Entanglement, *Antonello Scardicchio; Princeton Univ., USA.* We study a random matrix model for the statistics of bipartite entanglement. We find two phase transitions, characterized by different Schmidt spectra. One critical phase is described by a theory of random surfaces.

QTuA3 • 11:30 a.m. Invited
Single Atom – Single Photon Interfaces, *F. Rohde, C. Schuck, M. Hennrich, M. Almendros, A. Haase, N. Piro, F. Dubin, M. Mitchell, R. Gehr, Juergen Eschner; ICFO - Inst. of Photonic Sciences, Spain.* In an experimental system of two distant ion traps we trap simultaneously strings of Ca^{+} ions and observe Hong-Ou-Mandel interference between their scattered photons. We also generate entangled photon pairs whose frequency and bandwidth are matched to an absorption line in the ions, and work towards heralded single photon – single ion interaction.

QTuA4 • 12:00 p.m.
Transforming Entanglement without Communication, *Bing He, János Bergou; Dept. of Physics and Astronomy, Hunter College, CUNY, USA.* We present a local unitary operation strategy to realize the transformations between bi-partite entangled pure states without any communication between the sharing parties. It also saves the interaction with an ancilla in implementing the transformations.

QTuA5 • 12:15 p.m.
Entanglement on Demand through Time Reordering, *Joseph E. Avron[1], Gili Bisker[1], David Gershoni[1], Netanel H. Lindner[1], Eli A. Meirom[1], Richard J. Warburton[2]; [1]Dept. of Physics, Technion-Israel Inst. of Technology, Israel, [2]School of Engineering and Physical Sciences, Heriot-Watt Univ., UK.* Entangled photons can be generated on demand in a novel scheme involving unitary time reordering of the photons emitted in a radiative decay. This scheme can be applied to the biexciton cascade in quantum dots.

12:30 p.m.–2:00 p.m.
Lunch Break

QTuB • Quantum Imaging and Emerging Topics

Salons H–J
2:00 p.m.–4:00 p.m.
QTuB • Quantum Imaging and Emerging Topics
Wolfgang Schleich; Dept. of Quantum Physics, Univ. of Ulm, Germany, Presider

QTuB1 • 2:00 p.m. Invited
The Physics of Ghost Imaging, *Yanhua Shih; Univ. of Maryland, Baltimore County, USA.* Two types of ghost imaging have been experimentally demonstrated since 1995. Type-one ghost imaging uses entangled photon pairs and type-two ghost imaging uses chaotic light. This talk will explore and analyze the quantum nature of both type-one and type-two ghost imaging.

QTuB2 • 2:30 p.m.
X-Entanglement of PDC Photon Pairs, *Alessandra Gatti, Lucia Caspani, Enrico Brambilla, Ottavia Jedrkiewicz, Luigi A. Lugiato;*

Inst. Natl. per la Fisica della Materia, Consiglio Natl. delle Ricerche, CNISM and Dept. di Fisica e Matematica, Univ. dell'Insubria, Italy. The X-wave picture is adopted to describe the spatio-temporal entanglement of PDC photons. Key elements of novelty are the non-factorability of the state and the extreme relative localization of photons in space and time.

QTuB3 • 2:45 p.m.
Single Photon Image Discrimination, *Curtis J. Broadbent[1], John C. Howell[1], Heedeuk Shin[2], Petros Zerom[2], Robert W. Boyd[2]; [1]Dept. of Physics and Astronomy, Univ. of Rochester, USA, [2]Inst. of Optics, Univ. of Rochester, USA.* We present experimental results demonstrating image discrimination with a single photon. A multiplexed hologram is used to distinguish between two single photon images with a confidence of greater than 93.4% without requiring an ensemble.

QTuB4 • 3:00 p.m.
Resonant Interferometric Lithography beyond the Diffraction Limit, *Jörg Evers[1], Martin Kiffner[1], M. Suhail Zubairy[1,2]; [1]Max-Planck-Inst. für Kernphysik, Germany, [2]Texas A&M Univ. at Qatar, Qatar.* We discuss interferometric optical subwavelength lithography using resonant light-matter interactions only. As compared to previous schemes, no multiphoton processes are required, such that the scheme works at low light intensities.

QTuB5 • 3:15 p.m.
Quantum Imaging with Single Photon Sources, *Joachim von Zanthier[1], Christoph Thiel[1], Thierry Bastin[2], Girish S. Agarwal[3]; [1]Inst. for Optics, Information and Photonics, Univ. of Erlangen-Nuremberg, Germany, [2]Inst. de Physique Nucléaire, Atomique et de Spectroscopie, Univ. de Liège au Sart Tilman, Belgium, [3]Dept. of Physics, Oklahoma State Univ., USA.* We propose to employ photons emitted from single photon sources to image a physical object of sub-wavelength size with 100% contrast by making use of joint detection probabilities.

QTuB6 • 3:30 p.m.
Quantum Illumination: Enhanced Background-Limited Target Detection by Means of Entanglement, *Si-Hui Tan[1], Baris I. Erkmen[1], Vittorio Giovannetti[2], Saikat Guha[1], Seth Lloyd[1], Lorenzo Maccone[3], Jeffrey H. Shapiro[1]; [1]MIT, USA, [2]Scuola Normale Superiore, Italy, [3]Univ. degli Studi di Pavia, Italy.* Use of an entangled-state transmitter is shown to provide a significant performance advantage—in comparison to a coherent-state transmitter—in background-limited target detection, even though the received state is not entangled.

QTuB7 • 3:45 p.m.
Individual Addressing of Trapped Ions and Coupling of Motional and Spin States Using rf Radiation, *M. Johanning[1], A. Braun[1], N. Timoney[1], V. Elman[1], W. Neuhauser[2], Chr. Wunderlich[1]; [1]Univ. of Siegen, Germany, [2]Univ. of Hamburg, Germany.* Two essential steps towards a novel concept for quantum information science—an ion spin molecule—are demonstrated for the first time: Individual rf-addressing of trapped ions and spin-motion interaction induced by an rf-field.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

QTuC • Decoherence and Algorithms

Salons H–J
4:30 p.m.–6:30 p.m.
QTuC • Decoherence and Algorithms
Zdenek Hradil; Dept. of Optics, Palacky Univ., Czech Republic, Presider

QTuC1 • 4:30 p.m. Invited
Non-Markov Control of Quantum Thermodynamics in Multipartite Systems, *Gershon Kurizki; Dept. of Chemical Physics, Weizmann Inst. of Science, Israel.* We predict drastic deviations from ordinary thermodynamic trends, which are monotonic approach to thermal equilibrium and positive entropy production, when qubits coupled to bosonic baths are probed on non-Markovian time scales by quantum nondemolition measurements.

QTuC2 • 5:00 p.m.
Controlled Dephasing of a Quantum Dot Resonance, *Daniel Rohrlich[1], Oren Zarchin[2], Moty Heiblum[2], Diana Mahalu[2], Vladimir Umansky[2]; [1]Dept. of Physics, Ben Gurion Univ., Israel, [2]Dept. of Condensed Matter Physics, Weizmann Inst. of Science, Israel.* We couple electrons passing through a two-slit interferometer to electrons tunneling through a Fabry-Perot interferometer (a quantum dot) at resonance, and demonstrate that the mutual detection of these interferometer currents dephases and suppresses the resonance.

QTuC3 • 5:15 p.m. Invited
Factorization of Numbers and Gauss Sums, *Wolfgang Schleich; Dept. of Quantum Physics, Univ. of Ulm, Germany.* Gauss sums play an important role in number theory as well as quantum physics. We present schemes based on Gauss sums to factor large numbers. We review recent experiments and discuss possible extension using entanglement.

QTuC4 • 5:45 p.m. Invited
Quantum Walks–Types and Properties, *Igor Jex[1], Martin Stefanak[1], Tamas Kiss[2]; [1]Czech Technical Univ., Czech Republic, [2]RISPO Hungarian Acad. of Sciences, Hungary.* We review properties of quantum walks with one and two excitations. The Polya number concept is applied to quantum walks and used for their classification. Quantum walks with random

errors leading to localization are discussed.

QTuC5 • 6:15 p.m.
Quantum Walks on Highly Symmetric Graphs, *Mark Hillery; Dept. of Physics, Hunter College, CUNY, USA.* We study discrete-time quantum walks on the complete and bipartite graphs, and show how they can be used to perform searches. The symmetry of the graphs significantly reduces the dimension of the problem.

Salon F
6:30 p.m.–8:00 p.m.
Conference Reception

NOTES

• Wednesday, July 16 •

Atrium Foyer
7:30 a.m.–5:00 p.m.
Registration Open

QWA • Entanglement IV

Salons H–J
8:00 a.m.–10:00 a.m.
QWA • Entanglement IV
Alessandra Gatti; CNR-CNISM and Univ. dell' Insubria, Italy, Presider

QWA1 • 8:00 a.m. Invited
A Universal Set of Quantum Gates on Trapped Ions in a Decoherence-Free Subspace, *Hartmut Häffner; Inst. für Quantenoptik und Quanteninformation, Austria.* Pairs of trapped ions can store quantum information four orders of magnitude longer than single ions. We will discuss the realization of a universal set of quantum gates acting on such a decoherence-free suspace.

QWA2 • 8:30 a.m. Invited
Probing Quantum Rules with Single-Photon Creation and Annihilation Operators, *Marco Bellini; Inst. Nazionale di Ottica Applicata and LENS/Univ. of Florence, Italy.* We experimentally apply simple sequences of photon creation and annihilation operators to a light field. By a tomographic analysis of the resulting light states we provide the first direct test of quantum non-commutativity.

QWA3 • 9:00 a.m. Invited
One-Way Quantum Computation with Two-Photon Multiqubit Cluster States, *Paolo Mataloni; Univ. degli Studi di Roma, Italy.* We demonstrate one-way quantum computation by using cluster states of two photons and four-qubits. General single qubit rotations, either probabilistic or deterministic, and efficient C-NOT and C-Phase gates have been realized by this technique.

QWA4 • 9:30 a.m.
Strongly Correlated Photon Transport in One-Dimensional Systems, *Jung-Tsung Shen, Shanhui Fan; Stanford Univ., USA.* We show that two-photon transport is strongly correlated in one-dimensional waveguide coupled to a two-level system. Moreover, we show that the two-level system can induce effective attractive or repulsive interactions in space for photons.

QWA5 • 9:45 a.m.
Delay of Quantum Correlations with an Atomic System, *Alberto M. Marino, Raphael C. Pooser, Vincent Boyer, Paul D. Lett; NIST, USA.* We use a four-wave mixing process in an atomic system to delay quantum correlations in twin beams. We have obtained a delay of 13 ns without a significant degradation of the intensity-difference squeezing.

Salon Foyer
10:00 p.m.–10:30 p.m.
Coffee Break

QWB • Optical and Other Implementations II, Quantum State Reconstruction, Storage I

Salons H–J
10:30 a.m.–12:30 p.m.
QWB • Optical and Other Implementations II, Quantum State Reconstruction, Storage I
Yanhua Shih; Univ. of Maryland, Baltimore County, USA, Presider

QWB1 • 10:30 a.m. Invited
Tomography for Quantum Diagnostics, *Zdenek Hradil[1], Jaroslav Rehacek[1], Dmitri Mogilevtsev[2]; [1]Palacky Univ. Olomouc, Czech Republic, [2]Inst. of Physics, Belarus.* We introduce a resolution measure, which provides error bars for any quantity inferred from tomographic measurement. Method is illustrated with the diagnostics of non-classical behavior using homodyne tomography and Wigner function at the origin.

QWB2 • 11:00 a.m.
Experimental Quantum State Tomography in Mutually Unbiased Bases, *Robert B. A. Adamson, Aephraim M. Steinberg; Dept of Physics, Univ. of Toronto, Canada.* We present the first experiment in two-qubit quantum state tomography to take advantage of mutually unbiased bases. Measuring in these bases extracts the maximum information from a fixed number of copies of the state.

QWB3 • 11:15 a.m.
Experimental Quantum State Tomography of a Solid-State Qubit, *Andreas Walther, Lars Rippe, Brian Julsgaard, Stefan Kröll; Dept. of Physics, Lund Inst. of Technology, Sweden.* An ensemble of Pr^{3+} ions is prepared inside a zero-absorption spectral hole, to act as a qubit. Quantum state tomography with robust pulses, to compensate for inhomogeneities, is demonstrated with >90% fidelity.

QWB4 • 11:30 a.m.
Holey Fiber Microcavities, *Scott M. Hendrickson, Todd B. Pittman, James D. Franson; Physics Dept., Univ. of Maryland, Baltimore County, USA.* Microcavities have been formed by placing mirrors on the ends of a short section of holey fiber. The resonant behavior of these devices was analyzed and their suitability for use in nonlinear-optics experiments was evaluated.

QWB5 • 11:45 a.m.
Quantum Information Processing with Optical Fibers, *Jeremie Fulconis[1], Alexander Clark[1], Matthaeus Halder[1], Jeremy L. O'Brien[1], John G. Rarity[1], Chunle Xiong[2], William J. Wadsworth[2]; [1]Univ. of Bristol, UK, [2]Univ. of Bath, UK.* We demonstrate a fiber implementation of a Controlled-NOT gate using a fiber source of heralded single photons and three partially polarising couplers. We also investigate a new phase-matching scheme for pure state single photon generation.

QWB6 • 12:00 p.m.
Photon-Hole Nondemolition Measurement by Quantum Interference, *Alex Hayat, Pavel Ginzburg, David Neiman, Serge Rosenblum, Meir Orenstein; Dept. of Electrical Engineering, Technion-Israel Inst. of Technology, Israel.* We propose a quantum nondemolition measurement of photon-holes by electromagnetically-induced transparency schemes. Upon photon-hole arrival the destructive interference of electron transition amplitudes is destroyed, resulting in absorption of a drive photon, preserving the photon-hole state.

QWB7 • 12:15 p.m.
Deterministic Spin Entangler and Photon Entangler Using a Charged Quantum Dot in a Microcavity, *C. Y. Hu[1], W. J. Munro[2], A. Young[1], J. L. O'Brien[1], J. G. Rarity[1]; [1]Univ. of Bristol, UK, [2]Hewlett-Packard Labs, UK.* We present a deterministic photon-spin entangling gate using a charged quantum dot in a microcavity. This gate can be used for quantum non-demolition measurement of spin, spin entanglement, photon entanglement and as photon-spin quantum interface.

12:30 p.m.–2:00 p.m.
Lunch Break

QWC • Quantum Communication

Salons H–J
2:00 p.m.–4:00 p.m.
QWC • Quantum Communication
Mark Hillery; CUNY Hunter College, USA, Presider

QWC1 • 2:00 p.m. Invited
An Exponential Separation between the Entanglement and Communication Capacities of a Bipartite Unitary Interaction, *Debbie Leung; Univ. of Waterloo, Canada.* We consider asymptotic capacities of bipartite unitary gates. We present a gate with exponentially larger entanglement capacity than the total communication capacity. The key tool is a communication-efficient method to identify a bipartite quantum state.

QWC2 • 2:30 p.m. Invited
Unambiguous Preparation of Non-Orthogonal Quantum States, *Fabian Torres-Ruiz[1], José Aguirre[1], Aldo Delgado[1], G. Lima[1], Sebastiao Pádua[1,2], Luis Roa[1], Carlos Saavedra[1]; [1]Dept. de Física, Univ. de Concepción, Chile, [2]Dept. de Física, Univ. Federal de Minas Gerais, Brazil.* A probabilistic method for the unambiguous preparation of non-orthogonal polarization states is proposed. We show experimentally how this protocol is implemented by using two-photon states generated in the process of down conversion.

QWC3 • 3:00 p.m.
Experimental Restoration of Entanglement on an Entanglement Breaking Quantum Channel, *Fabio Sciarrino[1,2], Eleonora Nagali[1], Francesco De Martini[1,3], Radim Filip[4], Miroslav Gavenda[4]; [1]Univ. di Roma, Italy, [2]Ctr. di Studi e Richerche "Enrico Fermi," Italy, [3]Accademia Natl. dei Lincei, Italy, [4]Dept. of Optics, Palacky Univ., Czech Republic.* A new method revealing entanglement from a single photon entanglement breaking channel is proposed and experimentally verified. Via detection of noise leaving channel, the entanglement can be restored and further enhanced by single-copy entanglement filtration.

QWC4 • 3:15 p.m.
Spectrally Bright and Broad Fiber-Based Heralded Single-Photon Source, *Elizabeth A. Goldschmidt, Matthew D. Eisaman, Jingyun Fan, Sergey V. Polyakov, Jun Chen, Alan Migdall; NIST, USA.* We report the development of a spectrally bright and broad heralded single-photon source based on spontaneous four-wave-mixing in a single-mode fiber, measuring the second-order correlation function, $g^{(2)}(0)$, far below unity over a broad spectral range.

QWC5 • 3:30 p.m.
Space-to-Ground Single-Photon Link for the Realization of a Space Quantum Channel, *Paolo Villoresi[1], Thomas Jennewein[2], Fabrizio Tamburini[3], Markus Aspelmeyer[2,4], Cristian Bonato[1], Rupert Ursin[4], Claudio Pernechele[5], V. Luceri[6], Giuseppe Bianco[7], Anton Zeilinger[2,4], Cesare Barbieri[3]; [1]Dept. of Information Engineering, Univ. of Padova and Lab for Ultraviolet and X-Ray Optical Res., Inst. Natl. per la Fisica della Materia, Consiglio Natl. delle Ricerche, Italy, [2]Inst. for Quantum Optics and Quantum Information (IQOQI), Austrian Acad. of Sciences, Austria, [3]Dept. of Astronomy, Univ. of Padova, Italy, [4]Faculty of Physics, Inst. for Experimental Physics, Univ. of Vienna, Austria, [5]Inst. Natl. di Astrofisica-Cagliari, Italy, [6]e-GEOS S.p.A, Ctr. di Geodesia Spaziale "G. Colombo," Italy, [7]Ctr. di Geodesia Spaziale "G. Colombo," Agenzia Spaziale Italiana, Italy.* We present the experimental study of a quantum-channel between an orbiting source and a ground receiver. Different geodynamic satellites were used as a single-photon-source, obtaining an effective link with Ajisai at the distance of 1650-km.

QWC6 • 3:45 p.m.
Optimal Individual Attacks Against BB84, *Raul Garcia-Patron, Franco N. C. Wong, Jeffrey H. Shapiro; Res. Lab of Electronics, MIT, USA.* An economical version of asymmetric phase-covariant cloning is shown to provide an optimal

individual attack on the BB84 protocol with error correction that can be physically simulated using deterministic single-photon two-qubit quantum logic.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

QWD • Metrology, Storage II and Transfer of Quantum Information; Emerging Topics

Salons H–J
4:30 p.m.–6:30 p.m.
QWD • Metrology, Storage II and Transfer of Quantum Information; Emerging Topics
William K. Wootters; Williams College, USA, Presider

QWD1 • 4:30 p.m. Invited
Partial Measurement Based Quantum Operations, *Gerd Leuchs; Inst. für Optik, Information und Photonik, Germany.* Partial measurements play an important role in several quantum information protocols with discrete and continuous variables such as state generation and cloning. Here we report on distillation of entanglement in the presence of non-Gaussian noise.

QWD2 • 5:00 p.m. Invited
Electromagnetically-Induced Transparency with Squeezed Light, *Alexander Lvovsky; Univ. of Calgary, Canada.* We investigate propagation and storage of pulses of squeezed vacuum in rubidium vapor under the conditions of electromagnetically-induced transparency. Quantum states of retrieved pulses are characterized by optical homodyne tomography.

QWD3 • 5:30 p.m. Invited
Quantum Computing and Its Applications to Hybrid Quantum Repeaters, *Kae Nemoto; Natl. Inst. of Informatics, Japan.* Qubus computation is a type of quantum information processing where qubits couple through quantum bus (qubus). Exploring its hybrid and distributed nature, we investigate the characteristics of a quantum repeater protocol of the qubus type.

QWD4 • 6:00 p.m.
Where Is the Quantum Particle between Two Position Measurements? *Lev Vaidman; Physics Dept., Tel Aviv Univ., Israel.* A controversy about counterfactual computation reveals a paradoxical feature of a pre- and post-selected quantum particle: it can reach a certain location without being on the path that leads to and from this location.

QWD5 • 6:15 p.m.
Experimental Optomechanics with Single and Twin Moving Mirrors, *Pierre-Francois Cohadon, Chiara Molinelli, Pierre Verlot, Aurélien Kuhn, Tristan Briant, Antoine Heidmann; Lab Kastler Brossel, Univ. Pierre et Marie Curie, France.* We present experiments where the motion of micro-mirrors is optically monitored with a quantum-limited sensitivity. Direct effects of radiation pressure on single and twin-mirror cavities are experimentally demonstrated. Applications to quantum optics are discussed.

Slow and Fast Light (SL)

Abstracts

• Sunday, July 13 •

Atrium Foyer
4:00 p.m.–6:00 p.m.
Registration Open

• Monday, July 14 •

Atrium Foyer
7:00 a.m.–6:00 p.m.
Registration Open

JMA • Joint Plenary Session I

Salon E
8:00 a.m.–10:00 a.m.
JMA • Joint Plenary Session I

8:00 a.m.
Opening Remarks, *Conference Chairs (COTA, Slow Light, and ICQI).*

8:15 a.m.
ICQI Plenary
Photonic Entanglement in Quantum Communication and Quantum Computation, *Anton Zeilinger; Univ. Wien, Austria.*

9:00 a.m.
Opening Remarks, *Conference Chair (IPNRA).*

9:05 a.m.
IPNRA Plenary
The Intimate Merger of Photonics and Computing, *Ashok V. Krishnamoorthy, SUN Microsystems, USA.*

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

SMA • EIT and Quantum Information

Salon G
10:30 a.m.–12:30 p.m.
SMA • EIT and Quantum Information
Lene Vestergaard Hau; Harvard Univ., USA, Presider

SMA1 • 10:30 a.m. Invited
Title to Be Announced, *Peter Knight; Imperial College, UK.* No abstract available.

SMA2 • 11:00 a.m. Invited
Stationary Light and Bose-Einstein Condensation of Slow-Light Polaritons, *Michael Fleischhauer; Univ. of Kaiserslautern, Germany.* Stationary light with 3-D confinement based on EIT is discussed and Bose condensation of the associated quasiparticles at large temperatures is proposed. Incoherent generation, thermalization and detection methods for the condensate are analyzed.

SMA3 • 11:30 a.m.
Slow Light with Fourth Order Fields, *Curtis J. Broadbent, Praveen K. Vudyasetu, Ryan M. Camacho, Ran Xin, John C. Howell; Univ. of Rochester, USA.* We demonstrate experimentally the preservation of entanglement between delayed and non-delayed members of energy-time entangled biphotons, as well as the preservation of fourth order temporal coherence of thermal light with a delayed version of itself.

SMA4 • 11:45 a.m.
Electromagnetically Induced Transparency (EIT) and Slow Light in a ^{4}He* Hot Atomic Vapor, *Fabienne Goldfarb[1], Joyee Ghosh[1,2], Martin David[1], Jerome Ruggiero[1], Thierry Chaneliere[1], Jean-Louis Le Gouet[1], Herve Gilles[3], Rupamanjari Ghosh[2], Fabien Bretenaker[1]; [1]Lab Aime Cotton, Ctr. Natl. de la Res. Scientifique, France, [2]Jawaharlal Nehru Univ., India, [3]Ctr. de Res. sur les Ions, les Materiaux et la Photonique, France.* EIT and light velocities as low as 7000 m.s^{-1} were observed at 1.083 μm using a ^{4}He* cell at room temperature. The 1 GHz Doppler broadening opens the door to broadband radar applications.

SMA5 • 12:00 p.m.
Observation of Electromagnetically Induced Transparency in a Quantum Dot Ensemble, *Saulius Marcinkevicius[1], Aleksander Gushterov[2], Johann P. Reithmaier[2]; [1]Royal Inst. of Technology, Sweden, [2]Kassel Univ., Germany.* Electromagnetically induced transparency (EIT) based on exciton spin transitions is observed in InGaAs quantum dots. Inhomogeneous broadening of the quantum dot ensemble, detrimental for EIT, is effectively reduced by using spectrally narrow pulses.

SMA6 • 12:15 p.m.
Manipulate Retrieval of Stored Light Pulses, *Yong-Fan Chen[1], Ite A. Yu[2]; [1]Dept. of Physics, Natl. Cheng Kung Univ., Taiwan, [2]Dept. of Physics, Natl. Tsing Hua Univ., Taiwan.* We have experimentally demonstrated that the width, frequency, and polarization of stored light pulses can be manipulated by controlling the retrieval process. The manipulation of stored light pulses may facilitate the application of optical communications.

12:30 p.m.–2:00 p.m.
Lunch Break

SMB • Metamaterials

Salon G
2:00 p.m.–4:00 p.m.
SMB • Metamaterials
Shanhui Fan; Stanford Univ., USA, Presider

SMB1 • 2:00 p.m. **Invited**
Optical Cloaking and "Fast Light," *Vladimir M. Shalaev, W. Cai, U. Chettiar, A. V. Kildishev; Purdue Univ., USA.* Recent advances in metamaterial research have provided us with a blueprint for cloaking capabilities. We analyze practical designs to convert concepts into real-life devices along with limitations to cloaking and its relation to "fast light."

SMB2 • 2:30 p.m. **Invited**
Plasmon Assisted Transparency in Metallodielectric Resonators, *Miriam Deutsch; Univ. of Oregon, USA.* We present a theoretical study of light scattering in spherical metallodielectric multi-layered particles and their ordered assemblies. A tunable electromagnetic transparency and possible left-handed optical response are discussed.

SMB3 • 3:00 p.m.
Stopped Light in Negative-Index Metamaterial Heterostructures, *Kosmas L. Tsakmakidis, Ortwin Hess; Advanced Technology Inst. and Dept. of Physics, Faculty of Engineering and Physical Sciences, Univ. of Surrey, UK.* Lightwaves guided along an adiabatically tapered negative-index heterostructure can efficiently be brought to a complete halt. We prove this conclusion by means of, both, full-wave and pertinent ray-tracing analyses.

SMB4 • 3:15 p.m.
Slow Surface Plasmons, *Eric R. Eliel, Nikolay V. Kuzmin, Barry J.G. van der Meer, Anna L. Tchebotareva, Gert W. 't Hooft; Leiden Univ., Netherlands.* We have studied surface plasmons propagating along a smooth silver-glass interface at energies up to 2.6 eV. These short-wavelength plasmons, with an effective wavelength of 260 nm, travel at a group velocity equal to c/3.

SMB5 • 3:30 p.m.
Slow Light in "Zero Thickness" Metamaterials, *Nikitas Papasimakis[1], Vassili A. Fedotov[1], Sergey L. Prosvirnin[2], Nikolay I. Zheludev[1]; [1]Optoelectronics Res. Ctr., Univ. of Southampton, United Kingdom, [2]Inst. of Radio Astronomy, Natl. Acad. of Sciences of Ukraine, Ukraine.* We show for the first time that a classical analogue of EIT can be realized in "zero thickness" planar metamaterials (meta-surfaces) resulting in substantial delay of propagating electromagnetic pulses.

SMB6 • 3:45 p.m.
Split Band Edge Structures and Negative Index, *John O. Schenk[1], Robert P. Ingel[1], Michael A. Fiddy[1], Weiguo Yang[2]; [1]Univ. of North Carolina at Charlotte, USA, [2]Western Carolina Univ., USA.* Highly anisotropic periodic waveguide structures show gigantic field enhancements near a split band-edge due to low group velocities. An effective negative index regime is observed, leading to strong but localized field emission around the waveguide.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

SMC • Applications in Optical Communications

Salon G
4:30 p.m.–6:30 p.m.
SMC • Applications in Optical Communications
Moshe Tur; Tel-Aviv Univ., Israel, Presider

SMC1 • 4:30 p.m. **Invited**
High-Performance Gbit/s Data Transmission through Slow Light Elements, *Alan E. Willner; Univ. of Southern California, USA.* This paper will highlight various systems issues that relate to transmitting high-speed data through slow-light delay elements, such as: (i) data-pattern-dependent penalties, (ii) PSK and QPSK data signals, and (iii) synchronization and multiplexing.

SMC2 • 5:00 p.m. **Invited**
How to Build an Optical Buffer for IP Packets, *Rodney S. Tucker; Univ. of Melbourne, Australia.* We describe the design of Internet Protocol (IP) buffers for optical packet switches. We show that slow light delay lines and ring resonator arrays show potential, but a number of key challenges remain.

SMC3 • 5:30 p.m.
Large Multi Gbit/s Delays Generated in an All-Optical Tunable Delay Line Preserving Wavelength and Signal Bandwidth, *Sanghoon Chin, Luc Thévenaz; Ecole Polytechnique Fédéral de Lausanne, Switzerland.* Large all-optical tunable delays are generated in a dispersive fiber by double wavelength conversion through cross gain modulation in semiconductor optical amplifiers. A 156 ps pulse train is continuously delayed up to 14 ns.

SMC4 • 5:45 p.m.
All-Optical Tunable Delay Line Based on Soliton Self-Frequency Shift for 10 Gbit/s Data Modulated RZ Pulses with the Assist of Pulse Compression, *Tomochika Kanou, Takashi Kunihiro, Akihiro Maruta; Osaka Univ., Japan.* We propose a novel all-optical tunable delay line based on soliton self-frequency shift for 10 Gbit/s data modulated RZ

pulses with the assist of pulse compression and experimentally demonstrate the error free operation.

SMC5 • 6:00 p.m.
Performance of a Silicon-Microring Slow-Light Delay Line for Advanced Modulation Formats, *Qiang Li[1], Fangfei Liu[1], Ziyang Zhang[2], Min Qiu[2], Tong Ye[1], Yikai Su[1]; [1]Shanghai Jiao Tong Univ., China, [2]Royal Inst. of Technology, Sweden.* We experimentally demonstrate a delay line in silicon microring resonator with a 20-μm radius. The delay performances of six advanced modulation formats are investigated, including NRZ, RZ, DPSK, CSRZ, RZ-DB and RZ-AMI.

SMC6 • 6:15 p.m.
Simulation of Sub-Wavelength Metal Gratings for On-Chip Applications in Optical Communications, *Erica D. Lively, Daniel J. Blumenthal; Univ. of California at Santa Barbara, USA.* Finite-difference time-domain (FDTD) and finite element method (FEM) techniques are used to demonstrate the potential of integrating sub-wavelength metal gratings onto an InP based material platform. Dispersion relations and pulse propagation are simulated.

JMB • Joint Poster Session

Salon F
6:30 p.m.–8:00 p.m.
JMB • Joint Poster Session

JMB10
Enhancement of Brillouin Slow-Light in Optical Fibers through Optical Pulse Shaping, *Sanghoon Chin, Luc Thévenaz; Ecole Polytechnique Fédéral de Lausanne, Switzerland.* The impact of pulse shape is studied in order to enhance time delaying in Brillouin slow-light. An exponential-like pulse with 14-ns FWHM duration is delayed up to 31-ns in a 27 MHz wide Brillouin resonance.

JMB11
Experimental Observation of Pulse Delay and Speed-up in Cascaded Quantum Well Gain and Absorber Media, *Per L. Hansen, Mike V. D. Poel, Kresten Yvind, Jesper Mørk; Technical Univ. of Denmark, Denmark.* Slow-down and speed-up of 180 fs pulses in semiconductor waveguides beyond the existing models is observed. Cascaded gain and absorbing sections is shown to provide significant temporal pulse shifting at near constant output pulse energy.

JMB12
Chirp Dependence of Filter Assisted Slow and Fast Light Effects in Semiconductor Optical Amplifiers, *Weiqi Xue[1], Yaohui Chen[1], Filip Öhman[1], Salvador Sales[2], Jesper Mørk[1]; [1]Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark, [2]Inst. of Telecommunications and Multimedia Applications, Univ. Politécnica de Valencia, Spain.* We demonstrate that the initial optical phase difference between the carrier and sidebands will strongly influence the final RF phase shift induced by filter assisted slow and fast light effects in semiconductor optical amplifiers.

JMB13
Comparison of EIT Schemes in Semiconductor Quantum Dots, *Jakob Houmark[1], Torben R. Nielsen[2], Jesper Mørk[2], Antti-Pekka Jauho[1]; [1]Dept. of Micro- and Nanotechnology, Technical Univ. of Denmark, Denmark, [2]Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark.* We compare the slowdown capabilities of different EIT schemes in a transient regime using a many-body approach. The V scheme is preferable as it requires the lowest pump power to achieve reasonable slowdown factors.

JMB14
Semi-Analytical Model of Filtering Effects in Microwave Phase Shifters Based on Semiconductor Optical Amplifiers, *Yaohui Chen, Weiqi Xue, Filip Öhman, Jesper Mørk; DTU Fotonik, Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark.* We present a model to interpret enhanced microwave phase shifts based on filter assisted slow and fast light effects in semiconductor optical amplifiers. The model also demonstrates the spectral phase impact of input optical signals.

JMB15
Electromagnetically-Induced-Transparency Effect in a V-Type Medium Controlled by an Incoherent Pumping Field, *Wenzhuo Tang, Luming Li, Hong Guo; Peking Univ., China.* The electromagnetically induced transparency effect in a V-type medium controlled by an incoherent pumping field is studied both experimentally and theoretically, which shows that different propagation directions have absolutely opposite effect.

JMB16
Fractional Advancement Enhancement in Erbium-Doped Fiber Amplifiers by Bi-Directional Pumping, *Jose Miguel Ezquerro, Sonia Melle, Oscar G. Calderón, Fernando Carreño, Miguel A. Antón; Univ. Complutense de Madrid, Spain.* We experimentally analyze the fractional advancement of amplitude-modulated 1550 nm signals when propagating through highly-doped erbium fibers pumped at 980 nm in different pump configurations.

JMB17
Controlling the Photonic Band Structure of Driven Color Centers in Diamond, *Jin Hui Wu[1], Giuseppe C. La Rocca[2], Maurizio Artoni[3]; [1]College of Physics, Jilin Univ., China, [2]Scuola Normale Superiore, Italy, [3]European Lab for Nonlinear Spectroscopy and Dept. of Physics and Chemistry of Materials, Brescia Univ., Italy.* Inhomogeneously broadened optical transitions of nitrogen-vacancy centers in diamond may be

employed to attain fully developed photonic band-gap structures. Reflectivities very close to unity and sufficiently large bandwidths may be observed for realistic parameters.

JMB18
Slow Higher-Order Optical Soliton in a Resonance Photonic Crystal with Self-Engineered Defect, *Igor V. Mel'nikov[1], Anton N. Knigavko[2]; [1]Optolink Ltd, Russian Federation, [2]High Q Labs, Inc, Canada.* We demonstrate previously unforeseen properties of stable propagation and trapping of a higher-order solitons of self-induced transparency which can be mediated by a superradiance decay inside the resonance photonic crystal.

JMB19
Magnetically Induced Reduction of Energy Transport Velocity in Magnetic Colloids, *Rajesh J. Patel, Bhupendra N. Chudasama, Nidhi M. Andhariya, R. V. Upadhyay, R. V. Mehta; Bhavnagar Univ., India.* Magnetically induced modulation of refractive index and Mie resonance is employed to reduce energy transport velocity of incident polarized light in magnetic colloids. At a critical field complete halt of light is observed.

JMB20
Electromagnetically Induced Transparency with a Standing Drive Field in Rubidium D2 Line, *XiaoGang Wei, Yi Chen, KiYoung Cho, ByoungSeung Ham; Inha Univ., Republic of Korea.* We studied electromagnetically induced transparency in a Rubidium D2 line with standing coupling fields and demonstrated absorption grating control for both real levels and crossover virtual levels.

JMB21
The Excitation Trapping in a Symmetrically Pumped DFB Fiber Laser with a Variable Phase Shift, *Igor V. Mel'nikov[1], Alexander V. Kir'yanov[1], M. V. Andrés[1], Anton Knigavko[2]; [1]Optolink Ltd, Russian Federation, [2]High Q Labs, Inc, Canada.* We study, both theoretically and experimentally, the generation dynamics and light trapping in a distributed feedback fiber (DFB) laser that is due to the phase shift introduced into the fiber Bragg grating structure.

JMB22
N Type Atomic System in Hot Rubidium D2 Line, *Yi Chen, XiaoGang Wei, KiYoung Cho, ByoungSeung Ham; Inha Univ., Republic of Korea.* We studied all four possible N-configuration schemes in hot Rubidium 87 D2 line, by using a second coupling field to couple the ground state of the probe field with another excited state.

JMB23
Inversion of the Coupling Absorption at the Two-Photon Resonance in a Coupling-Probe-Spectroscopy Experiment, *Katrin Dahl[1,2], Luca Spani Molella[1,2], Rolf-Hermann Rinkleff[1,2], Karsten Danzmann[1,2]; [1]Albert Einstein Inst., Max Planck Inst. für Gravitationsphysik, Germany, [2]Inst. für Gravitationsphysik, Gottfried Wilhelm Leibniz Univ. Hannover, Germany.* Using probe and coupling lasers, a system characterized by electromagnetically induced absorption was investigated. A switch of the EIA peak of the coupling laser to a dip was measured as function of the laser intensities.

JMB24
Experimental Comparison between the Index of Refraction in Strongly Driven and Degenerate Two-Level Systems, *Rolf-Hermann Rinkleff[1,2], Luca Spani Molella[1,2], Alessandra Rocco[2], Andreas Wicht[2], Karsten Danzmann[1,2]; [1]Inst. für Gravitationsphysik, Leibniz Univ., Germany, [2]Albert Einstein Inst., Max Planck Inst. für Gravitationsphysik, Germany.* Negative dispersion and transparency in a strongly driven calcium two-level system and positive dispersion and transparency or anomalous dispersion and enhanced absorption in closed degenerate two-level systems in caesium have been observed using pump-probe spectroscopy.

JMB25
Investigation of Quantum Coherent Control of Pulse Propagation in a Cold Atomic Ensemble, *Yan Xue, Byoung Seung Ham; Ctr. for Photon Information Processing, Inha Univ., Republic of Korea.* We present numerical calculations of slow light propagation through a cold atomic ensemble and discuss the followings: Bragg reflection, four-wave mixing, and temporal pulse splitting.

JMB26
Study of Fiber Ring Parameters and Their Effect on SBS Based Slow Light in Fibers, *Chung Yu[1], Christopher K. Horne[1], YongKab Kim[2]; [1]North Carolina Agricultural and Technical State Univ., USA, [2]Wonkwang Univ., Republic of Korea.* The SBS based fiber ring with orders of magnitude enhanced gain and linewidth should be an ideal candidate as a fiber slow light device. We have conducted a study with attempts for optimum slow light.

JMB27
Chirped Quantum Cascade Laser Induced Transient Gain in Strongly Absorbing Molecular Gases, *Geoffrey Duxbury, Nigel Langford, Kenneth G. Hay; Dept. of Physics, Univ. of Strathclyde, UK.* Using a mW power chirped pulse quantum cascade laser propagating in a 60 m pathlength Herriott cell, delayed rapid passage and transient gain signals have been observed in the 8 micron spectrum of acetylene.

JMB28
Subluminal and Superluminal Propagation in Er^{3+} Doped Fiber Bragg Grating, *Z. C. Zhuo, Byoung S. Ham; Inha Univ., Republic of Korea.* We present a method to achieve subluminal/ superluminal propagation in optical fiber Bragg grating

written in Er^{3+} doped optical fiber. The group velocity with effects of modulation amplitude of the grating is discussed

JMB29
Slow Light in Distributed Feedback Laser for All-Optical Inverter, *P. C. Peng[1], F. M. Wu[1], W. J. Jiang[2], C. T. Lin[2], J. H. Chen[2], P. T. Shih[2], W. C. Kao[2], S. Chi[2,3]; [1]Natl. Chi Nan Univ., Taiwan, [2]Natl. Chiao Tung Univ., Taiwan, [3]Yuan Ze Univ., Taiwan.* This work experimentally demonstrates slow light in a distributed feedback laser for an all-optical inverter. The optical inverter operated with a binary phase-shift keying signal.

JMB30
Double Electromagnetically Induced Transparency Effect in Multi-Level Atomic Medium, *Xiao Li, Yu Liu, Bin Luo, Hong Guo; Peking Univ., China.* We report the progress in our research on the quantum coherence in multi-level atomic gases, especially the double electromagnetically induced transparency effect in four-level N-type and tripod-type atomic medium.

JMB31
Tunable Phase Control of Coherent Population Oscillations, *Francisco Arrieta-Yáñez, Oscar G. Calderón, Sonia Melle, Fernando Carreño, Miguel A. Antón; Univ. Complutense de Madrid, Spain.* We study the propagation of an amplitude modulated 1550-nm signal along an EDF pumped with an amplitude modulated 980-nm beam. A transition from super- to subluminal light depending on the phase between them is observed.

JMB32
Effect of Ion Pairs in Fast-Light Bandwidth in High-Concentration Erbium-Doped Fibers, *Oscar G. Calderón, Sonia Melle, Miguel A. Antón, Fernando Carreño; Univ. Complutense de Madrid, Spain.* The effect of ion pairs in high-concentration erbium doped fibers on slow and fast light propagation enabled by coherent population oscillations at room temperature has been experimentally investigated.

JMB33
Enhancement of Second-Order Nonlinearity and Slow-Light Generation in an Er-Doped Glass via Electromagnetically Induced Transparency, *Igor V. Mel'nikov[1], Anton N. Knigavko[2]; [1]Optolink Ltd, Russian Federation, [2]High Q Labs, Inc, Canada.* A combination of a four-level electromagnetically induced transparency and second-order nonlinearity is shown to enhance profoundly the efficiency of frequency conversion in an Er-doped glass owing to the pump-pulse slowing down.

JMB1-JMB9 can be found in the COTA abstracts.
JMB34-JMB41, JMB81 can be found in the IPNRA abstracts.
JMB42-JMB88 can be found in the ICQI abstracts.

• Tuesday, July 15 •

Atrium Foyer
7:30 a.m.–5:00 p.m.
Registration Open

JTuA • Joint Plenary Session II

Salon E
8:00 a.m.–10:00 a.m.
JTuA • Joint Plenary Session II

8:00 a.m.
Slow Light Plenary
Electro-Optic Modulation of Photons and Biphotons, *Stephen E. Harris; Stanford Univ., USA.*

8:40 a.m.
ICQI Plenary
Entanglement, Information Processing and Decoherence in Trapped Atomic Ions, *David J. Wineland; NIST, USA.*

9:20 a.m.
COTA Plenary
Coherence Cloning and Phase Controlled Apertures Using Optical Phase-Lock Loops, *Amnon Yariv; Caltech, USA.*

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

STuA • Semiconductor Structures and CPO Effects

Salon G
10:30 a.m.–12:30 p.m.
STuA • Semiconductor Structures and CPO Effects
Hailin Wang; Univ. of Oregon, USA, Presider

STuA1 • 10:30 a.m. Invited
Slow and Fast Light in THz Regime, *Forrest G. Sedgwick; Univ. of California at Berkeley, USA.* A chirp-and-compensate scheme is employed to increase the advance-bandwidth product of 400 fs pulses in a semiconductor optical amplifier as well as to realize tunable delay, producing a record temporal shift of 10.7 pulses.

STuA2 • 11:00 a.m. Invited
Mid-Infrared Semiconductor Metamaterials, *Claire Gmachl; Princeton Univ., USA.* We report on a new class of 3-D, thick, broadband, n^+-InGaAs/i-AlInAs semiconductor heterostructure metamaterials that employs a strongly anisotropic dielectric function to achieve negative refraction in the mid- and long-wave infrared region of the spectrum.

STuA3 • 11:30 a.m.
Pulse-Distortion Management Using the Pulse-on-Background Method and Multiple Closely Spaced Gain Lines in Slow/Fast Light Propagation, *Heedeuk Shin, Zhimin Shi, Aaron Schweinsberg, George Gehring, Robert W. Boyd; Insitute of Optics, Univ. of Rochester, USA.* We propose using the pulse-on-background method and multiple gain lines to reduce pulse distortion in slow/fast light pulse propagation based on CPO and linear resonance system, respectively. Both methods will be described in this work.

STuA4 • 11:45 a.m.
Electrically Tunable Fast Light of 86 fs Pulses in Semiconductor Optical Amplifiers, *Bala Pesala, Forrest G. Sedgwick, Wai Son Ko, Connie Chang-Hasnain; Univ. of California at Berkeley, USA.* Large tunable advance of 6.5 pulses is achieved for an 86 fs pulse using non-linear processes in SOAs. Pulse width dependence of fast light is studied by gradually increasing the width to 1 ps.

STuA5 • 12:00 p.m.
Experimental Demonstration of Strongly Enhanced Light Slow-Down in Semiconductor Optical Amplifiers by Optical Filtering, *Weiqi Xue[1], Filip Öhman[1], Yaohui Chen[1], Salvador Sales[2], Jesper Mørk[1]; [1]Dept. of Photonics Engineering,Technical Univ. of Denmark, Denmark, [2]Inst. of Telecommunications and Multimedia Applications, Univ. Politécnica de Valencia, Spain.* Optical filtering is shown to be a powerful way of increasing light-speed control in SOAs. More than 120 degrees microwave phase shift over a bandwidth close to 15GHz is achieved.

STuA6 • 12:15 p.m.
Slow and Fast Light in Liquid Crystal Light-Valves, *Umberto Bortolozzo[1], Stefania Residori[1], Jean-Pierre Huignard[2]; [1]Inst. Non Linéaire de Nice, Univ. de Nice Sophia-Antipolis, Ctr. Natl. de la Res. Scientifique, France, [2]Thales Res. and Technology, France.* We show that fast and slow-light result from non-degenerate two-wave mixing in a liquid crystal light-valve. The large response time of the liquid crystals allows obtaining group velocities as slow as 0.13 mm/s.

12:30 p.m.–2:00 p.m.
Lunch Break

STuB • Gratings and Coupled Resonators

Salon G
2:00 p.m.–4:00 p.m.
STuB • Gratings and Coupled Resonators
Michal Lipson; Cornell Univ., USA, Presider

STuB1 • 2:00 p.m. Invited
Grating Induced Transparency (GIT) and the Dark Mode in Optical Waveguides, *Amnon Yariv, Hsi-Chun Liu; Caltech,*

USA. We describe a new type of propagating optical mode in a bi-perodic wavegide. It possesses a Dark Mode in formal analogy to the Dark atomic state involved in EIT. It displays transparency and slow-light behavior free from the bandwidth-delay product constraint.

STuB2 • 2:30 p.m. Invited

1 Byte Reconfigurable Integrated Optic Delay Line, *Andrea Melloni; DEI, Italy.* We experimentally demonstrated a continuously variable delay from 0 to 8bits with ps resolution with 8 coupled resonators at 10 and 25Gbit/s. The on-chip footprint is 7mm^2 and the fractional loss is smaller than 1dB/bit.

STuB3 • 3:00 p.m.

Capturing Light Pulses Completely Using a Few Dynamic Microcavities, *Clayton R. Otey, M. L. Povinelli, Shanhui Fan; Stanford Univ., USA.* We use temporal coupled mode theory to describe a dynamic microcavity system capable of completely capturing light pulses in a pair of cavities with negligible reflection.

STuB4 • 3:15 p.m.

Phase-Disorder in Coupled-Resonator Optical Waveguides, *Carlo Ferrari, Francesco Morichetti, Andrea Melloni; Politecnico di Milano, Italy.* The effects of phase-disorder in coupled-ring-resonator optical waveguides are theoretically predicted and experimentally observed. The thermal control of the rings' resonances is exploited to measure the back-reflection of the structure for different disorder degrees.

STuB5 • 3:30 p.m.

Analysis of CROW, SCISSOR and REMZI Architectures in the Slow-Light Regime, *Vishnupriya Govindan, Steve Blair; Univ. of Utah, USA.* Under the constraint of fixed pulse distortion, REMZI architecture has the highest bandwidth-delay product compared to SCISSOR and CROW. Nonlinear response of CROW fails to improve with increasing number of resonators, but inter-pulse interaction decreases.

STuB6 • 3:45 p.m.

Control of the Group Velocity of Light in Erbium Doped Fibers Via the Modulation Frequency, *Sonia Melle, Oscar G. Calderón, Eduardo Cabrera-Granado, Miguel A. Antón, Fernando Carreño; Univ. Complutense de Madrid, Spain.* We report a change from sub- to super-luminal propagation solely upon increasing the modulation frequency of an amplitude-modulated 1550 nm signal when propagating through highly-doped erbium fibers pumped at 980 nm.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

STuC • Slow Light in Optical Fibers

Salon G
4:30 p.m.–6:30 p.m.
STuC • Slow Light in Optical Fibers
Jose Capmany; Univ. Politecnica de Valencia, Spain, Presider

STuC1 • 4:30 p.m. Invited

Slow Light Based on Stimulated Brillouin Scattering: New Possibilities and Open Questions, *Miguel Gonzalez-Herraez; Dept. of Electronics, Univ. of Alcala, Spain.* Slow light based on stimulated Brillouin scattering offers new capabilities that are unique to this interaction. These capabilities are reviewed, and the limits and potential applications of this technique are analyzed.

STuC2 • 5:00 p.m. Invited

Using Nonuniform Fiber to Generate Slow Light via Stimulated Brillouin Scattering, *Xiaoyi Bao; Univ. of Ottawa, Canada.* The pulse delay based on stimulated Brillouin scattering in a nonuniform dispersion decreasing fiber (DDF) is demonstrated. The pulse delay of more than one bit with small distortion is observed for 2ns pulse using DDF.

STuC3 • 5:30 p.m.

Observation of Large 8-Gb/s SBS Slow Light Delay with Low Distortion Using an Optimized Gain Profile, *Eduardo Cabrera Granado[1], Daniel J. Gauthier[1], Oscar G. Calderón[2], Sonia Melle[2]; [1]Duke Univ., USA, [2]Escuela Univ. de Óptica, Spain.* We obtain over 3 pulse widths SBS slow light delay for an input pulse width of 125 ps. By optimizing the gain profile, the output-to-input pulse width ratio is less than 2.

STuC4 • 5:45 p.m.

Delay Limits of SBS Based Slow Light, *Thomas Schneider, Ronny Henker, Kai-Uwe Lauterbach, Markus Junker; Hochschule für Telekommunikation, Leipzig, Germany.* We discuss the maximum time delay of slow light systems. As we will show, the maximum time delay can be enhanced from 2 to around 10 times if a gain is superimposed with two losses.

STuC5 • 6:00 p.m.

Self-Pumped Optical Delay Line Based on Brillouin Fast Light in Optical Fibers, *Luc Thevenaz, Sanghoon Chin; EPFL Swiss Federal Inst. of Technology, Switzerland.* An extremely simple technique is demonstrated to realize tunable delays in optical fibers controlled by the signal average power. The system self-adapts in real time to the Brillouin fiber properties and to the signal bandwidth.

STuC6 • 6:15 p.m.

Slow Light in Spun Fiber Optical Parametric Amplification, *Marco Santagiustina, Luca Schenato, Carlo G. Someda; Dept. of Information Engineering, Univ. of Padova, Italy.* The random birefringence mitigation effect in spun fibers is

theoretically and numerically studied for slow and fast light applications in narrow band optical parametric amplification. Enhanced performances are demonstrated and explained.

Salon F
6:30 p.m.–8:00 p.m.
Conference Reception

NOTES

• Wednesday, July 16 •

Atrium Foyer
7:30 a.m.–5:00 p.m.
Registration Open

SWA • Fundamental Limitations and New Applications

Salon G
8:00 a.m.–10:00 a.m.
SWA • Fundamental Limitations and New Applications
Shun L. Chuang; Univ. of Illinois, USA, Presider

SWA1 • 8:00 a.m. Invited
Loss, Noise, Power Dissipation: How They Affect Performance of Slow Light Devices, *Jacob B. Khurgin; Johns Hopkins Univ., USA.* Performance of diverse slow light schemes is analyzed from the vantage point of signal to noise ratio, dynamic range, and power dissipation. Applications that can be most positively affected by using slow light are identified.

SWA2 • 8:30 a.m. Invited
Fundamental Limits in Linear One-Dimensional Slow Light Structures, *David A. B. Miller; Stanford Univ., USA.* An upper limit can be deduced for the number of bits of delay, depending only on the materials used and independent of detailed design. The proof and applications of this limit will be discussed.

SWA3 • 9:00 a.m.
Enhancement of the Spectral Performance of Interferometers Using Slow Light under Practical Conditions, *Zhimin Shi, Robert W. Boyd; Inst. of Optics, Univ. of Rochester, USA.* We investigate how slow light can enhance the performance of various types of spectroscopic interferometers, and how the performance is influenced by the associated gain/absorption and by the group index dispersion of the slow-light medium.

SWA4 • 9:15 a.m.
Superluminal Pulse Propagation on a Silicon Chip, *Sasikanth Manipatruni, Po Dong, Qianfan Xu, Michal Lipson; Cornell Univ., USA.* We demonstrate superluminal pulse propagation on a silicon chip using an all-optical analog to electromagnetically induced absorption created by the coherent interaction between two micro-resonators. We show group indices tunable between -1158 and -312.

SWA5 • 9:30 a.m.
Information Theoretic Analysis of a Slow-Light Channel, *Mark A. Neifeld, Myungjun Lee; Univ. of Arizona, USA.* We present a new formalism for the analysis of a slow-light channel, which enables natural information-theoretic definitions for delay and capacity. We apply this formalism to a simple gain-based delay system.

SWA6 • 9:45 a.m.
Controlling Light Propagation via Radiation Pressure and Optomechanical Coupling, *Olivier Arcizet, Albert Schliesser, Tobias J. Kippenberg; Max Planck Inst. for Quantum Optics, Germany.* We experimentally demonstrate for the first time the possibility of controlling the propagation properties of a light pulse using cavity assisted radiation pressure coupling to mechanical modes. Both pulse delay and advancement are experimentally demonstrated.

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

SWB • Metamaterials and Photonic Crystals

Salon G
10:30 a.m.–12:30 p.m.
SWB • Metamaterials and Photonic Crystals
Luc Thevenaz; EPFL Swiss Federal Inst. of Technology, Switzerland, Presider

SWB1 • 10:30 a.m. Invited
Broad Bandwidth Slow Light, Enabled by Surface Plasmons and Polaritons, *Marin Soljacic; MIT, USA.* We discuss a few different slow light systems, enabled by polaritons and surface plasmons: slow light in resonant photonic crystals, and small modal area surface plasmon waveguides, with low group velocities over unusually large bandwidths.

SWB2 • 11:00 a.m. Invited
Slow Light in Photonic-Crystal Waveguides and Cavities, *Solomon Assefa, Fengnian Xia, William M. J. Green, Yurii Vlasov; IBM TJ Watson Res. Ctr., USA.* Coupling losses and high-order dispersion in the slow-light regime of photonic-crystal (PhC) waveguides are investigated by utilizing an integrated Mach-Zehnder interferometer. Furthermore, PhC cavities coupled to photonic-wires through surface-states are experimentally characterized.

SWB3 • 11:30 a.m.
Enhanced Slow Light in Quantum Dot Photonic Crystal Waveguides, *Torben R. Nielsen, Andrei Lavrinenko, Jesper Mørk; Dept. of Photonics Engineering, Technical Univ. of Denmark, Denmark.* We present a theoretical analysis of pulse propagation in a quantum dot semiconductor photonic crystal waveguide in the regime of electromagnetically induced transparency. The slow-down factor for the combined system is determined.

SWB4 • 11:45 a.m.
Negative Group Velocity: Is It a Negative Index Material or

Fast Light? *Eyal Feigenbaum, Noam Kaminski, Meir Orenstein; Technion, Israel.* When negative slop of the dispersion curve is encountered, the propagating light may be either "fast light" or "backward propagating." We show that the same photonic (plasmonic) system can support both these disjoint solutions.

SWB5 • 12:00 p.m.
Energy Velocity in Negative Group Index Structures, *Weiguo Yang[1], John O. Schenk[2], Michael A. Fiddy[2]; [1]Western Carolina Univ., USA, [2]Univ. of North Carolina at Charlotte, USA.* Energy velocity in negative group index structures is investigated. It is shown that the negative group index phenomenon is an exhibition of effective negative index-of-refraction while the group velocity still equals the energy velocity.

SWB6 • 12:15 p.m.
Lossless Negative Refraction in an Active Gas of Atoms, *Jörg Evers, Peter P. Orth, Christoph H. Keitel; Max-Planck-Inst. für Kernphysik, Germany.* Lossless negative refraction in an active dense gas of atoms is predicted. A weak incoherent pumping field renders the gas active, enabling a qualitatively new parameter range not accessible with current devices.

12:30 p.m.–2:00 p.m.
Lunch Break

SWC •Photonic Crystals

Salon G
2:00 p.m.–4:00 p.m.
SWC •Photonic Crystals
Marin Soljacic; MIT, USA, Presider

SWC1 • 2:00 p.m. Invited
Slow Light Media Based on Ultrahigh-*Q* Nanocavities, *Masaya Notomi, T. Tanabe, E. Kuramochi, H. Taniyama; NTT Basic Res. Labs, Japan.* In this study, we apply ultrahigh-*Q* (>1 million) nanocavities in silicon photonic crystals for slowlight application. We have observed the group velocity down to c/50,000 and succeeded in cascading N>100 ultrahigh-Q cavities in series.

SWC2 • 2:30 p.m. Invited
Impact of Nonlinearity and Disorder on Slow Modes in Membrane Photonic Crystals, *Alfredo Rossi; Thales Res. and Technology, France.* Disorder induced scattering is crucial for understanding slow light in Photonic Crystal. We investigate dispersion and scattering losses on PhC structures with tailored dispersion and discuss their potential for delay control and all-optical switching.

SWC3 • 3:00 p.m.
100 Gbit/s / 1 V Optical Modulator with Slotted Slow-Light Polymer-Infiltrated Silicon Photonic Crystal, *Jan M. Brosi[1], Christian Koos[1], Lucio C. Andreani[2], Pieter Dumon[3], Roel Baets[3], Juerg Leuthold[1], Wolfgang Freude[1]; [1]Inst. of High-Frequency and Quantum Electronics, Univ. of Karlsruhe, Germany, [2]Dept. of Physics "A. Volta", Univ. of Pavia, Italy, [3]Ghent Univ., Belgium.* An optical modulator with 78 GHz bandwidth, 1 V drive voltage and 80 μm length is proposed, allowing 100 Gbit/s transmission. Design, modulator performance parameters and measurements of the slow-light photonic crystal waveguide are discussed.

SWC4 • 3:15 p.m.
Systematic Design of Broadband Slow Light Photonic Crystal Waveguides, *Thomas P. White[1], Juntao Li[2], Liam O'Faolain[1], Thomas F. Krauss[1]; [1]Univ. of St. Andrews, UK, [2]Sun Yat-sen Univ., China.* We present a systematic design approach for broadband slow light photonic crystal waveguides. Precise control of group velocities between c/30 and c/90 is possible while maintaining an almost constant group index-bandwidth product.

SWC5 • 3:30 p.m.
Slow-Light Enhanced Second Harmonic Generation in a Two-Dimensional Photonic Crystal, *Rumen Iliew[1], Christoph Etrich[2], Thomas Pertsch[2], Falk Lederer[1]; [1]Inst. für Festkörpertheorie und -optik, Friedrich-Schiller-Univ. Jena, Germany, [2]Inst. für Angewandte Physik/ultra optics, Friedrich-Schiller-Univ. Jena, Germany.* We obtain greatly enhanced conversion efficiencies of second harmonic generation by achieving small group velocity at phasematch in a two-dimensional quadratically nonlinear photonic crystal. The theoretically proposed efficiency is confirmed with rigorous finite-difference time-domain calculations.

SWC6 • 3:45 p.m.
Revisiting Photon Tunneling through Finite 1-D Dielectric Photonic Crystals, *Daniel R. Solli[1], James J. Morehead[2], Colin F. McCormick[3], Jandir M. Hickmann[4]; [1]Univ. of California at Los Angeles, USA, [2]JDSU, USA, [3]U.S. House of Representatives Committee on Science and Technology, USA, [4]Optics and Materials Group, Optma Inst. de Física, Univ. Federal de Alagoas, Brazil.* We re-examine the propagation of light in the band gaps of 1-D dielectric photonic crystals comparing with the evanescent solutions of matter waves in classically forbidden potentials and determining similarities and differences.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

SWD • Slow Light in Atomic Vapors

Salon G
4:30 p.m.–6:30 p.m.
SWD • Slow Light in Atomic Vapors
Daniel Gauthier; Duke Univ., USA, Presider

SWD1 • 4:30 p.m. Invited
Ultralong Tunable Delays, *Alexander Gaeta; Cornell Univ., USA.* We describe review our recent work on all-optical techniques for producing tunable delays as large as 100 ns in optical waveguides.

SWD2 • 5:00 p.m.
Diffusion of Slow-Light in Thermal Vapor, *Ofer Firstenberg[1], Moshe Shuker[1], Rami Pugatch[2], Donald R. Fredkin[3], Nir Davidson[2], Amiram Ron[1]; [1]Dept. of Physics, Technion-Israel Inst. of Technology, Israel, [2]Dept. of Physics of Complex Systems, Weizmann Inst. of Science, Israel, [3]Dept. of Physics, Univ. of California, USA.* We study the effect of thermal motion on slow-light with electromagnetically-induced transparency. By incorporating the atomic motion into the Maxwell-Bloch equations, we find a transmission filter that leads to diffusion-like behavior of the field's envelope.

SWD3 • 5:15 p.m.
Slowing and Storing Images in Atomic Vapor, *Moshe Shuker[1], Ofer Firstenberg[1], Rami Pugatch[2], Amiram Ron[1], Nir Davidson[2]; [1]Technion-Israel Inst. of Technology, Israel, [2]Weizmann Inst. of Science, Israel.* We study slowing and storage of three-dimensional light fields in atomic vapor. We demonstrate a technique which reduces the effect of diffusion on the storage fidelity and prove that the phase pattern was also maintained.

SWD4 • 5:30 p.m.
Storage and Retrieval of Images in Hot Atomic Rubidium Vapor, *Praveen K. Vudyasetu, Ryan M. Camacho, John C. Howell; Univ. of Rochester, USA.* We demonstrate four wave mixing and electromagnetically induced transparency mediated storage of multimode transverse images carried by optical pulses in hot atomic Rubidium vapor and show that the images retrieved are robust to diffusion.

SWD5 • 5:45 p.m.
Four Wave Mixing Based Stopped Light in Optically Thick Hot Rubidium Vapor, *Ryan M. Camacho, Praveen K. Vudyasetu, John C. Howell; Univ. of Rochester, USA.* We discuss stored light in warm Rubidium vapor. Mediated by FWM, the idler pulses are spontaneously generated in the medium, and then stored and retrieved simultaneously with the signal pulses.

NOTES

Integrated Photonics and Nanophotonics Research and Applications (IPNRA)

Abstracts

• Sunday, July 13 •

Atrium Foyer
4:00 p.m.–6:00 p.m.
Registration Open

• Monday, July 14 •

Atrium Foyer
7:00 a.m.–6:00 p.m.
Registration Open

JMA • Joint Plenary Session I

Salon E
8:00 a.m.–10:00 a.m.
JMA • Joint Plenary Session I

8:00 a.m.
Opening Remarks, *Conference Chairs (COTA, Slow Light, and ICQI).*

8:15 a.m.
ICQI Plenary
Photonic Entanglement in Quantum Communication and Quantum Computation, *Anton Zeilinger; Univ. Wien, Austria.*

9:00 a.m.
Opening Remarks, *Conference Chair (IPNRA).*

9:05 a.m.
IPNRA Plenary
The Intimate Merger of Photonics and Computing, *Ashok V. Krishnamoorthy, SUN Microsystems, USA.*

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

Salon E

10:30 a.m.–12:30 p.m.
IMA • Transmitters and Other Devices
Maura Raburn; Infinera Corp., USA, Presider

IMA1 • 10:30 a.m. Invited
Compact Advanced Modulation Format InP Modulators and Receivers, *Chris Doerr; Bell Labs, Alcatel-Lucent, USA.* We present recent work on high-speed monolithic InP devices for advanced modulation formats, including optical differential quadrature phase-shift keying, optical quadrature amplitude modulation, and optical polarization-division multiplexing.

Salons A/B

10:30 a.m.–12:30 p.m.
IMB • Plasmonic Structures
Thomas J. Suleski; Univ. of North Carolina at Charlotte, USA, Presider

IMB1 • 10:30 a.m. Invited
Plasmonic Waveguide Devices and Networks, *Harry Atwater; Caltech, USA.* No abstract available.

Salon E

IMA2 • 11:00 a.m.
Widely Tunable 40 Gbps Transmitter Utilizing a High-Impedance Traveling-Wave EAM and SG-DBR Laser, *Matthew M. Dummer, Jonathan Klamkin, John P. Mack, Larry A. Coldren; Univ. of California at Santa Barbara, USA.* A tunable transmitter featuring an SG-DBR laser is integrated with an undercut-etched, high impedance traveling-wave EAM. This device demonstrates 40 Gbps operation with >8.5 dB extinction over 25 nm tuning with 2.1 V drive.

IMA3 • 11:15 a.m.
Semiconductor Two-Photon Laser: Ultra-Short Pulses and Wide Tuneability, *Noam Kaminski, Alex Hayat, Pavel Ginzburg, Meir Orenstein; Dept. of Electrical Engineering, Technion, Israel.* Nonlinear two-photon gain in semiconductor is shown to compress pulses from hundreds of femto-seconds down to several optical cycles. Contentious-wave two-photon laser central wavelength can be adjusted over an ultra-wide spectrum by tuneable cavities.

IMA4 • 11:30 a.m. **Invited**
InP Mach-Zehnder Modulators for Advanced Modulation Formats, *Nobuhiro Kikuchi; NTT Basic Res., Japan.* We have developed InP-based Mach-Zehnder modulators suitable for advanced modulation formats. We confirmed 40-Gbit/s NRZ signal generation and a 220-km 10 Gbit/s optical duobinary transmission. We also demonstrated a DQPSK modulator operating at 80 Gbit/s.

IMA5 • 12:00 p.m.
Mach-Zehnder Interferometer Based on Collimation Effect of Photonic Crystal, *Hoang Nguyen, Sven Rogge, Jaap Caro, Emile van der Drift, Huub Salemink; Kavli Inst. of Nanoscience, Delft Univ. of Tech., Netherlands.* A Mach-Zehnder interferometer based on photonic crystal is designed utilizing collimation effect and line defects with the aim to realize a switchable band-pass filter for optical telecommunication. The fabrication contains e-beam lithography and plasma etching.

IMA6 • 12:15 p.m.
Compact 1×8 Mode-Conversion-Type Optical Coupler with a Low Interchannel Imbalance for Monolithically Integrated SOA Gate Switch, *Seok-Hwan Jeong, Shinsuke Tanaka, Susumu*

Salons A/B

IMB2 • 11:00 a.m.
Novel Discrete Modes in Highly Asymmetrical Plasmonic Waveguides, *Nikolai Berkovitch, Meir Orenstein, Stephen G. Lipson; Technion, Israel.* Highly asymmetrical plasmonic waveguides exhibit guiding in dimensions below the expected cutoff. A new family of discrete guided modes of asymmetrical waveguides with losses is found which assists in nano plasmonic guiding.

IMB3 • 11:15 a.m.
Supermodes of Plasmonic Wedges in Structured Waveguides, *David Arbel, Meir Orenstein; Technion, Israel.* In many plasmonic waveguides, modes are determined by the complex coupling of wedges within the structure. We examine systematically the mode stemming from wedge coupling and subsequently validate experimentally the generation of such modes.

IMB4 • 11:30 a.m.
Photonic Integration with Dielectric-Loaded SPP Waveguides, *Alexey V. Krasavin[1], Padraig M. Bolger[1], Anatoly V. Zayats[1], Tobias Holmgaard[2], Sergey I. Bozhevolnyi[2], Laurent Markey[3], Alain Dereux[3]; [1]Queen's Univ. of Belfast, UK, [2]Aalborg Univ., Denmark, [3]Univ. de Bourgogne, France.* We present full 3-D numerical modelling as well as experimental demonstration of highly efficient and compact integrated photonic circuit components based on dielectric-loaded surface plasmon polariton waveguides.

IMB5 • 11:45 a.m. **Invited**
Plasmonic Components and Devices, *Olivier J. F. Martin; Swiss Federal Inst. of Technology Lausanne (EPFL), Switzerland.* Different plasmonic components are investigated numerically and experimentally: strip waveguides, V-groove waveguides and plasmonic antennas. Emphasis is put both on the modelling requirements and on practical applications in optical signal processing and biosensing.

IMB6 • 12:15 p.m.
Study of the Sidelobe Suppression in a Plasmon Waveguide Grating Filter Using the LOD-FDTD Method, *Jun Shibayama, Akifumi Nomura, Ryo Takahashi, Junji Yamauchi, Hisamatsu*

Salon E

Yamazaki, Shuichi Tomabechi, Ayahito Uetake, Mitsuru Ekawa, Ken Morito; Fujitsu Ltd., Japan. We designed a 1×8 mode conversion-type optical coupler and experimentally demonstrated that the monolithically integrated SOA gate switch that uses it has low interchannel gain imbalance (<1.8 dB) and a high fiber-to-fiber gain (>14.5 dB).

12:30 p.m.–2:00 p.m.
Lunch Break

2:00 p.m.–4:00 p.m.
IMC • Active Silicon Devices
Diana Huffaker; Ctr. for High Technology Materials, USA, Presider

IMC1 • 2:00 p.m. **Invited**
III-V/Silicon Photonics: Technology and Integrated Devices, *Gunther Roelkens, Liu Liu, Joost Brouckaert, Joris Van Campenhout, Frederik Van Laere, Dries Van Thourhout, Roel Baets; IMEC- Ghent Univ., Belgium.* III-V/Silicon photonics comprises the heterogeneous integration of a III-V layer on top of an SOI waveguide circuit. We elaborate on the bonding technology used and on the fabrication of III-V/Silicon integrated circuits.

IMC2 • 2:30 p.m.
Integrated GeSi Electro-Absorption Modulators on SOI, *Jifeng Liu[1], Sarah Bernardis[1], Jing Cheng[1], Rong Sun[1], Mark Beals[1], Lionel C. Kimerling[1], Jurgen Michel[1], Andrew T. Pomerene[2]; [1]MIT, USA, [2]BAE Systems, Semiconductor Technology Ctr., USA.* We demonstrate 1.2 GHz waveguide-integrated GeSi electro-absorption modulators on SOI platform with an extinction ratio of >7 dB over a broad wavelength range of 1510-1552 nm and an ultralow energy consumption of 50 fJ/bit.

IMC3 • 2:45 p.m.
CMOS-Compatible Wideband Silicon Modulator, *Steven J. Spector[1], Michael W. Geis[1], Gui-Rong Zhou[2], Matt E. Grein[1], Robert T. Schulein[1], Fuwan Gan[2], Mios A. Popovic[2], Jung U. Yoon[1], Donna M. Lennon[1], Erich P. Ippen[2], Franz X. Kaertner[2], Theodore M. Lyszczarz[1]; [1]MIT Lincoln Lab, USA, [2]MIT, USA.* A Mach-Zehnder based silicon optical modulator has been demonstrated with a bandwidth of 26 GHz and a VπL of 2 V·cm. The design of this modulator does not require an epitaxial overgrowth.

IMC4 • 3:00 p.m.
High-Speed Large Area Ge on Si Photodetectors, *Jing Cheng, Wojciech Giziewicz, Jifeng Liu, Ching-Yin Hong, Lionel C. Kimerling, Jurgen Michel; MIT, USA.* We design and demonstrate GHz large area lateral Ge on Si p-i-n photodetectors with a significant bandwidth improvement over vertical junction devices of the same area for direct coupling with >100μm diameter polymer optical fibers.

Salons A/B

Nakano; Faculty of Engineerring, Hosei Univ., Japan. A plasmon waveguide filter with an apodized grating is numerically investigated to suppress sidelobes in the transmission spectrum using the unconditionally stable finite-difference time-domain method based on the locally one-dimensional scheme.

12:30 p.m.–2:00 pm.
Lunch Break

2:00 p.m.–4:00 p.m.
IMD • Photonic Crystal Cavities and Waveguides
Richard Osgood; Columbia Univ., USA, Presider

IMD1 • 2:00 p.m. **Invited**
Nonlinear Switching in High-Q Photonic Crystal Nanocavities, *Takasumi Tanabe, Akihiko Shinya, Eiichi Kuramochi, Masaya Notomi; NTT Basic Res. Labs, NTT Corp., Japan.* All-optical switching is achieved at an extremely low energy by using silicon photonic crystal nanocavities with a large Q/V. They present the possibility of fabricating all-optical photonic integrated logic gates on a chip.

IMD2 • 2:30 p.m.
Slotted Photonic Crystal Waveguides and Cavities, *Andrea Di Falco, Liam O' Faolain, Thomas F. Krauss; School of Physics and Astronomy, UK.* We demonstrate experimentally slow-light factor in excess of 100 and spatio-temporal confinement with quality factor up to Q=7000 in suspended slotted photonic crystal waveguides and cavities, where light is confined in extremely small air volumes.

IMD3 • 2:45 p.m.
Advancing the Performance of One-Dimensional Photonic Crystal/Photonic Wire Micro-Cavities in Silicon-on-Insulator, *Ahmad Rifqi Md Zain, Marc Sorel, Richard De La Rue; Univ. of Glasgow, UK.* We present new results that demonstrate advances in the performance achievable in photonic crystal/photonic wire micro-cavities. In one example, a quality-factor value as high as 147,000 has been achieved experimentally at a useful transmission level.

IMD4 • 3:00 p.m.
Investigation on High Quality Factor 12-Fold Quasi-Photonic Crystal Microcavities with Different Central Post Sizes, *Tsan-Wen Lu, Chung-Chuan Tseng, Yi-Yu Tsai, Po-Tsung Lee; Dept. of Photonics and Inst. of Electro-Optical Engineering, Taiwan.* We investigate the variations of modal properties of 12-fold quasi-photonic crystal microcavities sustaining whispering-gallery (WG) mode with different central post sizes. WG mode lasing action with quality factor of 8,400 and 420nm post is achieved.

Salon E

IMC5 • 3:15 p.m.
Band-Engineered Ge as Gain Medium for Si-Based Laser, *Xiaochen Sun[1], Jifeng Liu[1], Lionel C. Kimerling[1], Jurgen Michel[1], Thomas L. Koch[2]; [1]MIT, USA, [2]Lehigh Univ., USA.* Optical gain and net material gain via direct bandgap transition at around 1550nm of the tensile-strain band-engineered n-type Ge has been analyzed. Photoluminescence spectra measured at room temperature confirm the theoretical predictions.

IMC6 • 3:30 p.m.
Design of Ultra-Small Polarization Splitter Based on Silicon Wire Waveguides, *Masaaki Komatsu, Kunimasa Saitoh, Kuniaki Kakihara, Masanori Koshiba; Hokkaido Univ., Japan.* We propose a novel design of ultra-small polarization splitter based on silicon wire waveguides. Numerical simulations show that a 12-μm-long polarization splitter with the extinction ratio better than -20 dB in entire C-band is achievable.

IMC7 • 3:45 p.m.
Dispersion Engineering in Silicon Photonic Wires Using Thin Si_3N_4 Conformal Dielectric Coating, *Xiaoping Liu[1], William M. J. Green[2], I-Wei Hsieh[1], Jerry I. Dadap[1], Yurii A. Vlasov[2], Richard M. Osgood, Jr.[1]; [1]Columbia Univ., USA, [2]IBM T.J. Watson Res. Ctr., USA.* We investigate numerically dispersion engineering in silicon photonic wires using conformal Si_3N_4 coatings. We analyze the impact of coating thickness upon the group-velocity-dispersion and effective waveguide nonlinearity, and show broadband four-wave-mixing gain in engineered waveguides.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

4:30 p.m.–6:30 p.m.
IME • Silicon Photonic Components
Steven Spector; MIT, USA, Presider

IME1 • 4:30 p.m. **Invited**
Si Photonics Integrated Circuits: Path to Commercial Reality, *Mehdi Asghari; Kotura, Inc., USA.* An assessment of key technical challenges and benefits associated with commercial realization of Si Photonics Integrated Circuits is provided with a review of conflicting needs associated with its implementation in telecom, data-com and interconnect applications.

Salons A/B

IMD5 • 3:15 p.m.
Ultra-High Quality Factor Silicon Nitride Planar Microdisk Resonators for Integrated Photonics in the Visible Range, *Ehsan Shah Hosseini, Siva Yegnanarayanan, Ali Adibi; Georgia Tech, USA.* Ultra-high-quality (>5x10^6) microdisk resonators are demonstrated in a Si_3N_4 platform at 655nm with integrated in-plane coupling waveguides on a Si substrate. Critical coupling to first-order radial mode is demonstrated using pedestal layer to control coupling.

IMD6 • 3:30 p.m. **Invited**
Multiscale Fabrication and Properties of Photonic Nanostructures, *Teri Odom; Northwestern Univ., USA.* This paper describes how soft interference lithography, a multiscale patterning technique, can generate new types of plasmonic structures with unexpected optical properties. Theoretical modeling of these photonic metal nanostructures is in excellent agreement with experiment.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

4:30 p.m.–6:30 p.m.
IMF • Nanophotonic Structures
Richard DelaRue; Univ. of Glasgow, UK, Presider

IMF1 • 4:30 p.m.
An Efficient Method for Analyzing Two-Dimensional Photonic Crystal Devices, *Zhen Hu[1,2,3], Ya Yan Lu[1]; [1]City Univ. of Hong Kong, Hong Kong, [2]Joint Advanced Res. Ctr., Univ. of Science and Technology of China and City Univ., China, [3]Univ. of Science and Technology of China, China.* For 2-D photonic crystal devices, an improved Dirichlet-to-Neumann map method is developed by incorporating an operator marching scheme to reduce memory requirement and the Bloch mode expansion technique for structures with partial periodicity.

IMF2 • 4:45 p.m. **Invited**
Micro- and Nano-Optical Modeling of Organic LED, *Norbert Danz, Michael Flämmich, Dirk Michaelis, Christoph A. Wächter;*

Salon E

Salons A/B

Fraunhofer Inst. für Angewandte Optik und Feinmechanik, Germany. The optical performance of organic LED can be optimized by using diffractive and/or refractive structures. Simulation of such complex systems requires mixed modeling of the emission from thin film stacks, diffractive, and refractive elements.

IME2 • 5:00 p.m. **Invited**

Rethinking Photonics Design and Manufacture: Offshoring, Material Platforms and the Future of Integration, *Erica Fuchs; Carnegie Mellon Univ., USA.* No abstract available.

IMF3 • 5:15 p.m.

Analyzing Second Harmonic Generation in Photonic Crystals by Dirichlet-to-Neumann Maps, *Lijun Yuan, Ya Yan Lu; City Univ. of Hong Kong, Hong Kong.* A numerical method is developed for analyzing second harmonic generation in 2-D photonic crystals. The method makes use of the DtN maps of the unit cells to significantly reduce the total number of unknowns.

IME3 • 5:30 p.m.

High Efficiency SOI Fiber-to-Waveguide Grating Couplers Fabricated Using CMOS Technology, *Gunther Roelkens[1], Diedrik Vermeulen[1], Dries Van Thourhout[1], Roel Baets[1], Stephane Brision[2], Philippe Lyan[2], Pauline Gautier[2], Jean-Marc Fedeli[2]; [1]Ghent Univ., Belgium, [2]CEA/LETI-MINATEC, France.* -2.6dB coupling efficiency between a silicon-on-insulator waveguide circuit and a single mode optical fiber was obtained, based on a grating coupling structure fabricated in a CMOS line. The -1dB optical bandwidth is 50nm.

IMF4 • 5:30 p.m.

Construction of Band Edge Diagrams for 2-D Photonic Crystals with Arbitrary 3-D Anisotropy by the Finite Element Method, *Sen-ming Hsu, Hung-chun Chang; Natl. Taiwan Univ., Taiwan.* A full-vectorial finite element method based eigenvalue algorithm is developed for the band structure analysis of two-dimensional photonic crystals with arbitrary three-dimensional anisotropy under the out-of-plane wave propagation. The band edge diagram is then constructed.

IME4 • 5:45 p.m.

Implementation of Silicon Microphotonic Devices in a Geographically-Distributed Fiber Optic Network, *J. T. Robinson[1], J. D. Marconi[2], N. Sherwood-Droz[1], A. Cerqueira, Jr.[2], Hugo H. Figueroa[2], H. L. Fragnito[2], Michal Lipson[1]; [1]Electrical and Computer Engineering Dept., Cornell Univ., USA, [2]Optics and Photonics Res. Ctr., Unicamp, IFGW, Brazil.* We experimentally investigate the performance of silicon microphotonic devices for filtering 10Gb/s data sent through a 40km fiber path from a real geographically-distributed fiber optic network.

IMF5 • 5:45 p.m. **Invited**

Flexible Modelling Approaches for Nanophotonics, *Phillip Sewell, Trevor M. Benson, Ana Vukovic; Univ. of Nottingham, UK.* We discuss challenges facing designers of photonics-simulation software. Flexibility, accuracy and scale are still the principal drivers for research. We consider the role of numerical schemes today and in the context of future generalized optimizations.

IME5 • 6:00 p.m.

Wide Temperature Range Operation of Resonant Silicon Electro-Optic Modulators, *Sasikanth Manipatruni, Rajeev Dokania, Bradley Schmidt, Jagat Shakya, Alyssa Apsel, Michal Lipson; Cornell Univ., USA.* We demonstrate wide-temperature range operation of a micron-size high-speed silicon electrooptic modulator over a temperature range of 15 K. We show that modulation can be maintained by varying the bias current to counter temperature changes.

Salon E

IME6 • 6:15 p.m.
Ultrashort Polarization Splitter Using Silicon Photonic Wires, *Byung-Ki Yang, Sang-Yung Shin, Daming Zhang; KAIST, Republic of Korea.* An ultrashort polarization splitter based on the zero-gap directional coupler is proposed and realized. Its interference section is 8.8 μm long. The extinction ratio for both TE- and TM-like polarizations is 16 dB.

Salons A/B

IMF6 • 6:15 p.m.
The Influence of Au Nanoparticles on the Electronic and Thermo-Optical Nonlinearities of a Colloidal System, *Rogério Souza[1], Márcio A R C Alencar[2], Eid C. da Silva[3], Mário R. Meneghetti[3], Jandir M. Hickmann[2]; [1]CEFET-AL, Brazil, [2]Optics and Materials Group - Optma, Inst. de Física, Univ. Federal de Alagoas, Brazil, [3]Inst. de Química e Biotecnologia, Univ. Federal de Alagoas, Brazil.* The influence of gold nanoparticles on the thermo-optical and electronic optical properties of a highly stable biocompatible colloid was investigated. The results indicate that local and nonlocal optical properties can be engineered in nanostructured systems.

JMB • Joint Poster Session

Salon F
6:30 p.m.–8:00 p.m.
JMB • Joint Poster Session

JMB34
Feasibility of a Silicon-Based Guided-Wave Optical Microphone, *Masashi Ohkawa, Manabu Hayashi, Hiroyuki Nikkuni, Noriyuki Watanabe, Takashi Sato; Niigata Univ., Japan.* Feasibility of a silicon-based guided-wave optical microphone was examined in this study. The fabricated microphone has a 10mm×10mm×40μm diaphragm and single-mode waveguides on the diaphragm. The microphone successfully detected sound pressure of 80dB-SPL at 1kHz.

JMB35
Chirped Multilayer Mirror Based on Silicon Nitride (Si_3N_4) with Air-Gap Interlayers, *Igor A. Sukhoivanov[1], Oleksiy V. Shulika[2], Sergii O. Yakushev[2], Sergey I. Petrov[2], Volodymyr V. Lysak[3]; [1]Univ. of Guanajuato, Mexico, [2]Kharkov Natl. Univ. of Radio Electronics, Ukraine, [3]Gwangju Inst. of Science and Technology, Republic of Korea.* Chirped multilayer mirror based on silicon nitride with air-gap interlayers is proposed and designed. The mirror provides high reflectivity and good dispersion properties in the range 400-1200 nm supporting the few-cycle pulses processing.

JMB36
Color Filter Based on a Subwavelength Silicon Grating, *Yeo-Taek Yoon[1], Hong-Shik Lee[1], Sang-Shin Lee[1], Sang-Hoon Kim[2], Ki-Dong Lee[2]; [1]Kwangwoon Univ., Republic of Korea, [2]LG Electronics Inst. of Technology, Republic of Korea.* A color filter using a subwavelength grating in silicon was realized with the laser interference lithography technique. The device worked as a blue filter centered at 460 nm with 90-nm bandwidth and 40% transmission.

JMB37
Synthetic Opal Matrices—New Material for Nonlinear Optics, *Anna D. Kudryavtseva, Nikolay V. Tcherniega; Lebedev Physical Inst., Russian Acad. of Sciences.* Photonic Flame Effect (PFE) properties were investigated experimentally in opal matrices and nanocomposites. Dependence of the PFE on the refractive index contrast of nanocomposite was shown. Stimulated Raman scattering has been obtained in photonic crystal.

JMB38
Engineering Surface Plasmon-Polaritons with Hetero-Dielectric Nanolayers for Ultra-Long Range Propagation, Anomalous Dispersion, and Nanoscale Confinement, *Junpeng Guo, Ronen Adato; Univ. of Alabama in Huntsville, USA.* We report our investigations of using hetero-dielectric nanolayers to engineer and control the attenuation, confinement, and dispersion of symmetric surface plasmon-polariton modes along thin metal film and finite width metal strip plasmon-polariton waveguides.

JMB39
A 2-D Square Rods-in-Air Photonic Crystal Optical Switch, *Huazhong Wang[1], Weimin Zhou[2], Jim P. Zheng[1]; [1]Dept. of Electrical and*

Computer Engineering, Florida A&M Univ. and Florida State Univ., USA, [2]Sensors and Electron Devices Directorate, ARL, USA. A 2-D square rods-in-air photonic crystal optical switch is proposed. Simulations show that up to 82.76% of incident transverse magnetic Gaussian point source energy can be switched into a channel vertical to source channel.

JMB40
Power Splitters with Different Output Power Levels Based on Photonic Crystal Waveguide Directional Coupler, *Afshin Ghaffari, Mehrdad Djavid, Faraz Monifi, Mohammad Sadegh Abrishamian; K.N.Toosi Univ. of Technology, Iran.* Here, properties of wideband photonic crystal power splitter with different power levels based on directional coupling are investigated. Different power levels are achieved by changing the coupling length and the radius of the coupling rods.

JMB41
Low-Loss Insulator-Metal-Insulator SPPs Bragg Reflector, *Jian-wei Mu, Wei-ping Huang; McMaster Univ., Canada.* A novel Surface plasmon polariton grating structures based on insulator-metal-insulator has been proposed and the comparable performances with reported structure have been investigated by rigorous numerical method.

JMB81
Use of a Ring Resonator-Based Modulator for the Measurement of Subpicosecond Optical Waveforms with Oscilloscopes, *Naum K. Berger; Technion – Israel Inst. of Technology, Israel.* Measuring 800 fs optical pulses with a conventional fast oscilloscope is numerically demonstrated. Temporal superresolution is achieved due to modulation of the pulses by a ring resonator-based traveling-wave modulator and the appropriate processing of oscillograms.

JMB1-JMB9 can be found in the COTA abstracts.
JMB10-JMB33 can be found in the Slow Light abstracts.
JMB42-JMB80 can be found in the ICQI abstracts.

NOTES

• Tuesday, July 15 •

Atrium Foyer
7:30 a.m.–5:00 p.m.
Registration Open

JTuA • Joint Plenary Session II

Salon E
8:00 a.m.–10:00 a.m.
JTuA • Joint Plenary Session II

8:00 a.m.
Slow Light Plenary
Electro-Optic Modulation of Photons and Biphotons, *Stephen E. Harris; Stanford Univ., USA.*

8:40 a.m.
ICQI Plenary
Entanglement, Information Processing and Decoherence in Trapped Atomic Ions, *David J. Wineland; NIST, USA.*

9:20 a.m.
COTA Plenary
Coherence Cloning and Phase Controlled Apertures Using Optical Phase-Lock Loops, *Amnon Yariv; Caltech, USA.*

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

Salon E

10:30 a.m.–12:30 p.m.
ITuA • Planar Lightwave Circuits and Filters
Mehdi Asghari; KOTURA, Inc., USA, Presider

ITuA1 • 10:30 a.m.
Demonstration of a Reconfigurable 8-Bit Optical Correlator Filter Using High-Index-Contrast Silica Waveguides, *Mahmoud S. Rasras[1], Inuk Kang[1], Mihaela Dinu[1], Jim Jaques[2], Niloy Dutta[2], Alfonso Piccirilli[2], Mark A. Cappuzzo[1], Evans Chen[1], Louis T. Gomez[1], Annjoe Wong-Foy[2], Steven Cabot[2], Lawrence Buhl[1], Gregory Johnson[2], Sanjay S. Patel[1]; [1]Bell Labs, Alcatel-Lucent, USA, [2]LGS, Bell Labs Innovations, USA.* We present a compact reconfigurable 8-bit optical matching filter fabricated using 4% delta high-index-contrast silica-on-silicon waveguides. We demonstrate its working by successfully correlating 8-bit binary phase-shift keyed patterns.

ITuA2 • 10:45 a.m.
8-Channel WDM Optical Interconnect Device Using Add-Drop Multiplexers Integrated in a Thin-Film Waveguide, *Kenji Kintaka[1], Junji Nishii[1], Shunsuke Murata[2], Shogo Ura[2]; [1]Natl. Inst. of Advanced Industrial Science and Technology, Japan, [2]Kyoto Inst. of Technology, Japan.* Eight-channel thin-film-waveguide WDM optical interconnect device with free-space-wave add-drop

Salons A/B

10:30 a.m.–12:30 p.m.
ITuB • Microlasers and Emission
Richard DelaRue; Univ. of Glasgow, UK, Presider

ITuB1 • 10:30 a.m. **Invited**
Membrane Microlasers and Their Integration, *Christian Seassal; INL-CNRS, Ecole Centrale de Lyon, Univ. of Lyon, France.* We present various micro-nanophotonic devices based on the III-V on silicon heterogeneous integration scheme. We particularly focus on microdisk lasers integrated onto silicon wire waveguide, and on "2.5-D" photonic crystal based surface emitting microlasers.

Salon E

multiplexers consisting of focusing grating couplers (FGCs) and distributed Bragg reflectors was demonstrated for the first time by improvement of the FGC coupling efficiency.

ITuA3 • 11:00 a.m.
Tunable Optical Dispersion Compensator Using a Hybrid-Lens Structure in an Arrayed-Waveguide Grating, *Yuichiro Ikuma, Hiroyuki Tsuda; Keio Univ., Japan.* A tunable optical dispersion compensator using a hybrid-lens structure in an arrayed-waveguide grating is proposed. The total dispersion can be controlled from -115 ps/nm to +182 ps/nm with a temperature change of 55 °C.

ITuA4 • 11:15 a.m.
Monolithic WDM Filter in Silicon-on-Insulator for Diplexer/Triplexer Application, *Dazeng Feng, Ning-Ning Feng, Hong Liang, Wei Qian, Cheng-Chih Kung, Joan Fong, Mehdi Asghari; Kotura Inc., USA.* We have designed and fabricated a 1.49μm/1.55μm WDM filter in Silicon-on-Insulator (SOI) platform. The filter is realized by Fourier-transform-based MZIs. The fabricated filter has <0.2dB ripple over 20nm flat pass-band and <0.3dB excess loss.

ITuA5 • 11:30 a.m. Invited
Advanced PLC Filter and Integration Technologies, *Matt Pearson; Enablence Technologies Inc., Canada.* We demonstrate our low-cost, silicon-based PLC platform which includes a compact on-chip grating technology with extremely wide free-spectral range, and passive hybridization of high-performance lasers and photodetectors.

ITuA6 • 12:00 p.m. Invited
Circuit Theory and Microphotonic Circuit Design: From

Salons A/B

ITuB2 • 11:00 a.m.
Controlling Nanowire Emission Profile Using Conical Taper, *Niels Gregersen[1], Torben R. Nielsen[1], Jesper Mørk[1], Julien Claudon[2], Jean-Michel Gérard[2]; [1]DTU Fotonik, Dept. of Photonics Engineering, Denmark, [2]CEA-Grenoble/INAC/SP[2]M/Lab Nanophysique et Semiconducteurs, France.* The influence of a conical taper on nanowire light emission is studied. For nanowires with divergent output beams, the introduction of tapers improves the emission profile and increases the collection efficiency of the detection optics.

ITuB3 • 11:15 a.m.
Double-Heterostructure Photonic Crystal Lasers with Reduced Threshold Pump Power and Increased Slope Efficiency Obtained by Quantum Well Intermixing, *Ling Lu, Eui Hyun Hwang, John O'Brien, P. Daniel Dapkus; Univ. of Southern California, USA.* Double-Heterostructure photonic crystal microcavity lasers were fabricated in which much of the photonic crystal mirror region was disordered by quantum well intermixing. An increased slope efficiency and a reduced threshold pump power was obtained.

ITuB4 • 11:30 a.m.
Strong Luminescence in 1500 nm from HgTe Colloidal Quantum Dots Infiltrated in a Photonic Crystal Lattice, *Pablo A. Postigo[1], Héctor Martínez[1], Iván Prieto[1], Vladimir Lesnyak[2], Nikolai Gaponik[2]; [1]Inst. de Microelectronica de Madrid, Spain, [2]TU Dresden, Germany.* We report the measurement at room temperature of strong and linearly polarized photoluminescence emission in 1550 nm on HgTe colloidal quantum dots infiltrated inside photonic crystal slabs.

ITuB5 • 11:45 a.m.
High-Purcell Factor, Ultra-Small Mode Volume Quasi-H1 Photonic Crystal Defect Lasers in InGaAsP Membrane, *Yi-Chun Yang[1], Chun-Jung Wang[2], Yu-Chen Liu[3], Zi-Chang Chang[3], Kung-Shu Hsu[4], Yen-Chun Tseng[2], Jen-Inn Chyi[2], Meng-Chyi Wu[3], Po-Tsung Lee[4], Min-Hsiung Shih[1]; [1]Res. Ctr. for Applied Sciences, Academia Sinica, Taiwan, [2]Dept. of Electrical Engineering,Natl. Central Univ., Taiwan, [3]Dept. of Electrical Engineering,Natl. Tsing Hua Univ., Taiwan, [4]Dept. of Photonics, Natl. Chiao Tung Univ., Taiwan.* The ultra-small mode volume, high-Q quasi-H1 photonic crystal cavity was demonstrated in InGaAsP membrane. The lasing properties of the cavity were characterized. The operated mode and profile were analyzed with the finite-difference time-domain method.

ITuB6 • 12:00 p.m.
Two-Dimensional Surface Emitting Photonic Crystal Laser

Salon E

Resonant Filters to Light-Powered Nanomachines, *Milos A. Popovic, Peter T. Rakich, Tymon Barwicz, Marcus S. Dahlem, Fuwan Gan, Charles W. Holzwarth, Henry I. Smith, Franz X. Kärtner, Erich P. Ippen; MIT, USA.* Physically intuitive coupled-mode and equivalent electrical-circuit theories are described for synthesis of nanophotonic resonator/interferometer circuits, including a new phase law for general 4-ports. Synthesis of self-adaptive (highly-nonlinear) optomechanical systems based on light forces is introduced.

12:30 p.m.–2:00 p.m.
Lunch Break

2:00 p.m.–4:00 p.m.
ITuC • Sensors and Lightwave Circuits
Attila Mekis; Luxtera Inc., USA, Presider

ITuC1 • 2:00 p.m. **Invited**
Integrated Optical Bio Sensors, *Igal Brener; Sandia Natl. Labs, USA.* We will present our recent progress on 1) waveguide-based sensor arrays that can operate as high density immunoassay sensors for detection of proteins and other biomolecules in solution, 2) metamaterial and plasmonic-based chem-bio sensors.

ITuC2 • 2:30 p.m. **Invited**
Polymeric Optical Wire-Bonding for Planar Lightwave Circuit Packaging, *Roberto R. Panepucci, Abdullah J. Zackariya, Tao Liu; Florida Intl. Univ., USA.* Flexible SU8 optical waveguide coupling to on-chip waveguides is investigated numerically for single mode, and experimentally for multimode waveguides. An optical wire-bonding platform enabling optical coupling from fiber-ribbon connectors to planar lightwave circuits is proposed.

Salons A/B

with Hybrid Triangular-Graphite Structure, *Luis Javier Martínez[1], Héctor Martínez[1], Iván Prieto[1], Pablo A. Postigo[1], Christian Seassal[2], Pierre Viktorovitch[2]; [1]Inst. de Microelectronica de Madrid, Spain, [2]Inst. des Nanotechnologies de Lyon (INL), France.* Laser emission of a compact surface-emitting microlaser, optically pumped and operating at 1.5 μm at room temperature is presented. The two-dimensional photonic crystal is conformed in a hybrid triangular-graphite lattice designed for vertical emission.

ITuB7 • 12:15 p.m.
Characterization of the Resonant Third-Order Nonlinear Susceptibility of Si-Doped GaN/AlN Quantum Wells and Quantum Dots at 1.5 μm, *S. Valdueza-Felip[1], F.B. Naranjo[1], M. González-Herráez[1], H. Fernández[2], J. Solís[2], F. Guillot[3], E. Monroy[3], M. Tchernycheva[4], L. Nevou[4], F. H. Julien[4]; [1]Grupo de Ingeniería Fotónica (GRIFO), Dept. de Electrónica, Univ. de Alcalá, Spain, [2]Inst. de Óptica, C.S.I.C., Spain, [3]Equipe Mixte CEA, Ctr. Natl. de la Recherche Scientifique, Nanophysique et Semiconducteurs, INAC/SP2M/NPSC CEA-Grenoble, France, [4]Inst. d´Electronique Fondamentale, Ctr. Natl. de la Recherche Scientifique, France.* We report third order optical nonlinearity around 1500nm of GaN/AlN QW and QD. Intersubband transitions show a high $X^{(3)}$ value and an ultrafast nonlinear response, rendering these nanostructures suitable for all-optical switching and wavelength-conversion applications.

12:30 p.m.–2:00 p.m.
Lunch Break

2:00 p.m.–4:00 p.m.
ITuD • Multi-Core Photonics and Simulations
Jurgen Michel; MIT, USA, Presider

ITuD1 • 2:00 p.m. **Invited**
Nanoscale Silicon Photonic Networks-on-Chip for Multicore Processors Communications, *Keren Bergman; Columbia Univ., USA.* We explore how recent advances in nanoscale silicon photonic technologies can be exploited for developing on-chip optical interconnection networks that address the bandwidth and power challenges presented for the communications infrastructure in multicore processors.

ITuD2 • 2:30 p.m. **Invited**
A Nanophotonic Interconnect for High-Performance Many-Core Computation, *Ray Beausoleil[1], J. Ahn[2], N. Binkert[2], A. Davis[2], D. Fattal[1], M. Fiorentino[1], N. P. Jouppi[2], M. McLaren[3], C. M. Santori[1], R. S. Schreiber[2], S. M. Spillane[1], D. Vantrease[2], Q. Xu[1]; [1]Information and Quantum Systems, Hewlett-Packard Labs, USA, [2]Exascale Computing, Hewlett-Packard Labs, USA, [3]Exascale Computing, Hewlett-Packard Labs, UK.* We describe the results of a design study of DWDM on-chip and off-chip nanophotonic interconnects and device technologies that could improve

Salon E

ITuC3 • 3:00 p.m.
Sensitive and Compact Silicon Wire Evanescent Field Molecular Sensors, *D.-X. Xu, A. Densmore, P. Waldron, S. Janz, J. Lapointe, A. Delage, G. Lopinski, T. Mischki, P. Cheben, J. H. Schmid; Natl. Res. Council of Canada, Canada.* Densely folded silicon wire waveguide evanescent field sensors demonstrate high sensitivity and compact foot-print. Real time monitoring of molecular binding resolves ~0.2% of a protein monolayer, corresponding to a mass of ~5 femtograms.

ITuC4 • 3:15 p.m.
Two-Dimensional Photonic Crystal Slot Microcavity Sensor for Virus-Sized Particle Detection, *Mindy R. Lee[1], Benjamin L. Miller[2], Philippe M. Fauchet[3]; [1]Inst. of Optics, Univ. of Rochester, USA, [2]Dept. of Dermatology, Univ. of Rochester, USA, [3]Inst. of Optics, Dept. of Electrical and Computer Engineering, Univ. of Rochester, USA.* We theoretically and experimentally demonstrate a new sensor design that consists of a 2-D silicon slot photonic crystal microcavity and is capable of detecting virus-sized particles.

ITuC5 • 3:30 p.m.
Design and Optimization of Surface Plasmon Resonance Based Biosensor for the Detection of *E. coli*, *Muttukrishnan Rajarajan[1], Tuffail Dar[1], Christos Themistos[1], Aziz Rahman[1], Kenneth Grattan[1], Joseph Irudayaraj[2]; [1]City Univ., UK, [2]Purdue Univ., USA.* Finite element analysis based on the vector H-field formulation and incorporating the perturbation technique is used to optimize a surface plasmon resonance based fiber optic sensor for the detection of *E coli*.

ITuC6 • 3:45 p.m.
Generalized Treatment of Optically Induced Forces and Potentials in Optomechanically Variable Photonic Circuits, *Peter T. Rakich, Milos A. Popovic; MIT, USA.* We establish a fundamental relationship between the phase and amplitude responses of an optomechanically variable photonic circuit and the forces and potentials produced by light. These results are illustrated through resonant and nonresonant multi-port systems.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

Salons A/B

computing performance by a factor of 20 above industry projections over the next decade.

ITuD3 • 3:00 p.m. Invited
Intrachip Photonic Network for Multicore Communications, *Mark Beals; MIT, USA.* No abstract available.

ITuD4 • 3:30 p.m.
Temperature Dependence Analysis of Photonic Devices, *V. F. Rodríguez-Esquerre[1], J. P. Da Silva[2], C. E. Rubio-Mercedes[3], J. J. Isídio-Lima[1], H. E. Hernández-Figueroa[4]; [1]CEFET-BA, Brazil, [2]UFERSA, Brazil, [3]UEMS, Brazil, [4]UNICAMP, Brazil.* The chromatic-dispersion of an ultra-flattened optical fiber and the resonant-wavelength of a microring-filter were computed for several temperatures by using temperature-dependent Sellmeier coefficients in combination with efficient finite-element approaches. Both parameters exhibited linear-dependence with temperature.

ITuD5 • 3:45 p.m.
Using the Penalty Method for Imposing Boundary Conditions in the Pseudospectral Optical Waveguide Mode Solver, *Po-Jui Chiang[1], Nai-Hsiang Sun[2], Hung-chun Chang[1]; [1]Natl. Taiwan Univ., Taiwan, [2]I-Shou Univ., Taiwan.* A penalty method for imposing boundary conditions at material interfaces is considered in the recently developed multidomain pseudospectral optical waveguide mode solver. The method is demonstrated to offer better numerical convergency and stability.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

NOTES

Salons A/B

4:30 p.m.–6:30 p.m.
ITuE • Computer Aided Design for Integrated and Nano Photonics
Hugo Enrique Hernandez-Figueroa; UNICAMP, Brazil, Presider

ITuE1 • 4:30 p.m. **Invited**

Addressing Photonic Applications via a Broad Range of Integrated Simulation Methods, *Robert Scarmozzino, E. Heller, M. Bahl; RSoft Design Group, Inc., USA.* Presented here is an integrated set of methods for device simulation (FDTD, BPM, FEM, RCWA, EME, PWE), calculation of multiple physical processes (electro/thermo/stress-optic and active carrier transport), high-performance computing, and multilevel connection to system simulation.

ITuE2 • 4:45 p.m. **Invited**

Designing Active Photonic Integrated Circuits Using TDTW, *Dominic F. Gallagher; Photon Design, UK.* We present a new photonic circuits simulator PICWave based on the TDTW method, capable of modelling both active and passive photonic circuits. We illustrate its performance with reference to an SOA based all-optical 2R regenerator.

ITuE3 • 5:00 p.m. **Invited**

Multi-Disciplinary Simulation of Electro-Opto-Thermal Networks Using a SPICE-Like Framework, *Pavan Gunupudi[1], Tom Smy[1], Jackson Klein[2], Jan Jakubczyk[2]; [1]Carleton Univ., Canada, [2]Optiwave Systems, Canada.* This paper presents a method to simulate coupled multi-disciplinary problems using a single-engine approach by embedding system characteristics of optoelectronic devices relating to each energy domain in a SPICE-like simulation framework.

ITuE4 • 5:15 p.m. **Invited**

JCMsuite: An Adaptive FEM Solver or Precise Simulations in Nano-Optics, *Sven Burger, Lin Zschiedrich, Jan Pomplun, Frank Schmidt; JCMwave, Germany.* We present the finite-element solver JCMsuite for Maxwell-type, time-harmonic scattering, eigenvalue and resonance problems. We report on the current status and discuss application examples like the precise computation of leaky modes in photonic crystal fibers.

A round table discussion will conclude the last hour of this session, 5:30 p.m.–6:30 p.m.

Salon F
6:30 p.m.–8:00 p.m.
Conference Reception

• Wednesday, July 16 •

Atrium Foyer
7:30 a.m.–5:00 p.m.
Registration Open

Salon E

8:00 a.m.–10:00 a.m.
IWA • Micro-Resonators and Lightwave Devices
Greg Nordin; Univ. of Alabama at Huntsville, USA, Presider

IWA1 • 8:00 a.m. Invited
Electrical Network Approach to Synthesizing Coupled-Cavity Optical Devices, *Vien Van; Univ. of Alberta, Canada.* Generalized electrical network approach for synthesizing multiple-coupled micro-resonator devices of the most general two-dimensional coupling topology is presented. Complex device coupling topologies are also presented to highlight their various potential applications in spectral engineering.

IWA2 • 8:30 a.m.
Integrated HIC High-Q Resonators in Chalcogenide Glass, *Juejun Hu[1], Nathan Carlie[2], Ning-Ning Feng[1], Laeticia Petit[2], Anuradha Agarwal[1], Kathleen Richardson[2], Lionel Kimerling[1]; [1]MIT, USA, [2]Clemson Univ., USA.* We have demonstrated the first planar waveguide-coupled chalcogenide glass micro-resonators using a CMOS-compatible lift-off technique. The microdisk resonators support whispering-gallery-mode (WGM) with cavity Q exceeding 2×10^5, the highest Q reported in chalcogenide resonators.

IWA3 • 8:45 a.m.
A Compact Chromatic Dispersion Compensator Using Unequal and Mutually-Coupled Microring Resonators, *Lin Zhang[1], Muping Song[2], Jeng-Yuan Yang[1], Raymond G. Beausoleil[3], Alan E. Willner[1]; [1]Univ. of Southern California, USA, [2]Zhejiang Univ., China, [3]HP Labs, USA.* We propose ultra-small silicon microring-based dispersion compensators, with -530 ps/nm dispersion over 8.5 μm and power fluctuation of 0.15 dB. Equivalent dispersion is up-to 6.23×10^{10} ps/nm/km. Dispersion slope compensation is also achieved.

IWA4 • 9:00 a.m.
Design and Optimization of Devices for C-Band Photonic-Crystal Waveguide Interleaver with Flattened Pass-Band, *Lorenzo Rosa, Kunimasa Saitoh, Kuniaki Kakihara, Masanori Koshiba; Grad. School of Information Science and Technology, Hokkaido Univ., Japan.* We investigate the optimization of a C-band photonic-crystal waveguide (PCW) interleaver with flattened pass-band, using coupled-resonator optical waveguides (CROW). A genetic algorithm (GA) is employed for optimizing the filter devices for high transmittivity and flatness.

Salons A/B

8:00 a.m.–10:00 a.m.
IWB • Modeling Optical Fibers and Waveguides
Ronald Hadley; Sandia Natl. Labs, Presider

IWB1 • 8:00 a.m. Invited
Microstructured Fibers: Modelling, Design and Applications, *Annamaria Cucinotta, Federica Poli, Davide Passaro, Stefano Selleri; Univ. of Parma, Italy.* The finite element method has been successfully applied to analyze the properties of microstructured fibers. Their geometrical and physical characteristics have been designed in order to obtain the features suitable for specific applications.

IWB2 • 8:30 a.m.
Characterization of a Teflon PCF for THz Frequency Applications by Using the Finite Element Method, *Kejalakshmy Namassivayane, B.M. Azizur Rahman, Arti Agrawal, Ken Grattan; City Univ., UK.* A finite element based full-vectorial modal solution approach has been developed to identify single mode operation of Teflon photonic crystal fibers and to characterize their modal and bending losses in the THz frequencies.

IWB3 • 8:45 a.m.
Single-Mode Large-Mode-Area Leakage Channel Fibers with Octagonal Symmetry, *Lorenzo Rosa[1], Kunimasa Saitoh[1], Yukihiro Tsuchida[1], Shailendra Kumar Varshney[1], Masanori Koshiba[1], Federica Poli[2], Davide Passaro[2], Annamaria Cucinotta[2], Stefano Selleri[2], Luca Vincetti[3]; [1]Div. of Media and Network Technologies, Hokkaido Univ., Japan, [2]Univ. of Parma, Italy, [3]Univ. of Modena e Reggio Emilia, Italy.* A novel design for large-mode-area leakage channel fibers with a single ring of air-holes organized with octagonal symmetry has been proposed, obtaining lower bending loss and guided mode distortion with respect to hexagonal symmetry fibers.

IWB4 • 9:00 a.m.
Finite-Element and Boundary Integral Method for Analysis of Open Dielectric Waveguides, *Hyoungsuk Yoo, Anand Gopinath; Univ. of Minnesota, USA.* To analyze dielectric waveguides, the vector finite-element method is used in the interior region while boundary integral equations are applied in the exterior region. The propagation constant has been obtained by an iterative method.

Salon E

IWA5 • 9:15 a.m.
Stratified Photonic Crystal Demultiplexer, *Amin Khorshidahmad, Andrew G. Kirk; McGill Univ., Canada.* Using diffraction compensation, a compact wide-band coarse wavelength division demultiplexer in a stratified heterostructure photonic crystal is proposed. With almost diffraction limited beam sizes, seven-fold size reduction is achieved compared to a convectional S-vector superprism.

IWA6 • 9:30 a.m.
Highly Sensitive Compact On-Chip Micro-Interferometers, *Maysamreza Chamanzar, Babak Momeni, Ali Adibi; Georgia Tech, USA.* Photonic crystals (PCs) are used in a two-wave interference architecture to enhance the spectral sensitivity of on-chip optical interferometers. The proposed interferometers are shown to have applications in sensing and spectroscopy.

IWA7 • 9:45 a.m.
T-Shaped Channel-Drop Filters Using Photonic Crystal Ring Resonators, *Mehrdad Djavid, Faraz Monifi, Afshin Ghaffari, Mohammad Sadegh Abrishamian; K.N.Toosi Univ. of Technology, Iran, Islamic Republic of.* We demonstrate a new type of 2-D photonic crystal T-shaped channel-drop filter using ring-resonator with high normalized transmission; we investigate parameters which affecting resonant frequency in these filters. FDTD method concludes output efficiency over 95%.

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

Salons A/B

IWB5 • 9:15 a.m.
A Modified Semivectorial Beam-Propagation Method Retaining the Longitudinal Field Component, *Junji Yamauchi, Yuta Nito, Hisamatsu Nakano; Faculty of Engineering, Hosei Univ., Japan.* The formulation of the beam-propagation method is revisited, taking into account the effects of the longitudinal field component. The improvement is demonstrated through the analysis of a vertically tapered rib waveguide.

IWB6 • 9:30 a.m.
Novel Frequency Domain Approach for the Analysis of Photonic Devices in Cylindrical Coordinates, *C. E. Rubio-Mercedes[1], V. F. Rodríguez-Esquerre[2], H. E. Hernández-Figueroa[3]; [1]UEMS, Brazil, [2]CEFET-BA, Brazil, [3]UNICAMP, Brazil.* A novel scheme based on a finite element method (FEM) in conjunction with the perfectly matched layers (PML) for the analysis of discontinuities in photonic devices with cylindrical symmetry is proposed and validated.

IWB7 • 9:45 a.m.
A Quasi-Crystal Spiral Photonic Crystal Fiber: Modal Solutions and Dispersion Properties, *Arti Agrawal, N. Kejalakshmy, F. Tian, B. M. A. Rahman, K. T. V. Grattan; City Univ., UK.* A novel quasi crystal spiral design for a Photonic Crystal Fiber is optimized by the Finite Element method. The fiber dispersion can be designed to have large negative values by tuning the design parameters.

Salon Foyer
10:00 a.m.–10:30 a.m.
Coffee Break

10:30 a.m.–12:30 p.m.
IWC • Photonic Integration
Pietro Bernasconi; Bell Labs, Alcatel-Lucent, USA, Presider

IWC1 • 10:30 a.m. **Invited**
Digital vs. Analog Photonic Integration, *Martin Hill[1], M. K. Smit[1], Peter Crombez[2], Carel van der Poel[2]; [1]COBRA—TU Eindhoven, Netherlands, [2]NXP Semiconductor, Netherlands.* In this presentation, analog integration is reviewed, digital integration is discussed and a comparison is made between photonics and electronics.

IWC2 • 11:00 a.m. **Invited**
Photonic Integrated Circuits for Communications, Signal Processing and Computing Applications, *S. J. Ben Yoo; Univ. of California at Davis, USA.* This paper describes PICs realized on semiconductor platforms (InP, Si, etc) to support future communication and computing systems integrated on a chip. Integration of lasers, mux/demux, micro-resonators, optical switches will be described.

10:30 a.m.–12:30 p.m.
IWD • Solar Cells and Nanostructures
Edward Sargent; Univ. of Toronto, Canada, Presider

IWD1 • 10:30 a.m. **Invited**
Engineering of Charge and Light Transport at the Micro and Nanoscale for Low-Cost, Large-Area Solar Cells, *Peter Peumans; Stanford Univ., USA.* No abstract available.

IWD2 • 11:00 a.m.
Ultracompact Plasmonic Waveguide Bend Based on Nanoscale Cavity Resonance, *Jaeyoun Kim, Yu Liu; Iowa State Univ., USA.* It is well-known that incorporating resonant cavities into dielectric waveguide bends can improve their transmission efficiency. Using 3-D simulations, we demonstrate that the technique can generate ~3dB improvement in ultracompact plasmonic waveguide bends as well.

Salon E

IWC3 • 11:30 a.m.
High-Power High-Linearity Modified Uni-Traveling Carrier Photodiodes, *Andreas Beling, Huapu Pan, Hao Chen, Joe C. Campbell; Univ. of Virginia, USA.* We demonstrate a modified uni-traveling carrier photodiode (MUTC-PD) with a record-high third-order intercept point of 52dBm at 75mA and 300MHz. To further enhance the dynamic range we propose a monolithically integrated traveling wave MUTC-PD array.

IWC4 • 11:45 a.m.
Photonic Chip Recirculating Buffer for Optical Packet Switching, *Emily F. Burmeister, John P. Mack, Henrik N. Poulsen, Milan L. Mašanović, Biljana Stamenić, Daniel J. Blumenthal, John E. Bowers; Univ. of California at Santa Barbara, USA.* The first on-chip optical buffer is demonstrated with up to 64 ns of delay with 98% packet recovery. The recirculating buffer is implemented using a fast, InP-based switch butt-coupled to a low-loss silica waveguide delay.

IWC5 • 12:00 p.m. **Invited**
Photonic Integrated Circuits for Optical Routing and Switching Applications, *Milan L. Masanovic, Emily F. Burmeister, Anna Tauke-Pedretti, Brian R. Koch, Matthew M. Dummer, Joseph A. Summers, Jonathon S. Barton, Larry A. Coldren, John E. Bowers, Daniel J. Blumenthal; Univ. of California at Santa Barbara, USA.* We report on the latest advances in implementation of integrated photonic components required for optical routing: wavelength converters, optical buffers, and mode-locked lasers.

12:00 p.m.–2:00 p.m.
Lunch Break

Salons A/B

IWD3 • 11:15 a.m.
Design and Analysis of Metal Slab Waveguide Reflector for Substrate Removed Nanowire Waveguides, *Changwan Son, Byungchae Kim, Jaehyuk Shin, Nadir Dagli; Univ. of California at Santa Barbara, USA.* Metal slab waveguide reflectors for nanowire waveguides are designed and simulated. The reflection coefficient can be controlled by adjusting the gap and length of the reflector. Reflection coefficients higher than metal coated facets are possible.

IWD4 • 11:30 a.m.
Retardation Effects to the Rescue of Particle Plasmon-Based Nano-Cavities, *Eyal Feigenbaum, Meir Orenstein; Technion, Israel.* ultra-small modal volume of ~$10^{-4}\cdot\lambda 3$ with relatively enhanced Q-factors is obtained when a particle-plasmon is modified to accumulate retardation effects, although the field propagation length is only few tens of nanometer.

IWD5 • 11:45 a.m.
The Nano Plasmonic Slotline and Coplanar Waveguides and Their Edge Guiding, *Yinon Stav, Nikolai Berkovitch, Meir Orenstein; Technion, Israel.* Slotlines and Coplanar plasmonic waveguides at the nanometric regime are studied both theoretically and experimentally, including their mutual coupling. Edge guiding in these structures enables relatively long plasmon propagation (tens of micrometers).

IWD6 • 12:00 p.m.
3-D Numerical Simulations of Light Scattering from 2-D Silver-Nanorod Hexagonal Arrays Embedded in Nano-Gap Substrates, *Bang-Yan Lin[1], Chun-Hao Teng[2], Hung-chun Chang[1]; [1]Natl. Taiwan Univ., Taiwan, [2]Natl. Cheng Kung Univ., Taiwan.* Light scattering from hexagonal-lattice silver-nanorod arrays embedded in nano-gap substrates are simulated using a high-accuracy 3-D pseudospectral time-domain numerical scheme. A more realistic Drude-Lorentz material model is numerically implemented to facilitate efficient computation.

IWD7 • 12:15 p.m.
Reduced Basis Method for Nano Optical Simulations, *Jan Pomplun, Frank Schmidt; Zuse Inst. Berlin, Germany.* We explain the reduced basis method for the finite element simulation of nano optical problems which allows to obtain rigorous solutions of the electromagnetic field for large parameterized problems in very short time.

12:00 p.m.–2:00 p.m.
Lunch Break

Salon E

2:00 p.m.–4:00 p.m.
IWE • Active Structures
Mark Earnshaw; Alcatel-Lucent, USA, Presider

IWE1 • 2:00 p.m. **Invited**
Nanostructure Patterned Active Regions for Semiconductor Diode Lasers, *James Coleman; Univ. of Illinois at Urbana-Champaign, USA.* We describe a nanoscale selective area epitaxy process for uniform patterned quantum dot growth and present laser device results for both conventional quantum dot lasers and a novel inverted quantum dot (nanopore) laser structure.

IWE2 • 2:30 p.m.
Enhanced Electro-Optic Phase Modulation in InGaAs Quantum Posts, *JaeHyuk Shin, Hyochul Kim, Pierre M. Petroff, Nadir Dagli; Univ. of California at Santa Barbara, USA.* Phase modulation of self-assembled InGaAs quantum posts were studied at 1500 nm. Enhancement of 29% over devices containing InGaAs quantum wells of similar composition was observed indicating significant electro-optic coefficient increase in quantum posts.

IWE3 • 2:45 p.m.
Low-Loss Ultra-Compact GaAs/AlGaAs Substrate Removed Waveguides, *JaeHyuk Shin, Yu-Chia Chang, Nadir Dagli; Univ. of California at Santa Barbara, USA.* Substrate removed GaAs/AlGaAs optical waveguides with propagation loss as low as 1 dB/cm was demonstrated using lifted-off Si for index loading. Loss components were identified, minimized and measured propagation loss correlated well with calculations.

IWE4 • 3:00 p.m.
Ultrafast Optical Beam Deflection in a GaAs Planar Waveguide by a Transient, Optically-Induced Prism Array, *Chris H. Sarantos, John E. Heebner; Lawrence Livermore Natl. Lab, USA.* We demonstrate a novel, ultrafast single-shot optical beam deflection technique based on an array of transient, optically induced prisms within a GaAs planar waveguide, enabling

Salons A/B

2:00 p.m.–4:00 p.m.
IWF • Simulations, Photonic Devices and Materials
Andrea Melloni; DEI, Italy, Presider

IWF1 • 2:00 p.m.
Waveguide Microgripper Power Distribution, *Tao Liu, Jose A. Martinez, Amit Bhanushali, Roberto R. Panepucci; Florida Intl. Univ., USA.* We studied the factors affecting the power distribution across the waveguide facet of novel microgrippers. Knife edge measurements, microscopy imaging and 2-D–FDTD numerical simulations are carried to study the effects of specifications of series microgrippers.

IWF2 • 2:15 p.m.
Effect of Implementation of a Bragg Reflector in the Photonic Band Structure of the Suzuki-Phase Photonic Crystal Lattice, *Pablo A. Postigo[1], Luis J. Martínez[1], Alfonso R. Alija[1], Matteo Galli[2], Juan F. Galisteo-López[2], Lucio C. Andreani[2], Christian Seassal[3], Pierre Viktorovitch[3]; [1]Inst. de Microelectronica de Madrid, Spain, [2]Dept. di Fisica "A. Volta," Univ. di Pavia, Italy, [3]Inst. des Nanotechnologies de Lyon (INL), France.* We report the change in the photonic band structure of the Suzuki-phase photonic crystal slab when transversal symmetry is broken by an underlying Bragg reflector, and an enhancement on the photoluminescence up to seven times.

IWF3 • 2:30 p.m.
Removing the Bandwidth Limitation in Slow-Light Mach-Zehnder Modulators, *Sean P. Anderson, Ashutosh R. Shroff, Philippe M. Fauchet; Inst. of Optics, Univ. of Rochester, USA.* We show that modulators using slow-light Mach-Zehnder interferometers can be miniaturized, but at the price of bandwidth. We offer guidelines to replace this tradeoff with a more favorable one between length reduction and manufacturing variation.

IWF4 • 2:45 p.m.
Thermally Tunable Ferroelectric Thin Film Photonic Crystals, *Pao T. Lin[1], Bruce W. Wessels[1], Alexandra Imre[2], Leonidas E. Ocola[2]; [1]Northwestern Univ., USA, [2]Ctr. for Nanoscale Materials, Argonne Natl. Lab, USA.* Thermally tunable PhCs are fabricated from ferroelectric thin films. Photonic band structure and temperature dependent diffraction are calculated by FDTD. 50% intensity modulation is demonstrated experimentally. This device has potential in active ultra-compact optical circuits.

IWF5 • 3:00 p.m.
Simulation, Fabrication and Measurement of Infrared Frequency Selective Surfaces, *David W. Peters, L. I. Basilio, A. A. Cruz-Cabrera, W. A. Johnson, J. R. Wendt, S. A. Kemme, S. Samora; Sandia Natl. Labs, USA.* We show reflection and transmission measurements from frequency selective surfaces over a broad angular and wavelength range in the midwave infrared and

Salon E

experimental measurement of signals with sub 3 ps temporal resolution.

IWE5 • 3:15 p.m.
General and Efficient Method for Calculating Modulation Responses and Noise Spectra of Active Semiconductor Waveguides, *Søren Blaaberg, Filip Öhman, Jesper Mørk; Technical Univ. of Denmark, Denmark.* We present a theoretical method for obtaining small-signal responses in a spatially resolved active semiconductor waveguide including finite end-facet reflectivities and amplified spontaneous emission. RF-modulation responses and output noise spectra of an SOA are shown.

IWE6 • 3:30 p.m.
One-Dimensional Photonic Crystal and Photoconductive PbTe Film for Low Cost Resonant-Cavity-Enhanced Mid-Infrared Photodetector, *Jianfei Wang[1], Juejun Hu[1], Xiaochen Sun[1], Anuradha M. Agarwal[1], Desmond R. Lim[2], Lionel C. Kimerling[1]; [1]MIT, USA, [2]DSO Natl. Labs, Singapore.* We demonstrate and characterize both one-dimensional photonic crystal monolithically integrated on a Si platform, and thermally evaporated PbTe film with room temperature photoconductivity, which are key components for low cost resonant-cavity-enhanced mid-infrared photodetectors.

IWE7 • 3:45 p.m.
Influence of Pure Dephasing on Emission Spectra from Quantum Dot-Cavity Systems, *Andreas N. Rasmussen, Troels S. Jørgensen, Philip T. Kristensen, Jesper Mørk; DTU Fotonik, Dept. of Photonics Engineering, Denmark.* We model the effect of dephasing on a QD-cavity QED system. The emission peaks are found to display surprising intensity shifts as the rate of dephasing is increased. This effect could explain recent experimental results.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

4:30 p.m.–5:45 p.m.
IWG • Waveguide Components
Dan-Xia Xu; Natl. Res. Council of Canada, Canada, Presider

IWG1 • 4:30 p.m.
Polarization-Selective Tunable Delay in Coupled-Resonator Optical Delay-Lines, *Francesco Morichetti[1], Carlo Ferrari[2], Andrea Melloni[2], Mario Martinelli[1]; [1]CORECOM, Italy, [2]Politecnico di Milano, Italy.* We experimentally demonstrate that an integrated reconfigurable coupled-resonator optical waveguide can introduce a continuously tunable delay between two data-streams with orthogonal polarization states. Applications to polarization-division multiplexing transmission systems at several Gbit/s bit-rates are discussed.

Salons A/B

compare to computational models using EIGERTM, a method-of-moments code.

IWF6 • 3:15 p.m.
Backward-Propagating-Slow-Light in Inverted Plasmonic Taper, *Eyal Feigenbaum, Meir Orenstein; Technion, Israel.* Modes in plasmonic metal-dielectric-metal structure, at frequencies exceeding the surface plasmon frequency can be simultaneous slow-light, have backward phase propagation and exhibit inverse cutoff characteristics compared to regular photonic characteristics.

IWF7 • 3:30 p.m.
Estimating Total Quality Factor of 2-D Photonic Crystal Slab Cavities with 2-D Simulation Techniques, *Tao Liu, Roberto R. Panepucci; Florida Intl. Univ., USA.* We propose a fast numerical method to evaluate total quality factor of photonic-crystal-slab-based microcavity. Cavity mode and in/out plane losses are calculated by 2-D–FDTD and 3-D–PWE methods. Results are compared with Full 3-D–FDTD simulations.

IWF8 • 3:45 p.m.
Efficient Approach for 3-D Full Vectorial Sensitivity Analysis Using ADI-BPM, *Mohamed A. Swillam, Mohamed H. Bakr, Xun Li; McMaster Univ., Canada.* A novel approach for sensitivity analysis using the 3-D full vectorial beam propagation method based on alternative direction implicit technique is proposed. Our approach is efficient, simple, easy to implement and has second order accuracy.

Salon Foyer
4:00 p.m.–4:30 p.m.
Coffee Break

4:30 p.m.–5:45 p.m.
IWH • Resonant Structures
Azizur B. M. Rahman; City Univ., UK, Presider

IWH1 • 4:30 p.m.
Confinement Analysis in Symmetric and Asymmetric Nanoscale Slab Slot Waveguides, *Qun Zhang[1], Changbao Ma[2], Edward Van Keuren[2]; [1]Minnesota State Univ., USA, [2]Georgetown Univ., USA.* Using the recently derived analytical TM modal field expression and the transcendental dispersion relation for a general nanoscale asymmetric slab slot waveguide, the confinement performance in symmetric vs. asymmetric geometries was systematically analyzed and compared.

Salon E

IWG2 • 4:45 p.m.
Non-Hermitian Quantum Mechanics for Linear Photonic Logic, *Vita Vishnyakov, Pavel Ginzburg, Alex Hayat, Meir Orenstein; Dept. of Electrical Engineering, Technion, Israel.* Unidirectional interference is proposed for controlling strong fields by weak ones, based on Maxwell-Schrödinger equation analogies. Electromagnetic equivalents of EIT under non-Hermitian Hamiltonian result in low-power linear photonic logic with unidirectional optical gratings.

IWG3 • 5:00 p.m.
Thermo-Optical Compensation in High-Index-Contrast Waveguides Using Polymer Claddings, *Winnie N. Ye[1], Jurgen Michel[1], Louay Eldada[2], Deepti Pant[2], Rong Sun[1], Po Dong[3], Michal Lipson[3], Lionel C. Kimerling[1]; [1]MIT, USA, [2]DuPont Photonics Technologies, USA, [3]Cornell Univ., USA.* We present the design and fabrication of temperature-insensitive high-index-contrast waveguides using acrylate polymer claddings. The large negative thermo-optic coefficient of the polymers effectively compensates the intrinsic positive thermo-optic effects induced from the waveguide core.

IWG4 • 5:15 p.m.
Dependence of Silicon-on-Insulator Waveguide Loss on Lower Oxide Cladding Thickness, *Adam Mock, John D. O'Brien; Univ. of Southern California, USA.* Silicon-on-insulator waveguide propagation and bending loss as a function of lower oxide cladding thickness is investigated using the finite-difference time-domain method. Certain non-rectangular waveguide cross-sections can reduce substrate loss.

IWG5 • 5:30 p.m.
Compact Slow-Wave Structures with Maximally-Flat Group Delays Based on Circular Arrays of Microring Resonators, *Vien Van[1], Tie-Nan Ding[2], Warren N. Herman[2], Ping-Tong Ho[2]; [1]Univ. of Alberta, Canada, [2]Univ. of Maryland, USA.* Cyclical propagation of light in circular arrays of microring resonators is exploited to realize efficient slow-wave structures with large group-delay enhancements. Devices with maximally-flat group-delay responses are designed for applications in dispersionless optical delay elements.

Salons A/B

IWH2 • 4:45 p.m.
A Wavelength Division Demultiplexer Based on T-Shaped Channel-Drop Filters Based on Heterostructure Photonic Crystals with Three Outputs, *Mehrdad Djavid, Afshin Ghaffari, Faraz Monifi, Mohammad Sadegh Abrishamian; K. N.Toosi Univ. of Technology, Iran.* In this paper, we demonstrate a new type of photonic crystal wavelength division demultiplexing based on ring resonator; FDTD method concludes output efficiency above 94%. The structure contains two different values of dielectric constant (Heterostructure).

IWH3 • 5:00 p.m.
Calculation and Correction of Coupling-Induced Resonance Frequency Shifts in Traveling-Wave Dielectric Resonators, *Qing Li, Siva Yegnanarayanan, Amir Atabaki, Ali Adibi; Georgia Tech, USA.* We study the CIFS effect in traveling-wave resonators. The physical source of CIFS is revealed and an efficient semi-analytical approximation method for 3-D structures is provided. Method to correct CIFS is also proposed.

IWH4 • 5:15 p.m.
Optical Bistability in Novel Retro-Reflector Based Semiconductor Micro-Ring Lasers, *Zhuoran Wang[1], Guohui Yuan[1], Siyuan Yu[2]; [1]Dept. of Electrical and Electronic Engineering, UK, [2]Dept of Electrical and Electronic Engineering, UK.* Optical bistability are achieved in novel semiconductor ring lasers based on retro-reflector cavities downsized to equivalent ring radius of 26 μm and 16μm at room temperature. L-I curves and optical spectra are observed.

IWH5 • 5:30 p.m.
Optical Transmission in Horizontal Slot Waveguides, *Rong Sun[1], Po Dong[2], Ning-ning Feng[1], Ching-yin Hong[1], Michal Lipson[2], Jurgen Michel[1], Lionel C. Kimerling[1]; [1]MIT, USA, [2]Cornell Univ., USA.* Horizontal single and multiple slot waveguides and ring resonators consisting of deposited amorphous silicon and silicon dioxide are demonstrated. Their waveguide propagation loss, optical confinement, and thermo-optic effects are studied.