Table of Contents

Program updates and changes may be found on the Conference Program Update Sheet distributed in the registration bags.

Conference-at-a-Glance	Sunday, 19 October	Monday, 20 October	Tuesday, 21 October	Wednesday, 22 October	Thursday, 23 October
GENERAL					
Registration	12:00–18:30	07:00–18 :00	07:00–17:30	07:30–18:00	07:30–18:00
Speaker/Presider Check-in		12:00–18:00	07:00–17:30	07:30–18:00	07:30–16:00
Exhibit - featuring FIO Poster Sessions, OSA Student Chapter Competition and more.			10:00–16:00	10:00–14:00	
PROGRAMMING					
Symposium on the 50th Anniversary of Optical Sciences	16:00–18:30				
Plenary Session/Award Presentations		08:00–12:00			
Laser Science Symposium on Undergraduate Research		12:00–18:00			
Symposium on Translational Biophotonics - Focus on Cancer		13:30–15:30			
DLS Dissertation Award Session		16:00–18:00			
Environmental Sensing Special Talk: AFOSR Program on Imaging and Beam Control Through Deep Turbulence		18:00–19:00			
Technical Sessions		13:30–18:00	08:00–17:30	08:00–18:00	08:00–18:00
Poster Sessions (in Exhibit Hall)			12:00–13:30	12:00–13:30	
FiO Postdeadline Paper Sessions					10:30–12:00
Symposium on 50 Years of Lasers in Opthalmology and the New ANSI Safety Standard				08:00–11:00	
Symposium on Laser Particle Acceleration and Novel Acceleration Methods				13:30–18:00	
Symposium on Radiation Reaction in Ultra-High Intensity Lasers					08:00–15:45
SPECIAL EVENTS					
Conference Welcome Reception	18:30–20:00				
OSA Optical Communications Technical Group Networking Event		13:30–15:00			
Meet OSA's Journal Editors		17:30–19:00			
Minorities and Women in OSA (MWOSA) Networking Reception		17:30–19:00			
OSA Student Member Reception		19:00–22:00			
VIP Industry Leaders Networking Event: Connecting Corporate Executives, Recent Graduates and Students			08:00–09:30		
"Mission IYL" OSA Student Chapter Competition (in Exhibit Hall)			12:00–16:00		
Meet the APS Journal Editors			15:30–17:00		
OSA Annual Business Meeting			18:00–19:00		
APS Annual Business Meeting			18:00–19:00		
OSA Holography & Diffractive Optics Technical Group Networking Event			18:00–19:00		
Laser Science Banquet (Ticket Required)			19:00–21:00		
OSA Science Educators' Day				17:00–20:00	
Celebrating 50 Years of Optical Science at Old Tucson (Pre-registration required).				18:00–22:00	
OSA Applications of Visual Science Technical Group Networking Event				18:30–19:30	
University of Arizona/Steward Observatory Mirror Lab Tour (Pre-registration required)					13:00–17:00

All events at JW Marriott Tucson Starr Pass Resort unless otherwise noted. Times are subject to change. Please check the Conference Program & Exhibit Guide Addendum and Update Sheet for updated information. All times reflect Mountain Standard Time Zone.

Welcome to Frontiers in Optics 2014

Welcome to Tucson, Arizona — one of the premier centers of optics and photonics research in the USA. We are pleased that you have chosen to join us for the 2014 Frontiers in Optics (FiO) conference, the 98th Annual Meeting of The Optical Society.

This year's conference encompasses the breadth of optical science and engineering and provides an atmosphere that fosters the exchange of information between those working on fundamental research and those looking for solutions to engineering problems. On behalf of the FiO Subcommittee Chairs, we would like to thank our colleagues from the Division of Laser Science (DLS) of the American Physical Society (APS) for assisting in cultivating joint topics and sessions that will greatly enhance the experience of the attendees at FiO 2014.

The technical program features over 700 invited, contributed oral and poster presentations by celebrated members of the community describing some of the most exciting advances in their fields. Special symposia and other major events further highlight major advances in many selected areas.

Rebecca Richards-Kortum, *Rice Univ., USA,* the FiO plenary speaker, will speak on Point-of-Care Diagnostics for Low-Resource Settings at the Plenary Session and Awards Ceremony, Monday, 20 October, 08:00 to 12:00. Paul Corkum, *National Research Council, Canada,* winner of the OSA 2014 Frederic Ives Medal/Jarus W. Quinn Prize, will also give his address. They will be joined by the LS plenary speaker and the recipient of the APS 2014 Arthur L. Schawlow Prize in Laser Science.

FiO is pleased to feature several special symposia – The Symposium on the 50th Anniversary of Optical Sciences (Sunday, 19 October, 16:00–18:30); the Symposium on Translational Biophotonics – Focus on Cancer (Monday, 20 October, 13:30–15:30); the Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard (Wednesday, 22 October, 08:00–11:00); the Symposium on Laser Particle Acceleration and Novel Acceleration Methods (Wednesday, 22 October, 13:30–18:00) ; and the Symposium on Radiation Reaction in Ultra-High Intensity Lasers (Thursday, 23 October, 08:00–15:45). Details about all the symposia are listed on the Symposia pages of this program.

This year's meeting is filled with many informational and networking events. Some of the highlights of FiO 2014 include the following:

- The FiO/LS Conference Welcome Reception will be held on Sunday, 19 October, from 18:30 to 20:00.
- OSA Students will be welcomed at the OSA Student Member reception on Monday, 20 October from 19:00–22:00.
- If you are an OSA member, be sure to join us at the OSA Member Reception on Tuesday, 21 October, from 19:00–21:00.
- Late-breaking advances in optics will be presented on Thursday, 23 October, in the FiO Postdeadline Paper Sessions, running from 10:30–12:00.
- FiO is pleased to announce the 6th annual Emil Wolf Outstanding Student Paper Competition. One award winner will be selected from each of the eight FiO subcommittees. Selections will be made based on the quality of the submitted technical summary and presentation. Winners will be announced at the end of the conference and in the next issue of *Optics & Photonics News* (OPN).
- Tuesday and Wednesday, while you are enjoying the poster sessions and the coffee breaks in the Exhibit Hall and or taking breaks from the presentations, please see the latest in scientific and optical instrumentation and information that our exhibitors have on display!
- Science Educators' Day will be held on Wednesday, 22 October, from 17:00–20:00, in the Tucson Ballroom, Salon E. Hosted by The Optical Society, Science Educator's Day (EDAY) provides middle and high school science teachers with a wide variety of optics-focused lesson plans and classroom demonstration guides. EDAY attendees receive materials that can be used in middle and high school classrooms.

We welcome you to FiO 2014 and encourage you to take full advantage of the benefits of this year's social and networking opportunities, technical sessions, corporate programming, poster sessions and exhibition!

Alfred U'Ren
General Chair
Instituto de Ciencias Nucleares, Mexico

Adam Wax
General Chair
Duke Univ., USA

P. Scott Carney
Program Chair
Univ. of Illinois at Urbana-Champaign, USA

Urs Utzinger
Program Chair
Univ. of Arizona, USA

Welcome to Laser Science 2014

The leadership of the Division of Laser Science (DLS) of the American Physical Society (APS) is pleased to welcome you to our 30th annual meeting, Laser Science (LS) 2014, in Tucson, Arizona, 19–23 October 2014. We are grateful for the help of our colleagues and technical program committee members, Julian Sweet, King-Chuen Lin, Jerry Moloney, Brian Anderson, Andy Kung, Joshua Hendrickson, Elohim Chavez, and Stephan Koch, in organizing a broad range of topics in physics, biology and chemistry.

This year's program includes many of the areas at the forefront of laser science that are customarily found at the annual DLS meeting, plus topics associated with nano-opto-mechanics, ultrafast x-rays from XFEL sources, chemical dynamics with ultrafast lasers, and quantum optics. We have collaborated with our colleagues in The Optical Society to coordinate schedules to encourage your intellectual wanderings between DLS and OSA sessions.

In addition to an outstanding technical program, there are many exciting special symposia and events scheduled for the meeting this year. Special attention is appropriate for the Symposium on Undergraduate Research on Monday afternoon, which showcases the work of some of our youngest scientists. The Symposium will feature a special poster session to present the work of selected undergraduate researchers.

Jeff Kimble, *California Inst. of Technology, USA*, the LS plenary speaker, will speak on Atom-Light Interactions in Photonic Crystals at the Plenary Session and Awards Ceremony, Monday, 20 October, 08:00 to 12:00. Mordechai Segev, *Technion – Israel Inst. of Technology, Israel*, winner of the APS 2014 Arthur L. Schawlow Prize in Laser Science, will also give his address. They will be joined by the FiO plenary speaker and the recipient of the OSA 2014 Frederic Ives Medal/Jarus W. Quinn Prize.

The technical sessions for the Laser Science meeting are organized around several broad themes: Photonic Crystals: Fundamentals and Applications; Optical and Laser-Based Approaches in Chemical and Biological Sensing; Filamentation of Ultrashort Intense Laser Pulses; Cold Atoms and Molecules – Exploring New Physics with Quantum Degenerate Gases; Attosecond EUV and X-ray Light Sources and Their Applicaionts; Innovative Resonator-Emitter Coupled Systems; Quantum Information with Photons; and Semiconductor Nanooptics. Also of special note is a symposium on the 50th Anniversary of Optical Sciences (Sunday, 19 October, 16:00–18:30).

Our DLS business meeting will be held Tuesday, 21 October from 18:00 to 19:00 in the Tucson Ballroom, Salon D. The Laser Science banquet will be Tuesday evening, following the business meeting, in the Signature Grill Restaurant, Outdoor Patio – JW Marriott Tucson Starr Pass Resort from 19:00 to 21:00.

We welcome you to the Laser Science 2014 Meeting and encourage you to take full advantage of this year's technical and poster sessions, symposia, and plenary lectures, as well as an exhibit hall showcasing leading suppliers to the laser science community.

Enjoy!

Galina Khitrova
Conference General Chair
Univ. of Arizona, USA

Cheuk-Yiu Ng
Conference Program Chair
Univ. of California Davis, USA

General Information

Conference Services

Registration
Arizona Ballroom Foyer

Registration Hours

Sunday, 19 October	12:00–18:30
Monday, 20 October	07:00–18:00
Tuesday, 21 October	07:00–17:30
Wednesday, 22 October	07:30–18:00
Thursday, 23 October	07:30–18:00

Speaker Preparation Room
San Luis 2

Speakers and presenters are encouraged to stop by the Speaker Preparation Room to test their computers and presentations prior to their session. The room will be equipped with LCD projectors and screens. Computers will be available to test presentations.

Speaker Preparation Hours

Monday, 20 October	12:00–18:00
Tuesday, 21 October	07:00–17:30
Wednesday, 22 October	07:30–18:00
Thursday, 23 October	07:30–16:00

Press Room
Executive Boardroom 2

A staffed press room is available for credentialed members of the media. Badges for pre-registered reporters and reporter registration are in the press room along with press kits, internet connectivity and printer, quiet work space and conference information.

Press Room Hours

Sunday, 19 October	12:00–16:00
Monday, 20 October	07:30–18:00
Tuesday, 21 October	07:30–18:00
Wednesday, 22 October	07:30–18:00
Thursday, 23 October	07:30–12:00

E-Center
Tucson Ballroom Foyer

The E-Center, offering free internet connectivity, will be open Sunday through Thursday during registration hours.

UPS Store (Business Center)
Monday through Thursday: 07:00–18:00
Friday: 07:00–17:00
Saturday and Sunday: 08:00–15:00
+1 520.791.6200

The UPS Store at JW Marriott Tucson Starr Pass is a full service business center offering a full range of services including printing (black & white, color), scanning, fax and email transmission, packaging and shipping, finishing services (laminating, binding), and wide format printing and laminating (posters, banners).

Lost and Found

For Lost and Found please check first at the registration counter in the Arizona Ballroom Foyer. **Please put your name on all conference materials (including your Conference Program), as they will only be replaced for a fee.**

Special Needs

If you have a disability and require special accommodations in order to fully participate in this conference, please contact Conference Management at the registration desk. Your specific needs will be addressed.

Exhibit Hall
Tuesday, 21 October, 10:00–16:00 and Wednesday, 22 October, 10:00–14:00
Arizona Ballroom, Salons 1-7

The FiO Exhibit is open to all registered attendees. Visit a diverse group of companies representing every facet of the optics and photonics industries. For more information, see page 21.

Wifi Access Instructions

To access the complimentary wifi services during the FiO/LS Conference, use the following information to log in. If you require more detailed instructions, a step-by-step access guide is available at the FiO registration desk.

SSID: FIO2014
Password: optical2014

Looking for Lunch? Restaurants, Food Trucks and Cash Concessions!

In addition to four on property restaurants we have planned some new exciting lunch options. On Monday, 20 October and Tuesday, 21 October a variety of food trucks will be available during lunch hours *(cash and credit accepted)*. On Wednesday, 22 October, cash concessions will be available in the exhibit hall from 12:00–13:30, visit with the exhibitors and poster session presenters and enjoy lunch *(cash only please)*. Cash concessions will also be available on Thursday, 23 October during lunch hours, set on the Ania Terrace. Please visit the conference mobile app for more information.

First Aid and Emergency Information

In the event of an emergency at the JW Marriott Tucson Starr Pass hotel go to the nearest house phone and dial "0", advise the operator of your identity and location so they can better assist you.

If you have an emergency and cannot wait at the phone dial "911" and leave the phone off the hook in that area. Please only use 911 in the event of a serious situation.

If you have a Security concerns for yourself or others in your group please contact the operator at "0" and you will be put in touch with the Loss Prevention Department.

Medical Facilities

Carondelet St. Mary's Hospital
1601 W St Mary's Rd.
Tucson, AZ 85745
+1 520.872.3000
Available 24 hours a day
Travel time from the hotel is about 5 minutes

University of Arizona Medical Center
1501 N Campbell Ave
Tucson, AZ 85724
+1 520.694.0111
Available 24 hours a day
Travel time from the hotel is about 15 minutes

Walgreens Take Care Clinic
2180 W. Grant Road
Tucson, AZ 85745
+1 520.620.1088
Monday and Thursday: 08:00–17:30
Tuesday, Wednesday and Friday: 08:00–19:30
Saturday and Sunday: 09:30–17:00
Travel time from the hotel is about 11 minutes

Next Care Urgent Care
4280 N. Oracle Rd., Suite 100
Tucson, AZ 85705
+1 888.381.4858
Monday through Sunday: 08:00–24:00
Travel time from the hotel is about 20 minutes

Sponsoring Society Membership Booths

Arizona Ballroom Foyer

Catch up on the latest product and service offerings of the meetings' sponsoring societies, APS and OSA, by visiting their membership booths.

Stay Connected

Download the FiO/LS Mobile Application

Frontiers in Optics/Laser Science 2014 (FiO/LS 2014) has gone mobile again this year using CrowdCompass! We strongly encourage you to download our mobile guide to enhance your experience at FiO/LS 2014. You'll be able to plan your day with a personalized schedule and browse exhibitors, maps and general show info.

The app is compatible with iPhone, iPad, iPod Touch and Android devices.

To get the guide, choose one of the methods below:

1. Visit http://www.osa.org/fioapp to download the application.
2. Scan the following image with your mobile phone (QR-Code reader required, e.g. 'Red Laser', 'Barcode Scanner')

Technical Digest and Postdeadline Papers

Technical attendees have EARLY (at least one week prior to the meeting) and FREE continuous online access to the FiO/LS 2014 technical digest and Postdeadline papers. These 1-2-page summaries of tutorial, invited, and accepted contributed papers can be downloaded individually or by downloading daily .zip files. (.zip files are available for 60 days.)

1. Visit the conference website at http://www.frontiersinoptics.com
2. Select the purple "Download Digest Papers" button on the right side of the web page
3. Log in using your email address and password used for registration. You will be directed to the conference page where you will see the .zip file links at the top of the page. [Please note: if you are logged in successfully, you will see your name in the upper right-hand corner.]

Access is limited to Full Technical Attendees only. If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

Join the Social Conversation at FiO/LS 2014!

We will be providing the latest updates throughout the conference using Twitter. Do you have a twitter handle? Join in the conversation and you could win a gift card for up to $100! Follow @Opticalsociety on Twitter. Tweet about your conference experience using #FiO14 in your tweets. Stop by the OSA booth for more details.

Join the conversation.
Follow @Opticalsociety on Twitter.
Use hashtag **#FiO14**.

Young Professional Bloggers

Watch for OSA's own Young Professional and Student Bloggers reporting on conference events and their unique experiences at FiO! The Luminous Insights Blog posts will be shared via the Conference Twitter stream #FiO14

Program Playback: Recorded Content

We are delighted to announce we are continuing to offer this valuable enhancement free to FiO/LS full technical registrants. More than 40% of the sessions at this year's conference are being digitally captured for on-demand viewing. The pre-selected content includes the plenary presentations, selected hot topics representing the full breadth of the FiO program. Session content will be available for on-demand viewing until **23 December 2014.** All captured session content will be live for viewing within forty-eight hours of being recorded. Just look for the ▶ symbol in the Agenda of Sessions to easily identify the presentations being captured.

1. Visit the conference website at www.frontiersinoptics.com
2. Select the purple "View Presentations" button on the right side of the web page
3. Log in using your email address and password used for registration. You will be directed to the conference page where you will see the .zip file links at the top of the page. [Please note: if you are logged in successfully, you will see your name in the upper right-hand corner.]

Access to the recorded sessions is limited to full technical attendees only.

Poster Presentation PDFs

Authors presenting posters have the option to submit the PDF of their poster, which will be attached to their papers in Optics InfoBase. If submitted, poster PDFs will be available about three weeks after the conference end date.

Not Mobile?

Be sure to check these printed resources to find program updates.

Conference Program Update Sheet

All technical program changes will be communicated in the onsite Conference Program Update Sheet. All attendees will receive this information with your onsite registration materials and we encourage you to review it carefully to stay informed on changes to the program.

Exhibit Buyers' Guide

The Exhibit Buyers' Guide is composed of descriptions and contact information for exhibiting companies at this year's conference, and exhibit hall activities. Guides will be provided to every FiO/LS attendee as part of registration. All exhibitor information changes will be communicated in the FiO/LS mobile application. We encourage you to review the mobile application carefully to stay informed of changes to the program.

Program Updates Board

Onsite Program changes will be posted on an update board located at the registration desk. Check daily for new information.

2015 OSA Optics and Photonics Topical Meetings and Congresses		Submit your abstract by:
Fourier Transform Spectroscopy (FTS)	1 – 4 March Lake Arrowhead, California, USA osa.org/fts	4 November 2014
Hyperspectral Imaging and Sounding of the Environment (HISE)	1 – 4 March Lake Arrowhead, California, USA osa.org/hise	4 November 2014
Bio-Optics: Design and Application (BODA) Novel Techniques in Microscopy (NTM) Optical Molecular Probes, Imaging and Drug Delivery (OMP) Optical Trapping Applications (OTA) Optics and the Brain (BRAIN)	Optics in the Life Sciences Congress 12 – 15 April Vancouver, Canada osa.org/lifesciencesOPC	13 January 2015
Digital Holography & 3-D Imaging (DH)	osa.org/dh 24 – 28 May Shanghai, China	4 February 2015
Adaptive Optics: Methods, Analysis and Applications (AO) Application of Lasers for Sensing & Free Space Communication (LS&C) Applied Industrial Optics; Spectroscopy, Imaging & Metrology (AIO) Computational Optical Sensing and Imaging (COSI) Freeform Optics (Freeform) Imaging Systems and Applications (IS) Propagation through and Characterization of Distributed Volume Turbulence (pcDVT)	Imaging and Applied Optics Congress osa.org/imagingOPC 7 – 11 June Washington, DC USA	18 February 2015
Integrated Photonics Research, Silicon and Nano Photonics (IPR) Novel Optical Materials and Applications (NOMA) Optical Sensors (Sensors) Photonics Networks and Devices (Networks) Signal Processing in Photonics Communications (SPPCom)	Advanced Photonics Congress osa.org/photonicsOPC 27 June – 1 July Boston, Massachusetts, USA	10 March 2015
Nonlinear Optics (NLO)	osa.org/nlo 26 – 31 July Kauai, Hawaii	7 April 2015
Advanced Solid State Lasers (ASSL) Mid-Infrared Coherence Sources (MICS)	The Laser Congress November Germany osa.org/lc	July 2015
Optical Nanostructures and Advanced Materials for Photovoltaics (PV) Optics and Photonics for Energy & the Environment (E2) Optics for Solar Energy (SOLAR) Solid-State and Organic Lighting (SOLED)	Light, Energy and the Environment Congress December Suzhou, China osa.org/energyOPC	September 2015

Awards Ceremony and Conference Plenary Session

Monday, 20 October, 08:00–12:00
Arizona Ballroom, Salons 1-6

Join your colleagues to recognize recent OSA and APS/Division of Laser Science award and honor recipients. The session includes the Ives Medal Presentation, the Schawlow Prize Lecture and two plenary presentations.

The order of events:

Welcome

Remarks by Congressman Ron Barber, Arizona's 2nd Congressional District

OSA Award and Honor Presentations

International Year of Light, Philip Russell

Ives Medal Lecture – A Petahertz Oscilloscope – All Optical Measurement in the Atto Domain, Paul B. Corkum, *National Research Council, Canada*

Coffee Break

The College of Optical Sciences: Lighting the Future Video

APS/Division of Laser Science Award and Honor Presentations

Schawlow Prize Lecture— Photonic Topological Insulators, Mordechai Segev, *Technion – Israel Inst. of Technology, Israel*

Point-of-Care Diagnostics for Low-Resource Settings, Rebecca Richards-Kortum, *Rice Univ., USA*

Atom-Light Interactions in Photonic Crystals, H. Jeff Kimble, *California Inst. of Technology, USA*

Closing Remarks

Plenary Presentations

Point-of-Care Diagnostics for Low-Resource Settings, Rebecca Richards-Kortum, *Rice Univ., USA*

Half the world's children live on less than $2/day and do not have access to basic medical technologies. This talk will describe efforts to engineer appropriate high-performance, low-cost biophotonics technologies to meet health needs in low-resource settings.

Rebecca Richards-Kortum is the Stanley C. Moore Professor and Chair of Bioengineering at Rice Univ. After receiving a B.S. in Physics and Mathematics from the Univ. of Nebraska-Lincoln in 1985, she continued her graduate work at the Massachusetts Inst. of Technology, where she received an M.S. in Physics in 1987 and a Ph.D. in Medical Physics in 1990. She joined the faculty in Bioengineering at Rice Univ. in 2005. In addition to being named a Howard Hughes Medical Inst. Professor in 2002 and 2006, she was elected to the U.S. National Academy of Engineering in 2008.

Dr. Richards-Kortum's research group is developing imaging systems to enable better screening for oral, esophageal, and cervical cancer and their precursors at the point-of-care. More recently, her group has worked to integrate advances in nanotechnology and microfabrication to develop novel, low-cost sensors to detect infectious diseases at the point-of-care, including cryptosporidium, malaria, and HIV.

Atom-Light Interactions in Photonic Crystals, H. Jeff Kimble, *California Inst. of Technology, USA*

New paradigms for strong atom-photon interactions would emerge by trapping arrays of atoms in one- and two-dimensional photonic crystals. Bringing this future to fruition requires the creation of an interdisciplinary "toolkit" for the control, manipulation, and interaction of atoms and photons with a complexity and scalability not currently possible.

H. Jeff Kimble is the William L. Valentine Professor and Professor of Physics at the California Inst. of Technology, where he is Director of the Inst. for Quantum Information and Matter. He completed his undergraduate degree at Abilene Christian Univ. in 1971, and his doctoral degree in 1977 at the Univ. of Rochester. He spent two years as a staff scientist at the General Motors Research Laboratories. In 1979, he joined the faculty at the Univ. of Texas at Austin, where he eventually held the Sid Richardson Regents' Chair of Physics before moving to Caltech in 1989. Professor Kimble is a Fellow of the American Association for the Advancement of Science, the American Physical Society, and The Optical Society, and he is a member of the U.S. National Academy of Sciences.

Awards Ceremony

APS Arthur L. Schawlow Prize and Lecture

The Schawlow Prize recognizes outstanding contributions to basic research that uses lasers to advance our knowledge of the fundamental physical properties of materials and their interaction with light. The Division of Laser Science of the American Physical Society will award the 2014 Arthur L. Schawlow Prize in Laser Science to **Mordechai Segev** for groundbreaking contributions to the study of light-matter interactions, in particular the discovery of optical spatial solitons in photorefractive media, for milestone contributions to nonlinear waves in photonic lattices, and for the observation of Anderson localization of light.

Photonic Topological Insulators, Mordechai Segev, *Technion – IsraelInst. of Technology, Israel*

Photonic systems are naturally an excellent avenue to study fundamental concepts of waves' interactions, and many times lead to new discoveries. In this context, the recent breakthroughs on photonic topological insulators will be discussed, with an emphasis on fundamental aspects that are universal to many waves systems in nature.

Mordechai (Moti) Segev is a Distinguished Univ. Professor and the Trudy and Norman Louis Professor of Physics at the Technion - Israel Inst. of Technology, Haifa, Israel. He received his B.Sc. and D.Sc. from the Technion, Israel, in 1985 and 1990, respectively. He spent one year at Caltech as a post-doctoral fellow followed by two years as a Senior Research Fellow. He joined Princeton in September of 1994 as an Assistant Professor, becoming an Associate Professor in 1997, and a Professor in 1999. In the summer of 1998, Segev went back to his home country, Israel, and joined the Technion, eventually resigning from Princeton in 2000. In 2009, he was appointed as Distinguished Univ. Professor - the highest rank at the Technion, currently held by only five other professors.

Moti Segev is a Fellow of The Optical Society (1997), and the American Physical Society (2000). He has won several awards, among them the European Physics Society's Quantum Electronics Prize (2007), , and the OSA Max Born Award (2009)., On the national level, he won the 2008 Israeli Landau Prize, and in 2011 he was elected to the Israel Academy of Sciences and Humanities.

Frederic Ives Medal /Jarus W. Quinn Prize

Recognizing overall distinction in optics, the Frederic Ives Medal is the highest award of the Society. It was endowed in 1928 by Herbert E. Ives, a distinguished charter member and 1924-1925 OSA President, to honor his father, who was noted as the inventor of modern photoengraving and who made pioneering contributions to color photography, three-color process printing, and other branches of applied optics. The medalist is asked to present a plenary address at OSA's Annual Meeting. The prize is funded by the Jarus W. Quinn Ives Medal Endowment, raised by members at the time of Quinn's retirement in recognition of his 25 years of service as OSA's first Executive Director. This year's Frederic Ives Medal/Jarus W. Quinn Prize will be presented to **Paul Corkum** for outstanding contributions to the foundation of the fields of attosecond science, high-harmonic spectroscopy and molecular optics.

A Petahertz Oscilloscope – All Optical Measurement in the Atto Domain, Paul Corkum, *National Research Council, Canada*

A highly multiphoton process is hardly modified by a weak perturbing field. Yet, the perturbing field can impress a subtle imprint that we can use for measurement. Applied to attosecond pulse generation, we can simultaneously measure the attosecond pulse and the time dependence of the perturbing field.

A Canadian originally from Saint John, New Brunswick, Paul Corkum is a Fellow of the Royal Society of London and a foreign member of both the U.S. and Austrian Academies of Sciences. An OSA Fellow, he has been awarded the King Faisal Prize for Science, the Harvey Prize for Science, the OSA Charles H. Townes Award, the IEEE Quantum Electronics Award, the Arthur L. Schawlow Prize of the American Physical Society (APS), and the Zewail Prize of the American Chemical Society.

Corkum received his Ph.D. from Lehigh Univ. in 1972 and joined the Canadian National Research Council in 1973. He introduced many concepts for how atoms and molecules interact with intense light pulses. From this work, he showed how atomic or molecular gases can be used to produce and measure attosecond pulses, as well as how a molecule can "photograph" itself. He currently directs the Joint Attosecond Science Laboratory in Ottawa and holds a Canada Research Chair in Attosecond Photonics at the Univ. of Ottawa.

The following Awards will be presented during the Plenary and Awards Ceremony:

- APS/Division of Laser Science Fellowships
- Arthur L. Schawlow Prize
- OSA Fellowships
- OSA Honorary Member
- 2013 and 2014 Frederic Ives Medal/Jarus W. Quinn Prize
- Esther Hoffman Beller Medal
- Max Born Award
- Stephen D. Fanton Distinguished Service Award
- Michael S. Feld Biophotonics Award
- Paul F. Forman Team Engineering Excellence Award
- Robert E. Hopkins Leadership Award Edwin Land Medal
- Sang Soo Lee Award
- Emmett Leith Medal
- Adolph Lomb Medal
- William F. Meggers Award
- David Richardson Medal
- R. W. Wood Prize

APS/Division of Laser Science Awards and Honors

APS/Division of Laser Science Fellowships
Randy A. Bartels**,** *Colorado State Univ., USA*
Daniel Mittleman, *Rice Univ., USA*
Martin C. Richardson, *Univ. of Central Florida, USA*

Arthur L. Schawlow Prize
Mordechai Segev, *Technion-Israel Inst. of Technology, Israel*

OSA Awards and Honors

OSA Fellowships
Chen Yuan Dong, *National Taiwan Univ., Taiwan*
Janice A. Hudgings, *Pomona College, USA*
Alan A. Madej, *National Research Council, Canada*
Jennifer C. Ricklin, *Air Force Research Laboratory, USA*

OSA Honorary Member
Stephen E. Harris, *Stanford Univ., USA*

2014 Frederic Ives Medal/Jarus W. Quinn Prize
Paul B. Corkum, *Univ. of Ottawa and National Research Council, Canada*
For outstanding contributions to the foundation of the fields of attosecond science, high-harmonic spectroscopy and molecular optics.

2013 Frederic Ives Medal/Jarus W. Quinn Prize
Alain Aspect, *Institut d'Optique, École Polytechnique and CNRS, France*
For carrying out pioneering research on photons and atoms, shedding light on the most intriguing quantum phenomena and prompting the development of the new field of quantum information.

Esther Hoffman Beller Medal
Shin-Tson Wu, *Univ. of Central Florida, USA*
For his broad and significant impact to academia and industry in photonics education through mentoring, textbooks, publications, seminars and onsite training courses.

Max Born Award
Costas M. Soukoulis, *Iowa State Univ. and Ames Laboratory, USA*
For his creative and outstanding theoretical and experimental research in the fields of photonic crystals and left-handed metamaterials and for novel applications of these materials to manipulate electromagnetic radiation.

Stephen D. Fantone Distinguished Service Award
Anthony J. Campillo, *The Optical Society, USA*
For sustained leadership, vision and outstanding dedication to the quality and impact of OSA publications.

Michael S. Feld Biophotonics Award
Rebecca Richards-Kortum, *Rice Univ., USA*
For exceptional contributions to advancing the applications of optics in disease diagnosis and inspiring work in disseminating low-cost health technologies to the developing world.

Paul F. Forman Team Engineering Excellence Award
Intel Silicon Photonics Group, *Intel Corp., USA*
For 12+ years of innovation in the research and development of a revolutionary 4x25G silicon photonics, fully integrated, optical transceiver that is designed to help change the way data centers are architected.

Robert E. Hopkins Leadership Award
Robert P. Breault, *Breault Research Organization, USA*
For pioneering leadership in the formation of global optics industry clusters.

Edwin Land Medal (co-sponsored with IS&T)
Mathias Fink, *École Supérieure de Physique et de Chimie Industrielles de la Ville de Paris, France*
For seminal investigations of time reversal of ultrasonic waves with applications to imaging and therapy.

Sang Soo Lee Award (co-sponsored with the Optical Society of Korea)
Maria Garavaglia, *Centro de Investigaciones Ópticas, Argentina*
For his key role in the development of optics and photonics research and education in Argentina.

Emmett Leith Medal
Posthumous recognition of Adam Kozma for his seminal contributions to optical information processing of radar data and holographic memories.

Adolph Lomb Medal
Alexander Szameit, *Friedrich-Schiller-Universität Jena, Germany*
For groundbreaking contributions to linear and nonlinear light evolution in photonic lattices, and photonic simulations of quantum, solid state and relativistic phenomena.

William F. Meggers Award
François Biraben, *Laboratoire Kastler Brossel, France*
For outstanding achievements in high resolution atomic spectroscopy and metrology of fundamental constants, leading to far-reaching tests of quantum electrodynamics.

David Richardson Medal
Jannick P. Rolland, *Univ. of Rochester, USA*
For visionary contributions and leadership in optical design and engineering, enabling noninvasive, optical biopsy.

R. W. Wood Prize
Michael Bass, *Univ. of Central Florida, USA*
For the discovery of optical rectification, which led to the development of very wide band terahertz wave sources.

OSA's awards and medals are endowed through the OSA Foundation. The OSA Foundation is proud to support this prestigious program and recognize outstanding contributions in optics and photonics. For more information about the OSA Foundation, please visit www.osa.org/foundation or contact staff at foundation@osa.org.

Awards and Special Recognitions

OSA Foundation Grant Recipients

The OSA Foundation benefits over 7,000 people a year. We inspire future optics innovators, support career development for optics students, recent graduates and young professionals, and recognize distinguished achievement in the field through the presentation of awards and honors.

We would like to congratulate our 2014 grant recipients. Through the following programs we have been able to provide over 30 grants to help students attending FiO. For more information on who we are and what we do, visit www.osa.org/Foundation.

OSA Foundation

Emil Wolf Outstanding Student Paper Competition

This competition recognizes the innovation, research excellence and presentation abilities of students presenting their work during FiO and honors Emil Wolf for his many contributions to science and the Optical Society. One winner is selected from each of the eight FiO subcommittees. Winners receive a complimentary OSA student membership, an award stipend of $300 USD and an award certificate.

Congratulations to our finalists competing at FiO:

FiO 1: Optical Design and Instrumentation
Giovanni Milione, *CUNY City College, USA*
Christopher Edwards, *Univ. of Illinois at Urbana-Champaign*, USA
Dustin Moore, *Univ. of Rochester, USA*

FiO 2: Optical Sciences
Marie Antier, *Thales Research & Technology, USA*
Elad Schleifer, *Hebrew Univ. of Jerusalem, Israel*
Rory Speirs, *Univ. of Melbourne, Australia*
Scott Wandel, *Penn State Univ., USA*

FiO 3: Optics in Biology and Medicine
Jessica Dobbs, *Rice Univ., USA*
Amy Shah, *Vanderbilt Univ., USA*
Wonju Lee, *Yonsei Univ., South Korea*

FiO 4: Optics in Information Processing
Yuecheng Shen, *Washington Univ. in St. Louis, USA*
Chien-Hung Lu, *Princeton Univ., USA*
Mohammad Mirhosseini, *Univ. of Rochester, USA*

FiO 5: Fiber Optics and Optical Communications
Lucien Mandeng, *Universite de Yaounde I, Cameroon*
Yamile Cardona Maya, *Universidad Nacional de Colombia, Colombia*
Yuhong Yao, *Univ. of Rochester, USA*

FiO 6: Integrated Photonics
Kenneth Goodfellow, *Univ. of Rochester, USA*
Daniel Bachman, *Univ. of Alberta, Canada*

FiO 7: Quantum Electronics
Ogaga Odele, *Purdue Univ., USA*
Hisashi Ogawa, *Univ. of Tokyo, Japan*

FiO 8: Vision and Color
Maria Vinas, *Instituto De Optica (CSIC), Spain*

Incubic/Milton Chang Travel Grant

Funded by an endowment from Milton and Rosalind Chang, this program provides 10 grants of $500 USD each to enable students who present papers to travel to the Frontiers in Optics. Grants are awarded to the presenter and usually the first author of the paper. Congratulations to the 2014 Incubic/Milton Chang Travel Grant Recipients:

Anderson Amaral, *Universidade Federal de Pernambuco, Brazil*

Li Chen, *Ohio State University, USA*

Vala Fathipour, *Northwestern University, USA*

Manuel Marques, *University of Kent, UK*

Giovanni Milione, *CUNY City College, USA*

Jelena Notaros, *University of Colorado Boulder, USA*

Jungwook Paek, *Iowa State University, USA*

Amy Shah, *Vanderbilt University, USA*

Caio Bruno Wetterich, *Universidade de Sao Paulo, Brazil*

Xiaorui Zheng, *Swinburne University of Technology, Australia*

Jean Bennett Memorial Student Travel Grant

Established in 2008, in memory of Jean M. Bennett, a highly decorated research physicist who was recognized for her contributions to the studies of optical surfaces and served as OSA's first female president, this $1,000 USD grant is awarded to a student presenting their work at FiO. This competition is administered by the OSA Foundation and is made possible through the generous support of Nanoptek Corporation, the Pennsylvania State Univ. Department of Physics and individual contributors.

Congratulations to our 2014 grant recipient:

Christopher Edwards, *University of Illinois at Urbana-Champaign, USA*

OSA Foundation Student Travel Grants

The OSA Foundation is pleased to provide travel support to help students from developing nations attend FiO. Each grant recipient receives $1,500 USD to offset costs associated with traveling to the conference.

Congratulations to our 2014 grant recipients:

Romita Chaudhuri, *Indian Institute of Technology, Madras, India*

Wen Ting Hsieh, *National Taiwan University, Taiwan*

Nithyanandan Kanagaraj, *Pondihcerry University, India*

Jian Li, *Beijing University of Posts and Telecommunications, China*

Lucien Mandeng, *Universite de Yaounde I, France*

Yamile Cardona Maya, *Universidad Nacional de Colombia, Columbia*

Vladimir Novikov, *M. V. Lomonosov Moscow State University, Russia*

Nidhi Paliwal, *Indian Institute of Technology Bombay, India*

Sergey Svyakhovskiy, *M. V. Lomonosov Moscow State University, Russia*

Tingyu Xue, *Harbin Institute of Technology, China*

You can help to inspire and support the next generation of science and engineering innovators by making a donation to the OSA Foundation. **For a limited time, all donations are matched 100% by the Optical Society**—so your gift has twice the impact. To learn more and to make a donation online, visit **www.osa.org/Foundation**, or stop by the OSA booth.

DLS Award for Outstanding Doctoral Dissertation in Laser Science

This award was established in 2013 by the American Physical Society (APS) Division of Laser Science (DLS). Its purpose is to recognize doctoral research in the Laser Science area and to encourage effective written and oral presentation of research results. The award consists of $1,000 USD and a certificate citing the contribution made by the recipient. The finalists will present their work at a special session of the Laser Science conference on Monday, 20 October from 16:00–18:00 in Tucson Ballroom Salon B. The winner will be announced during the Laser Science Banquet on Tuesday, 21 October from 19:00–21:00.

OSA Best Poster Presentation Prize

The Optical Society will be offering a prize for Best Poster Presentations. Presentations will be judged onsite and the winner will be announced at the conclusion of the conference and will receive a free conference registration to FiO/LS 2015.

Special Symposia

Symposium on the 50th Anniversary of Optical Sciences

Sunday, 19 October, 16:00–18:30
Arizona Ballroom, Salons 1-6

Organizer: Tom Koch, *Univ. of Arizona, USA*

This 50th Anniversary Symposium will include a brief tour through the history of the College of Optical Sciences at the Univ. of Arizona, leading to talks that capture how the seeds planted 50 years ago by Aden Meinel have blossomed into today's vibrant collection of research endeavors.

Welcoming remarks will be given by the **Honorable Jonathan Rothschild**, Mayor of the City of Tucson (Invited and Scheduled to attend).

Symposium Keynote: A Brief History of the College of Optical Sciences, James C. Wyant; *Univ. of Arizona, USA*

This keynote presentation will discuss the history of the college of Optical Sciences at the Univ. of Arizona

Invited Speakers:

Image Science at OSC, Harrison H. Barrett; *Univ. of Arizona, USA*

Biomedical Optics at OSC, Jennifer Barton; *Univ. of Arizona, USA*

Fabrication & Metrology of Large Optics at OSC, Jim Burge; *Univ. of Arizona, USA*

Atoms and Photons: One Perspective on Quantum Optics at the College of Optical Sciences, Poul Jessen; *Univ. of Arizona, USA*

Semiconductor Physics at the Optical Sciences Center, Stephan Koch; *Philipps-Universitat Marburg, Germany*

The Force Law of Classical Electrodynamics: Lorentz versus Einstein and Laub, Masud Mansuripur; *Univ. of Arizona, USA*

Photonics at OSC, Nasser Peyghambarian; *Univ. of Arizona, USA*

Laser Science Symposium on Undergraduate Research

Monday, 20 October, 12:00–18:00
Tucson Ballroom, Salon E

Organizer: Harold Metcalf, *Stony Brook Univ., USA*

This special DLS annual symposium started in 2001 and has rapidly become one of the most successful DLS traditions. During the past several years the number of undergraduates presenting papers has grown from only 10 to more than 40, and the talks have been of outstanding quality, some absolutely stellar. Last year's posters were outstanding as well, and generated a great deal of lively interest and on-the-spot discussion. This year's symposium will consist of afternoon poster and oral sessions. The event provides an opportunity for some of the student members of our community, who are already among the finest young scientists to be found anywhere, to present their work before an audience of their peers as well as the larger optics community.

For speaker information see the Symposium on Undergraduate Research program in your registration bag.

50 Years
1964 - 2014

OSA/APS congratulates the
University of Arizona
College of Optical Sciences
on its 50th Anniversary

Symposium on Translational Biophotonics – Focus on Cancer

Monday, 20 October, 13:30–15:30
Tucson Ballroom, Salon A

Organizers: Melissa Skala, *Vanderbilt Univ., USA*; Bernard Choi, *Univ. of California, Irivine, USA* and Nozomi Nishimura, *Cornell Univ., USA*

Optical tools have great potential for innovation in pathology and diagnostics. New imaging modalities, contrast mechanisms and design improvements could enable novel ways of diagnosing, treating and monitoring cancer. In addition, optical technologies are entering the operating room and clinic as in situ diagnostics. As research tools, optical technologies are enabling the measurement of function such as metabolism or tissue perfusion and new developments make it possible to use access, visualize and treat anatomy previously unreachable. Novel methods providing chemical information may also change how pathologists look at cancer. Optical technologies are attractive for probing cancer because they provide unique insight into tumor physiology, and are low cost platforms for clinical translation. This symposium will showcase promising optical technologies in cancer research and oncology that are at various stages of clinical translation.

Invited Speakers:

Knowledge of the Principles of Oxygen Transport in Solid Cancers Enables Translational Decisions, Mark Dewhirst; *Duke Univ., USA*

What Can We Learn About Cancer Therapy from Single Cell Tracking, Charles Lin; M*assachusetts General Hospital, USA*

Molecular and Metabolic Imaging of Tumors to inform Therapeutic Interventions, Narasimhan Rajaram; *Duke Univ., USA*

Preclinical and Clinical Chemotherapy Response Monitoring with Diffuse Optical Technologies, Darren Roblyer; *Boston Univ., USA*

Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard

Wednesday, 22 October, 08:00–11:00
Tucson Ballroom, Salon A

Organizer: Brian Vohnsen, *Univ. College Dublin, Ireland*

The first use of a ruby laser to destroy a retinal tumor was realized by Charles J. Campbell in 1961, but the clinical breakthrough on the ophthalmic use of lasers for photocoagulation to prevent retinal detachment was reported by Milton Flocks and Christian Zweng in 1964. In this symposium, historical highlights on the use of lasers in ophthalmology will be given alongside state-of-the-art in the current ophthalmic use of lasers and corresponding safety limits. This symposium consists of two sessions. See times and speakers below.

Invited Speakers:

The Limits of Human Vision, Josef Bille, *Heidelberg Univ., Germany*

Lasers in Retinal Imaging, Stephen A. Burns; *Indiana Univ., USA*

Laser Technologies Enhancing OCT Performance, Wolfgang Drexler; *Medical Univ. Vienna, Austria*

The ANSI 2014 Standard for Safe Use of Lasers, Francois Delori, *Schepens Eye Research Inst., USA*

Application of Second Harmonic Generation Imaging for Visualization of the Characteristics of Corneal Stromal Collagen in Normal and Diseased Eyes, Naoyuki Morishige; *Yamaguchi Univ., Japan*

Symposium on Laser Particle Acceleration and Novel Acceleration Methods

Wednesday, 22 October, 13:30–18:00
Arizona Ballroom, Salon 12

Organizer: Laszlo Veisz, *Max-Planck-Institut fur Quantenoptik, Germany* and Cameron Geddes, *Lawrence Berkeley National Lab, USA*

2014 is the tenth anniversary of the first generation of quasi-monoenergetic electron spectra from laser wakefield acceleration. This achievement has given a significant boost to the development of compact laser plasma acceleration as well as alternative laser-driven acceleration scenarios such as electron acceleration in vacuum by laser or THz fields producing high energies and ultra-short pulses. The rapid evolution of these sources has made them a competing alternative to conventional accelerators by extending their properties and opening up novel application fields from light sources to energy frontier physics. Contributions are sought that explore these laser-based electron accelerators.

Invited Speakers:

Laser Accelerator on a Chip (>300MeV/m): A Path to TeV Energy Scale Physics and Table Top Coherent X-rays, Robert Byer; *Stanford Univ., USA*

Multi-GeV Laser-plasma Electron Accelerators, Mike Downer; *Univ. of Texas at Austin, USA*

Development of a High Repetition Rate Laser-plasma Accelerator for Application to Ultrafast Electron Diffraction, Jérôme Faure; *LOA-ENSTA, France*

Dielectric Laser Acceleration -- From the Proof-of-concept Experiment with Non-relativistic Electrons to Future Applications, Peter Hommelhoff; *Friedrich-Alexander-Universitat Erlangen, Germany*

Optimized Photonic Structures for GV/M Laser Acceleration of Electrons, James Rosenzweig; Univ. *of California, Los Angeles, USA*

Electron Acceleration Experiments by Using a Density-tapered Capillary Plasma Source, Hyong Suk; *GIST, Korea*

Multi-GeV Laser Plasma Accelerators Using Plasma Waveguides and Integration of Multiple Acceleration Modules, Joroen van Tilborg, *LBNL, USA*

Symposium on Radiation Reaction in Ultra-High Intensity Lasers

Thursday, 23 October, 08:00–15:45
Tucson Ballroom, Salon A

Organizers: Richard T. Hammond, *US Army Research Office* and *Univ. of North Carolina Chapel Hill, USA* and Natalia M. Litchinitser, *Univ. at Buffalo, The State Univ. of New York, USA*

By 1905 the problem of radiation reaction in electrodynamics appeared in Abraham's book on the theory of electricity. In 1938 Dirac derived his famous relativistic equation for the equation of motion with radiation reaction, but it gave the infamous unphysical runaway solutions. Landau and Lifshitz used a perturbative form of Dirac's equation that gave sensible results. Since then there have been a number of theories of radiation reaction and the equation of motion, but the physics community has not generally accepted any one approach as correct. Today, with laser intensities already surpassing 10^{22}W cm^{-2} and higher expected in the near future, radiation reaction is a pressing problem. This symposium hopes to bring theoreticians and experimentalists together to find ways to test various theories of radiation reaction. This symposium consists of two sessions. See times and speakers below.

Invited Speakers:

High Repetition Rate kJ-class Nanosecond to Femtosecond Lasers, Todd Ditmire; *Univ. of Texas, Austin, USA*

Radiation Reaction and the Quantum Langevin Equation, George Ford; *Univ. of Michigan, USA*

Probing Radiation-Reaction in the igh Acceleration Regime, Yaron Hadad; *Univ. of Arizona, USA*

Solid-Density Experiments for Laser-Based Thomson Scattering: Approaching the Radiation Dominated Regime, John Nees; *Univ. of Michigan, USA*

Tutorial: Review of the Ford-O'Connell Results on Radiation Reaction in Electrodynamics, Robert O'Connell; *Louisiana State Univ., USA*

Tutorial: Nonlinear Radiation Effects with Filaments - Inside and Outside, Martin Richardson; *Univ. of Central Florida, CREOL, USA*

Radiation Reaction of Relativistic Electrons Scattered by Relativistic Intensity Light, Donald Umstadter; *Univ. of Nebraska, Lincoln, USA*

Radiation Reaction and Ultra-high Intensity Lasers, Sheldon Wu; *Lawrence Livermore National Laboratory, USA*

Special Events

Annual OSA Student Chapter Leadership Conference

Sunday, 19 October, 07:00–17:00
Tucson Ballroom, Salons E & F

The invitation-only Student Leadership Conference brings together OSA Student Chapter leaders from around the globe to network, present posters and learn about successful chapter management and the popular International OSA Network of Students (IONS). The program also features professional development presentations from esteemed leaders in the field.

Welcome Reception

Sunday, 19 October, 18:30–20:00
Ania Terrace

Complimentary to all Technical Conference Attendees: Get the FiO/LS 2014 meeting off to a great start by attending the welcome reception! Meet with colleagues from around the world. Light hors d'oeuvres will be served. Volunteers from the Tucson Amateur Astronomy Association will have telescopes set up for you to observe under the clear, dark skies of Tucson.

OSA Optical Communications Technical Group Networking Event

Monday, 20 October, 13:30–15:00
Arizona Ballroom Salon G

This networking event encourages members and non-members interested in optical communications to interact and exchange ideas and views. Please check the website and update sheet for updates on this event.

Meet OSA's Journal Editors

Monday, 20 October, 17:30–19:00
Ania Terrace

OSA's journal Editors invite you to join them for conversation and refreshments. The Editors welcome your questions, concerns and ideas for the journals, such as:

- What are best practices when submitting your manuscript?
- What constitutes a useful manuscript review?
- What criteria do journal editors look for in submitted manuscripts?
- How do you propose a Feature Issue topic for publication in an OSA Journal?
- Other topics of interest to you

Refreshments will be provided. All are welcome.

Minorities and Women in OSA (MWOSA) Networking Reception

Monday, 20 October, 17:30–19:00
Tucson Ballroom, Salons I-J

Women in Photonics: Working Together to Succeed, Dr. Jessie Rosenberg; *IBM TJ Watson Research Center, USA*

Dr. Jessie Rosenberg is a Research Staff Member at the IBM TJ Watson Research Center, where she focuses on developing silicon photonics technology integrated with CMOS electronics for optical communication applications. She received a Ph.D. degree in Applied Physics from the California Inst. of Technology in 2010 at the age of 23, and was recently named to the Forbes 30 Under 30 list of innovators in science.

OSA Student Member Reception

Monday, 20 October, 19:00–22:00
Starr Canyon River, JW Marriott Tucson Starr Pass Resort

This reception is a fun event that encourages Student Members of OSA to meet, enjoy refreshments and have a good time! Note that membership status will be checked. ID is required. Must be 21 or over to drink.

OSA Environmental Sensing Technical Group Guest Speaker: AFOSR Program on Imaging and Beam Control Through Deep Turbulence

Monday, 20 October, 19:00–20:00
Arizona Ballroom Salon 11

Special Guest Speaker:
Dr. Michael Roggemann

Biography: Dr. Michael C. Roggemann is a professor of electrical engineering at Michigan Tech. He is a world-renowned authority in the area of optical propagation through turbulence. He is coauthor of the book "Imaging Through Turbulence" and has authored or coauthored over sixty journal articles and over fifty conference papers. Dr. Roggemann is a member of the IEEE, and is a fellow of both The Optical Society and SPIE. His present research interests include imaging and beam projection through atmospheric turbulence, optical remote-sensing system design and analysis, and signal and image processing.

Abstract: Deep turbulence arises when the combination of optical path length and turbulence strength lead to saturated log amplitude fluctuations in the log amplitude of the field at either the transmit or the receive end of an optical system working in the presence of turbulence. Our team combines both optical and meteorological modeling expertise as we are

investigating both overcoming strong turbulence, and using meteorological modeling to help predict the best conditions for propagation. In this presentation we summarize our efforts and progress to date.

OSA Environmental Sensing

VIP Industry Leaders Networking Event: Connecting OSA Corporate Members and Young Professionals

Tuesday, 21 October, 08:00–09:30
Tucson Ballroom, Salon F

Includes a hot buffet breakfast. RSVP Required.

Presented by OSA Corporate Membership

Sponsored by GoFoton

This session brings together Industry Executives to share their business experience – from how they started their careers, lessons learned along the way, to using their degree in an executive position – with Young Professionals and Students. The program starts with informal networking during breakfast and then transitions into "speed meetings" – small, brief visits with 5-6 executives to discuss careers, industry trends or other career topics. Some participants include:

- Robert "Bob" Breault, *Breault Research Organization, Inc., USA*
- James Fisher, *Newport Corporation, USA*
- Thomas L. Koch, *College of Optical Sciences, University of Arizona, USA*
- Donald A. Pearson, II, *TRIOPTICS USA/ Davidson Optronics/Wells Research, USA*
- Stephen Schaffer, *Evaporated Coatings, Inc., USA*
- Andre Wong, *JDSU, USA*

Space is limited. Members of OSA's Young Professionals program will be given registration priority, but students and recent graduates are also welcome and encouraged to register.

On-site registration will be accepted pending availability. Please contact vipevents@osa.org if you would like to register.

To join the Young Professionals program, email yp@osa.org.

Poster Presentations

Tuesday, 21 October, 12:00–13:30
Wednesday, 22 October, 12:00–13:30
Arizona Ballroom, Salons 1-7

Poster presentations offer an effective way to communicate new research findings and provide a venue for lively and detailed discussion between presenters and interested viewers. Don't miss this opportunity to discuss current research one-on-one with the presenters. The Optical Society will be offering a prize for Best Poster Presentations. Presentations will be judged onsite and the winner will be announced at the conclusion of the conference.

"Mission: IYL" OSA Student Chapter Competition

Tuesday, 21 October, 12:00–16:00; Winners announced at 14:30.
Arizona Ballroom, Salons 1-7

OSA challenges student chapters to showcase their best ideas for youth education outreach at the annual meeting. This year's competition is Mission: IYL. For a chance to win a $500 USD first prize or $250 USD second prize, chapters have been challenged to create optical demonstrations for children that connect with the mission of the International Year of Light to improve public understanding of how light affects our daily lives. These youth education demos should be easy to recreate in all parts of the world, so chapters must demonstrate properties of light using at least one of three simple household items: food coloring, compact discs and/or slinkies. Volunteer judges will rate chapters on effectiveness, creativity, presentation and supplies. The rules and entry form are available at frontiersinoptics.com/missioniyl.

All FiO/LS attendees are welcome to stop by and join in the fun!

OSA Fellow Members Lunch

Tuesday, 21 October, 12:00–14:00
Tucson Ballroom, Salons G-I

Join your colleagues at the OSA Fellow Member Lunch and Program featuring Andre Wong from JDSU, who will present on their innovative light source used in 3D sensing technology. This technology enables interactions with devices naturally using bodies, gestures, eyes or voice and is used in gaming. Hear about this and other promising applications of 3D sensing technology during the program. JDSU is the corporate contest winner of the OSA Enabled by Optics Contest, which raises public awareness about the role optics and photonics plays as a key enabler of the technologies that improve daily life worldwide.

If you did not RSVP, you may ask if space is still available at the OSA Booth.

OSA Foundation

Meet the APS Journal Editors

Tuesday, 21 October, 15:30–17:00
Ania Terrace

The Editors of the APS journals invite you to join them for conversation and light refreshments. The Editors will be available to answer questions, hear your ideas, and discuss any comments about the journals. All are welcome. We hope you will be able to join us.

OSA Annual Business Meeting

Tuesday, 21 October, 18:00–19:00
Arizona Ballroom, Salon 8

Learn more about OSA and join the OSA Board of Directors for the Society's annual business meeting. The 2013 activity reports will be presented and the results of the Board of Directors election will be announced.

APS Division of Laser Science Annual Business Meeting

Tuesday, 21 October, 18:00–19:00
Tucson Ballroom, Salon D

All members and interested parties are invited to attend the annual business meeting of the Division of Laser Science (DLS). The DLS officers will report on the activities of the past year and on plans for the future. Questions will be taken from the floor. This is your opportunity to help define the operations of the DLS and the LS Conference.

OSA Holography & Diffractive Optics Technical Group Networking Event

Tuesday, 21 October, 18:00–19:00
Arizona Ballroom, Salon 10

Come to this Technical Group meeting for a meet and greet, with refreshments served. There will be a 30 minute tutorial lecture on how to get started with digital holograms in your laboratory. The lecture will cover modern topics with spatial light modulators targeted to graduate students.

OSA
Holography and Diffractive Optics

OSA Member Reception: The Scorchin' Sonoran

Tuesday, 21 October, 19:00–21:00
Tucson Ballroom, Salons E & F

OSA cordially invites **OSA Members** to a blazingly celebratory night amidst the Sonoran Desert. Meet up with friends and colleagues as you savor the flavors of the American Southwest. Tucson has a rich, tri-cultural heritage stemming from Native American, Hispanic and Old West traditions. Your evening is filled with a fusion of cuisine and culture from each group. Enjoy music, drinks and appetizers, and get an introduction to the tastes of Tucson and the sounds of the Southwest.

Please bring your conference registration badge or OSA Membership card; if you join OSA on-site, please bring your receipt.

This event is complimentary and is for OSA Members. Not a member yet? Join today to attend this OSA Member event.

Laser Science Banquet

Tuesday, 21 October, 19:00–21:00
Signature Grill Restaurant, Outdoor Patio – JW Marriott Tucson Starr Pass Resort

Join your colleagues for the annual LS Banquet. Tickets are required for this event and can be purchased at registration for US $70. There is a limited quantity of tickets and tickets must be purchased by 12:00 noon on Monday, 20 October.

OSA Members and Families: Arizona-Sonora Desert Museum Tour

Wednesday, 22 October, 08:30–12:30
Bus will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 08:30.

Sponsored by OSA Members, Family and Friends

OSA members and their families are invited to visit the Arizona-Sonora Desert Museum as guests of OSA. Ranked as the #9 museum in the world in 2013 by TripAdvisor.com, the Desert Museum interprets and showcases the Sonoran Desert region, widely recognized as the lushest desert on earth. Tour participants will enjoy a fusion experience: zoo, botanical garden, natural history museum, aquarium, art gallery and several live animal presentations, exhibited on 21 acres that include two miles of walking paths. Please visit the OSA Membership Booth before 12:00 on Tuesday, 21 October to see if space is still available for this event.

Science Educators' Day (EDAY)

Wednesday, 22 October, 17:00–20:00
Tucson Ballroom, Salon E

This annual event focuses on effective and innovative approaches to science education, with an emphasis on hands-on, interactive classroom lessons.

Teaching and Learning Science Literacy, Michael Raymer; *Univ. of Oregon, USA*

Michael Raymer is a physicist and Phillip H. Knight Professor of Liberal Arts and Sciences at the Univ. of Oregon. He was on the faculty at the Univ. of Rochester's Inst. of Optics before moving to Oregon, where he co-founded the Univ.'s Oregon Center for Optics. His interest in teaching began as an undergraduate at the Univ. of California at Santa Cruz, where he co-instructed a beginning course in chemistry. Many years later he parlayed that experience into the founding of the UO's Science Literacy Program, which is funded by the Howard Hughes Medical Inst., and which reaches across the departments of physics, chemistry, biology, and geology. His interest in teaching science literacy led him to author a textbook, *The Silicon Web: Physics for the Internet Age* (Taylor & Francis, 2009), to accompany a course he teaches called *The Physics Behind the Internet*. His research is in quantum optics, lasers, and atomic and molecular physics. He pioneered the field of quantum state tomography, important in quantum information science. Prof. Raymer is a Fellow of the American Physical Society (APS), and a Fellow of The Optical Society (OSA). He is a past member of the Board of Directors of The Optical Society. He served as Associate Divisional Editor for Physical Review Letters, as a member of the Board of Editors, J. Modern Optics, and as Topical Editor of the J. Optical Society of America B.

Univ. of Arizona, Celebrating 50 Years of Optical Science at Old Tucson

Wednesday, 22 October, 18:00–22:00
Old Tucson, 201 S Kinney Rd., Tucson AZ
$50 per person - Includes dinner/entertainment. Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 18:00.

Enjoy a bang up time at the world famous Old Tucson in celebration of the Univ. of Arizona, College of Optical Sciences 50th Anniversary.

Built in 1938 by Columbia Pictures as a replica of 1860's Tucson for the movie *Arizona*, Old Tucson has been the backdrop to over 70 major motion pictures including ¡Three Amigos! (1986), Tombstone (1993) and is considered Southern Arizona's premier outdoor entertainment venue with a full array of live shows, thrilling stunts, Old West dramas, and saloon musicals!

You will be transported in air-conditioned comfort via motor coach between the JW Marriott Starr Pass Resort & Spa and Old Tucson. Cowboys will welcome you into the town square as you arrive for a cocktail reception followed by a delicious western buffet and delightful western entertainment. At the height of the evening, Dean Thomas Koch will introduce you to the groundbreaking research being conducted at the Univ. of Arizona's College of Optical Sciences and a brief history of our past, present and future.

OSA Applications of Visual Science Technical Group Networking Event

Wednesday, 22 October, 18:30–19:30
Arizona Ballroom, Salon A

This technical group is hosting a social gathering at the end of the last visual optics session on Wednesday, allowing members and non-members interested in visual sciences to interact and exchange ideas and views. Please check the website and update sheet for updates on this event.

FiO Postdeadline Paper Presentations

Thursday, 23 October, 10:30–12:00
See the Update Sheet in your registration bag for exact times and locations

The FiO 2014 Technical Program Committee accepted a limited number of postdeadline papers for presentation. The purpose of postdeadline sessions is to give participants the opportunity to hear new and significant material in rapidly advancing areas. Only those papers judged to be truly excellent and compelling in their timeliness were accepted.

Univ. of Arizona, College of Optical Sciences and Steward Observatory Mirror Lab Tour

Thursday, 23 October,13:00–17:00
No additional fee. Transportation will be provided. Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 13:00. Closed-toe shoes required. Tours involve walking, climbing stairs and standing.

Tour College of Optical Sciences labs where research is being conducted in areas ranging from Bose Einstein condensates and quantum information and control, to biomedical imaging and 3D displays, to the future of internet communications technology. See the facilities where the largest optics on earth are being molded, ground, and polished for astronomical observatories world-wide. This includes the freeform 8.4m mirrors for the Giant Magellan Telescope that will form a single optical surface with an aperture of 24.5 meters, or 80 feet in diameter, and is scheduled to begin science operations at Las Campanas Peak in Chile in 2020.

Exhibit Information

Visit the Frontiers in Optics 2014 Exhibit in the **Arizona Ballroom, Salons 1-7** and get a glimpse of the latest optical innovations! The FiO 2014 exhibit floor will feature companies representing a broad range of the best products and applications in the optics and photonics industry. Don't miss this opportunity to learn about new products, find technical and business solutions and gain the most up-to-date market perspective of your industry.

There is no charge to attend the exhibit—it's open to all registered attendees!

Exhibit Hours

Tuesday, 21 October	10:00–16:00
Unopposed Exhibit-Only Time and PosterSession	12:00–13:30
Wednesday, 22 October	10:00–14:00
Unopposed Exhibit-Only Time and PosterSession	12:00–13:30

Exhibit Hall Coffee Breaks and Unopposed Exhibit-Only Times

Tuesday, 21 October	10:00–10:30 15:30–16:00
Wednesday, 22 October	10:00–10:30

Joint FiO/LS Poster Sessions

Arizona Ballroom, Salons 1-7

Poster presentations offer an effective way to communicate new research findings and provide an opportunity for lively and detailed discussion between presenters and interested viewers. Make sure to visit the poster sessions in the Exhibit Hall to see the more than 80 posters scheduled for presentation.

Tuesday, 21 October	12:00–13:30
Wednesday, 22 October	12:00–13:30

"Mission: IYL" Student Chapter Competition

Tuesday, 21 October, 12:00–16:00; Winners announced at 14:30.
Arizona Ballroom, Salons 1-7

Each year, OSA Student Chapters create innovative demonstrations for youth education outreach and showcase them in the FiO/LS Expo. To prepare for the International Year of Light (IYL), the 2014 Student Chapter Competition known as Mission: IYL challenges chapters to create demonstrations that use at least one of the following items that are easy to obtain most places in the world: food coloring, compact discs and/or slinkies. Volunteer judges will rate chapters on effectiveness, creativity, presentation and supplies. The rules and entry form completed by participating chapters are available at frontiersinoptics.com/missioniyl. All FiO/LS attendees are welcome to stop by and see the creativity of OSA chapters!

Exhibitor Appreciation Reception

Tuesday, 21 October, 16:00–17:30
Arizona Ballroom, Salons 1-7

Exhibitors, finish up your first day and come relax and mingle with your fellow exhibitors. Join us in the exhibit hall immediately following the close of the show for some food and beverages sponsored by OSA Corporate Membership.

Join OSA and discover the benefits of Corporate Membership. OSA can help corporations optimize product development resources and reduce time to market by giving professionals access to quality information, quality interactions and premium opportunities for collaboration. Join today! Contact Regan Pickett at (202) 416-1474 or rpickett@osa.org.

On Wednesday, 22 October, cash concessions will be available in the exhibit hall from 12:00–13:30, visit with the exhibitors and poster session presenters and enjoy lunch *(cash only please)*.

FiO 2014 Participating Companies: *(as of 09/19/2014)*

4D Technology Corporation
AdValue Photonics, Inc.
AIP Publishing
American Elements
American Physical Society (APS)
Andover Corporation
APPLIED IMAGE, Inc.
Arizona Optics Industry Association
Block Engineering
Breault Research Organization
Cambridge University Press
Chroma Technology Corp.
Diamond USA, Inc.
Edmund Optics, Inc.
Energetiq Technology, Inc.
ESDI - Engineering Synthesis Design, Inc.
Evaporated Coatings, Inc.
Femtolasers, Inc.
Fianium Inc.
Hamamatsu Corporation
Heraeus Quartz America, LLC
Imagine Optic
Inrad Optics
IOP Publishing Ltd.
Isuzu Glass, Inc.
Laser Focus World
Material Research Society
Menlo Systems, Inc.
Nature Publishing Group
Newport Corporation
NKT Photonics Inc.
NP Photonics
Nufern
Optical Perspectives Group, LLC
Optimax Systems, Inc.
Opto-Alignment Technology, Inc.
OptoSigma Corporation
OSA Corporate Membership
Photonics Media/Laurin Publishing
Physics Today
PI (Physik Instrumente) LP
Ruda Cardinal
Syntec Optics
Taylor & Francis
TDI International, Inc.
Thorlabs
Toptica Photonics, Inc.
TRIOPTICS USA
UltraFast Innovations
University of Arizona, College of Optical Sciences
Wordingham Technologies
Zygo Corporation

FiO/LS Committee

Thanks to the technical program committee members! Your time and efforts are appreciated!

Frontiers in Optics 2014
Technical Program Committee

Frontiers in Optics Chairs

Alfred U'Ren, *Instituto de Ciencias Nucleares, Mexico,* **General Chair**
Adam Wax, *Duke Univ., USA,* **General Chair**
P. Scott Carney, *Univ. of Illinois at Urbana-Champaign, USA,* **Program Chair**
Urs Utzinger, *Univ. of Arizona, USA,* **Program Chair**

Frontiers in Optics Subcommittees

FiO 1: Optical Design and Instrumentation

Ronguang Liang, *Univ. of Arizona, USA,* **Subcommittee Chair**
Florian Bociort, *TU Delf, Netherlands*
John Koshel, *Univ. of Arizona, USA*
Byoungho Lee, *Seoul National Univ., Korea*
Jannick Rolland, *Univ. of Rochester, USA*
Kevin Rolland-Thompson, *Synopsys, Inc., USA*
Din-Ping Tsai, *National Taiwan Univ., Taiwan*
Qiwen Zhan, *Univ. of Dayton, USA*

FiO 2: Optical Sciences

Laszlo Veisz, *Max Planck Inst. for Quantum Optics, Germany,* **Subcommittee Chair**
Selçuk Aktürk, *Istanbul Technical Univ., Turkey*
Ian Coddington, *National Inst. of Standards and Technology, USA*
Cameron Geddes, *LBL, USA*
Igor Jovanovic, *Penn State Univ., USA*
Carlos Lopez, *Mariscal Naval Research Laboratory, USA*
Rodrigo Lopez-Martens, *École Nationale Supérieure de Techniques Avancées, France*
Koichi Yamakawa, *Japan Atomic Energy Agency, Japan*

FiO 3: Optics in Biology and Medicine

Nozomi Nishimura, *Cornell Univ., USA,* **Subcommittee Chair**
Steven Adie, *Cornell Univ., USA*
Alvara Casas-Bedoya, *Univ. of Sydney, Australia*
Bernard Choi, *Univ. of California Irvine, USA*
Conor Evans, *Massachusetts General Hospital, USA*
Aydogan Ozcan, *Univ. of California Los Angeles, USA*
Sava Sakadzic, *Harvard Medical School, USA*
Melissa Skala, *Vanderbilt Univ., USA*
Alvin Yeh, *Texas A&M Univ., USA*

FiO 4: Optics in Information Processing

Michael Gehm, *Duke Univ., USA,* **Subcommittee Chair**
Mark Anastasio, *Washington Univ., USA*
Amit Ashok, *Univ. of Arizona, USA*
Johannes Courtial, *Univ. of Glasgow, UK*
Daniel Marks, *Duke Univ., USA*
Amy Oldenburg, *Univ. of North Carolina, USA*
Sapna Shroff, *Ricoh Innovations, USA*
Michael Stenner, *MITRE Corporation, USA*
Markus Testorf, *Dartmouth Univ., USA*
Laura Waller, *Univ. of California, Berkeley, USA*

FiO 5: Fiber Optics and Optical Communications

John Marciante, *Univ. of Rochester, USA,* **Subcommittee Chair**
John Ballato, *Clemson Univ., USA*
Mikhail Brodsky, *ATT Research, USA*
Iyad Dajani, *Air Force Research Lab, USA*
Fabrizio Di Pasquale, *Scuola Superiore Sant'Anna, Pisa, Italy*
Goëry Genty, *Univ. of Tempere, Finland*
Morten Ibsen, *Univ. of Southampton, UK*
Bill Kuo, *Univ. of California San Diego, USA*
Thomas Murphy, *Univ. of Maryland, USA*
Chongjin Xie, *Alcatel-Lucent Labs, USA*

FiO 6: Integrated Photonics

Ronald Reano, *Ohio State Univ., USA,* **Subcommittee Chair**
Ivan Biaggio, *Lehigh Univ., USA*
Long Chen, *Bell Labs, Alcatel-Lucent, USA*
Nicholas X. Fang, *Massachusetts Inst. of Technology, USA*
Wataru Nakagawa, *Montana State Univ., USA*
Nicolae C. Panoiu, *Univ. College London, UK*
Joyce Poon, *Univ. of Toronto, Canada*
Mahmoud Rasras, *Bell Labs, Alcatel-Lucent, USA*

FiO 7: Quantum Electronics

Alexander V. Sergienko, *Boston Univ., USA,* **Subcommittee Chair**
Mo Li, *Univ. of Minnesota, USA*
Cefe Lopez, *Instituto de Ciencia de Materiales, Spain*
Alan Migdall, *NIST, USA*
Jeremy O'Brien, *Univ. of Bristol, UK*
Christine Silberhorn, *Univ. of Padeborn, Germany*
Wolfgang Tittel, *Univ. of Calgary, Canada*
Paolo Villoresi, *Univ. of Padua, Italy*

FiO 8: Vision and Color

Brian Vohnsen, *Univ. College Dublin, Ireland,* **Subcommittee Chair**
Stacey Choi, *Ohio State Univ., USA*
Nathan Doble, *Ohio State Univ., USA*
Adam Dubis, *Univ. College London, UK*
Josua Fernandez, *Univ. de Murcia, Spain*
Andrew Mehta, *Univ. of Melbourne, Australia*
Jason Porter, *Univ. of Houston, USA*

Laser Science Program Committee

Laser Science Chairs

Galina Khitrova, College of Optical Sciences, *Univ. of Arizona, USA,* **General Chair**
Cheuk-Yiu Ng, Department of Chemistry, *Univ. of California Davis, USA,* **Program Chair**

Laser Science Session Organizers

1. **Photonic Crystals: Fundamentals and Applications**
   Julian Sweet, *Wyle Laboratories, USA*
2. **Optical and Laser-Based Approaches in Chemical and Biological Sensing**
   King-Chuen Lin, *National Taiwan Univ., Taiwan*
3. **Filamentation of Ultrashort Intense Laser Pulses**
   Jerry Moloney, *Univ. of Arizona, USA*
4. **Cold Atoms and Molecules - Exploring New Physics with Quantum Degenerate Gases**
   Brian Anderson, *Univ. of Arizona, College of Optical Sciences, USA*
5. **Attosecond EUV and X-ray Light Sources and Their Applications**
   Andy Kung, *Inst. of Atomic and Molecular Sciences, Taiwan*
6. **Innovative Resonator-Emitter Coupled Systems**
   Joshua Hendrickson, *AFRL (Wright-Patterson), USA*
7. **Quantum Information with Photons**
   Elohim Chavez, *Univ. of New Mexico, USA*
8. **Semiconductor Nanooptics**
   Stephan Koch, *Phillips-Universität Marburg, Germany*

APS Division of Laser Science Executive Committee

Executive Committee Officers

Antoinette Taylor, *Los Alamos Natl. Lab, USA,* **Chair**
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Kristan Corwin, *Kansas State Univ., USA*
Albert Stolow, *National Research Council, Canada*

Agenda of Sessions — Sunday, 19 October

07:00–17:00	**Annual OSA Student Chapter Leadership Conference (Invitation Only),** *Tucson Ballroom, Salons E & F*
12:00–18:30	**Registration,** *Arizona Ballroom Foyer*
16:00–18:30	**JS1A • Symposium on the 50th Anniversary of Optical Sciences,** *Arizona Ballroom, Salons 1-6* ▶
18:30–20:00	**Conference Welcome Reception,** *Ania Terrace*

Monday, 20 October

	Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11
07:00–18:00	**Registration,** *Arizona Ballroom Foyer*			
08:00–12:00	**JM1A • Conference Plenary Session and Awards Ceremony,** *Arizona Ballroom, Salons 1-6* ▶			
09:40–10:00	**Coffee Break,** *Tucson and Arizona Ballroom Foyer*			
12:30–15:25	**LM2A • Laser Science Symposium on Undergraduate Reseach Poster Session,** *Tucson Ballroom, Salon E*			
13:30–15:00	**OSA Optical Communication Technical Group Networking Event,** *Arizona Ballroom, Salon G*			
13:30–15:30	**FM3A • Silicon Photonics** ▶	**FM3B • Nonlinear Optics in Micro and Nano-Optical Structures I** ▶ (ends at 17:45)	**FM3C • Frequency Comb Generation in Optical Fibers and Their Applications**	**FM3D • Coherence, Interference, and Polarization I**
15:30–16:00	**Coffee Break,** *Tucson and Arizona Ballroom Foyers*			
16:00–18:00	**FM4A • Integrated Nanophotonics** ▶	**FM4B • Nonlinear Optics in Micro and Nano-Optical Structures II** ▶	**FM4C • Fiber Frequency Combs and Mode-Locked Lasers**	**FM4D • Coherence, Interference, and Polarization II**
17:30–19:00	**Minorities and Women in OSA (MWOSA) Networking Reception,** *Tucson Ballroom, Salons I & J*			
17:30–19:00	**Meet OSA's Journal Editors,** *Ania Terrace*			
19:00–20:00	**Guest Speaker: AFOSR Program on Imaging and Beam Control Through Deep Turbulence,** *Arizona Ballroom, Salon 11*			
19:00–22:00	**OSA Student Member Reception,** *Starr Canyon River, JW Marriott Tucson Starr Pass Resort*			
19:00–21:00	**President's Reception (Invitation Only),** *Catalina Barbeque Co., located at Starr Pass Country Club, JW Marriott Tucson Starr Pass Resort*			

Key to Shading

Frontiers in Optics Laser Science Joint ▶ Recorded Session

Arizona Ballroom Salon 12	Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon E
Registration, *Arizona Ballroom Foyer*				
JM1A • Conference Plenary Session and Awards Ceremony, *Arizona Ballroom, Salons 1-6*				
Coffee Break, *Tucson and Arizona Ballroom Foyer*				
LM2A • Laser Science Symposium on Undergraduate Reseach Poster Session, *Tucson Ballroom, Salon E*				
OSA Optical Communication Technical Group Networking Event, *Arizona Ballroom, Salon G*				
FM3E • Optical System Design for Information Optics (ends at 15:15)	**FM3F • Symposium on Translational Biophotonics - Focus on Cancer**	**LM3G • Semiconductor Nanooptics I**	**LM3H • Ultracold Gases I**	**LM3I • Laser Science Symposium on Undergraduate Research I** (15:45–16:45)
Coffee Break, *Tucson and Arizona Ballroom Foyers*				
FM4E • Information Capacity of the Photon (ends at 17:45)	**FM4F • Novel Methods for Tissue Imaging and Therapy**	**LM4G • DLS Dissertation Award Session**	**LM4H • Ultracold Gases II**	**LM4I • Laser Science Symposium on Undergraduate Research II** (17:00–18:00)
Minorities and Women in OSA (MWOSA) Networking Reception, *Tucson Ballroom, Salons I & J*				
Meet OSA's Journal Editors, *Ania Terrace*				
Guest Speaker: AFOSR Program on Imaging and Beam Control Through Deep Turbulence, *Arizona Ballroom, Salon 11*				
OSA Student Member Reception, *Starr Canyon River, JW Marriott Tucson Starr Pass Resort*				
President's Reception (Invitation Only), *Catalina Barbeque Co., located at Starr Pass Country Club, JW Marriott Tucson Starr Pass Resort*				

Agenda of Sessions — Tuesday, 21 October

	Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11
07:00–17:30	**Registration,** *Arizona Ballroom Foyer*			
08:00–09:30	**VIP Industry Leaders Networking Event: Connecting Corporate Executives, Recent Graduates and Students,** *Tucson Ballroom, Salon F*			
08:00–10:00	**FTu1A • Integrated Quantum Optics I** ▶	**FTu1B • Optical Interconnections for Data Centers** ▶	**FTu1C • Coherence, Interference, and Polarization III**	**FTu1D • Modulators**
10:00–10:30	**Coffee Break and Unopposed Exhibit Only Time,** *Arizona Ballroom, Salons 1-7*			
10:00–16:00	**Exhibit Open,** *Arizona Ballroom, Salons 1-7*			
10:30–12:00	**FTu2A • Integrated Quantum Optics II** ▶	**FTu2B • Optical Fiber Sensors I** ▶	**FTu2C • Wavefront Sensing and Adaptive Optics** (ends at 12:15)	**FTu2D • Integrated Photonic Quantum Circuits**
12:00–13:30	**Unopposed Exhibit Only Time,** *Arizona Ballroom, Salons 1-7*			
12:00–13:30	**JTu3A • Joint Poster Session I,** *Arizona Ballroom, Salons 1-7*			
12:00–16:00	**"Mission IYL" OSA Student Chapter Competition,** *Arizona Ballroom, Salons 1-7*			
12:00–14:00	**OSA Fellow Members Lunch,** *Tucson Ballroom, Salons G-I*			
13:30–15:30	**FTu4A • Quantum Communications** ▶	**FTu4B • Optical Fiber Sensors II** ▶	**FTu4C • Coherence, Interference, and Polarization IV**	**FTu4D • Integrated Optics**
15:30–16:00	**Coffee Break and Unopposed Exhibit Only Time,** *Arizona Ballroom, Salons 1-7*			
15:30–17:00	**Meet the APS Journal Editors,** *Ania Terrace*			
16:00–17:30	**FTu5A • Quantum Electronics I** ▶	**FTu5B • Optical Fiber Sensors III** ▶ (ends at 17:15)	**FTu5C • Coherence and Polarization I**	**FTu5D • Microresonators**
16:00–17:30	**Exhibitor Appreciation Reception,** *Arizona Ballroom, Salons 1-7*			
18:00–19:00	**APS Annual Business Meeting,** *Tucson Ballroom, Salon D*			
18:00–19:00	**OSA Annual Business Meeting,** *Arizona Ballroom, Salon 8*			
18:00–19:00	**OSA Holography & Diffractive Optics Technical Group Networking Event,** *Arizona Ballroom, Salon 10*			
19:00–21:00	**OSA Member Reception: The Scorchin' Sonoran,** *Tucson Ballroom, Salons E & F*			
19:00–21:00	**Laser Science Banquet,** *Signature Grill Restaurant, Outdoor Patio, JW Marriott Tucson Starr Pass Resort*			

Key to Shading

Frontiers in Optics Laser Science Joint ▶ Recorded Session

Arizona Ballroom Salon 12	Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon D
Registration, *Arizona Ballroom Foyer*				
VIP Industry Leaders Networking Event: Connecting Corporate Executives, Recent Graduates and Students, *Tucson Ballroom, Salon F*				
FTu1E • Materials for Plasmonics	**FTu1F • Optical Trapping and Manipulation**	**FTu1G • General Optical Sciences I**	**LTu1H • Ultracold Gases III**	**LTu1I • Semiconductor Nanooptics II**
Coffee Break and Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*				
Exhibit Open, *Arizona Ballroom, Salons 1-7*				
FTu2E • Parity-time Symmetry and Photonic Lattices	**FTu2F • General Optics in Biology and Medicine I**	**FTu2G • General Optical Sciences II**	**LTu2H • Attosecond Science I**	**LTu2I • Quantum Information I**
Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*				
JTu3A • Joint Poster Session I, *Arizona Ballroom, Salons 1-7*				
"Mission IYL" OSA Student Chapter Competition, *Arizona Ballroom, Salons 1-7*				
OSA Fellow Members Lunch, *Tucson Ballroom, Salons G-I*				
JTu4E • Novel Intense Attosecond Sources I	**FTu4F • Fibers for Biomedical Applications**	**FTu4G • Relativistic Light Sources** (ends at 15:15)	**LTu4H • Resonators and Photonic Crystals I**	**LTu4I • Semiconductor Nanooptics III**
Coffee Break and Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*				
Meet the APS Journal Editors, *Ania Terrace*				
FTu5E • Novel Image and Information Analysis Methods (ends at 17:15)	**FTu5F • General Optics in Biology and Medicine II**	**JTu5G • Novel Intense Attosecond Sources II**	**LTu5H • Chemical and Biological Sensing I**	**LTu5I • Quantum Information II**
Exhibitor Appreciation Reception, *Arizona Ballroom, Salons 1-7*				
APS Annual Business Meeting, *Tucson Ballroom, Salon D*				
OSA Annual Business Meeting, *Arizona Ballroom, Salon 8*				
OSA Holography & Diffractive Optics Technical Group Networking Event, *Arizona Ballroom, Salon 10*				
OSA Member Reception: The Scorchin' Sonoran, *Tucson Ballroom, Salons E & F*				
Laser Science Banquet, *Signature Grill Restaurant, Outdoor Patio, JW Marriott Tucson Starr Pass Resort*				

Agenda of Sessions — Wednesday, 22 October

	Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11
07:30–18:00	**Registration,** *Arizona Ballroom Foyer*			
08:00–10:00	**FW1A • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning I** ▶	**FW1B • Photonic Crystal Cavities and Waveguides** ▶	**FW1C • Quantum Optical Measurement and Quantum Technologies I**	**FW1D • Long Wavelength Mid-IR to THz Fiber Devices I**
08:30–12:30	**OSA Members and Families: Arizona-Sonora Desert Museum Tour,** *Bus will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 08:30.*			
10:00–10:30	**Coffee Break and Unopposed Exhibit Time,** *Arizona Ballroom, Salons 1-7*			
10:00–14:00	**Exhibit Open,** *Arizona Ballroom, Salons 1-7*			
10:30–12:00	**FW2A • Imaging** ▶ (ends at 11:30)	**FW2B • Materials for Integrated Photonics** ▶	**FW2C • Quantum Optical Measurement and Quantum Technologies II**	**FW2D • Long Wavelength Mid-IR to THz Fiber Devices II** (ends at 11:45)
12:00–13:30	**Unopposed Exhibit Only Time,** *Arizona Ballroom, Salons 1-7*			
12:00–13:30	**JW3A • Joint Poster Session II,** *Arizona Ballroom, Salons 1-7*			
13:30–15:30	**FW4A • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning II** ▶	**FW4B • Integrated Photonics** ▶	**FW4C • Quantum Optical Measurement and Quantum Technologies III**	**FW4D • Novel Fiber And Communications Devices** (ends at 15:15)
15:30–16:00	**Coffee Break,** *Tucson and Arizona Ballroom Foyer*			
16:00–18:00	**FW5A • General Optical Design, Fabrication, Testing, and Instrumentation I** ▶	**FW5B • Hybrid Integrated Photonics** ▶	**FW5C • Quantum Electronics II**	**FW5D • Enabling Technologies for Astrophotonics** (ends at 18:15)
17:00–20:00	**OSA Science Educators' Day,** *Tucson Ballroom, Salon E*			
18:00–22:00	**University of Arizona, Celebrating 50 Years of Optical Science at Old Tucson,** *Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 18:00.*			
18:30–19:30	**OSA Applications of Visual Science Technical Group Networking Event,** *Arizona Ballroom, Salon A*			

Key to Shading

Frontiers in Optics Laser Science Joint ▶ Recorded Session

<table>
<tr><th>Arizona Ballroom
Salon 12</th><th>Tucson Ballroom
Salon A</th><th>Tucson Ballroom
Salon B</th><th>Tucson Ballroom
Salon C</th><th>Tucson Ballroom
Salon D</th></tr>
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<tr><td>FW1E • Microscopy and OCT I</td><td>FW1F • Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard I</td><td>LW1G • Resonators and Photonic Crystals II</td><td>LW1H • Attosecond Science II</td><td>LW1I • Filamentation I</td></tr>
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<tr><td rowspan="2">FW2E • Coherence and Polarization II</td><td>FW2F • Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard II
(ends at 11:00)</td><td rowspan="2">FW2G • General Optics in Biology and Medicine III
(ends at 11:45)</td><td rowspan="2">LW2H • Quantum Information III</td><td rowspan="2">LW2I • Solid State Optical Physics</td></tr>
<tr><td>FW3F • Low-cost Ophthalmic Instrumentation and Imaging
(starts at 11:00)</td></tr>
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<tr><td colspan="5">JW3A • Joint Poster Session II, Arizona Ballroom, Salons 1-7</td></tr>
<tr><td>FW4E • Symposium on Laser Particle Acceleration and Novel Acceleration Methods I</td><td>FW4F • Ocular Aberrations and Wavefront Sensing
(ends at 15:00)</td><td>FW4G • Microscopy and OCT II</td><td>LW4H • Resonators and Photonic Crystals III</td><td>LW4I • Filamentation II
(ends at 15:15)</td></tr>
<tr><td colspan="5">Coffee Break, Tucson and Arizona Ballroom Foyer</td></tr>
<tr><td>FW5E • Symposium on Laser Particle Acceleration and Novel Acceleration Methods II</td><td>FW5F • Retinal Imaging and Analysis</td><td>FW5G • Frequency Combs in Novel Spectral Ranges</td><td>LW5H • Attosecond Science III
(ends at 18:15)</td><td>LW5I • Chemical and Biological Sensing II
(ends at 17:30)</td></tr>
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Agenda of Sessions — Thursday, 23 October

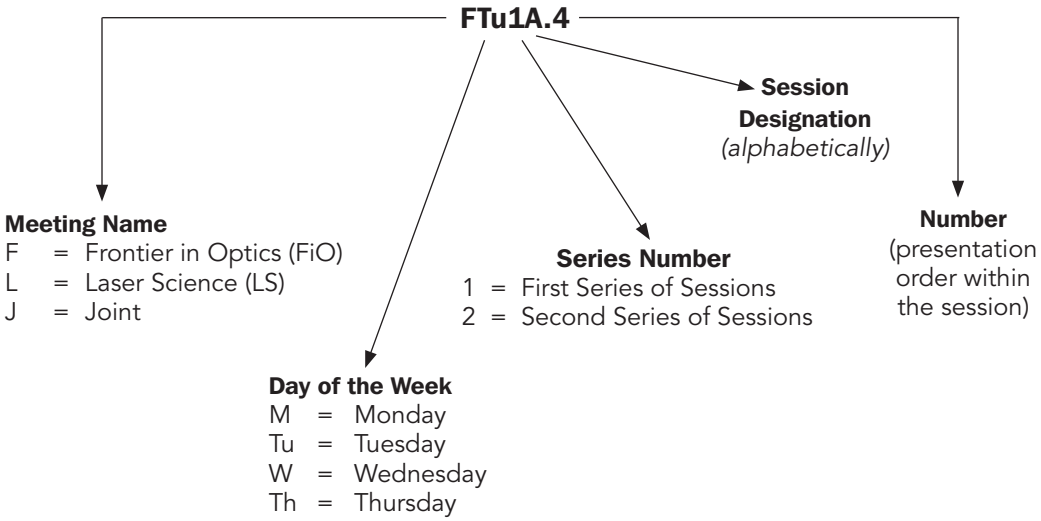
	Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11
07:30–18:00	**Registration,** *Arizona Ballroom Foyer*			
08:00–10:00	**FTh1A • General Optical Sciences III** ▶	**FTh1B • Enabling Technologies for High Speed Optical Communications I** ▶	**FTh1C • Optics and Photonics of Disordered Systems I**	**FTh1D • Metamaterials**
10:00–10:30	**Coffee Break,** *Tucson and Arizona Ballroom Foyers*			
10:30–12:00	**FTh2 • FiO Postdeadline Paper Sessions,** *Arizona Ballroom, Salons 8-9/Arizona Ballroom, Salons 11-12/Tucson Ballroom, Salons A-B*			
12:00–13:30	**Lunch Break** *(on your own)*			
13:00–17:00	**University of Arizona, College of Optical Sciences and Steward Observatory Mirror Lab Tour,** *Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 13:00.*			
13:30–15:30	**FTh3A • Coherent Combination of Laser Beams**	**FTh3B • Enabling Technologies for High Speed Optical Communications II**	**FTh3C • Optics and Photonics of Disordered Systems II**	**FTh3D • Beam Shaping and Enhanced Optical Transmission Plasmonics**
15:30–16:00	**Coffee Break,** *Tucson and Arizona Ballroom Foyers*			
16:00–18:00	**FTh4A • General Optical Sciences IV**	**FTh4B • Enabling Technologies for High Speed Optical Communications III** (ends at 17:45)	**FTh4C • Quantum Electronics III** (starts at 16:15)	**FTh4D • Imaging, Coherence and Propagation** (ends at 17:15)

Key to Shading

Frontiers in Optics | Laser Science | Joint | ▶ Recorded Session

Arizona Ballroom Salon 12	Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon D
Registration, *Arizona Ballroom Foyer*				
FTh1E • Lab-on-a-chip and Optofluidics ▶	**FTh1F • Symposium on Radiation Reaction in Ultra-High Intensity Lasers I** ▶ (ends at 10:15)	**FTh1G •General Optical Design, Fabrication, Testing, and Instrumentation II**	**LTh1H • Resonators and Photonic Crystals IV**	**LTh1I • Quantum States of Matter and Light** (ends at 09:45)
Coffee Break, *Tucson and Arizona Ballroom Foyers*				
FTh2 • FiO Postdeadline Paper Sessions, *Arizona Ballroom, Salons 8-9/Arizona Ballroom, Salons 11-12/Tucson Ballroom, Salons A-B*				
Lunch Break *(on your own)*				
University of Arizona, College of Optical Sciences and Steward Observatory Mirror Lab Tour, *Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 13:00.*				
FTh3E • Plasmonics	**FTh3F • Symposium on Radiation Reaction in Ultra-High Intensity Lasers II** (ends at 15:45)	**FTh3G • General Optical Design, Fabrication, Testing, and Instrumentation III**	**LTh3H • Filamentation III**	**LTh3I • Chemical and Biological Sensing III**
Coffee Break, *Tucson and Arizona Ballroom Foyers*				
FTh4E • Optical Antennas and Plasmonic Waveguide Devices (ends at 17:45)		**FTh4G • General Optical Design, Fabrication, Testing, and Instrumentation IV**	**LTh4H • Chemical and Biological Sensing IV** (ends at 17:00)	**LTh4I • Light Matter Interaction**

Explanation of Session Codes



The first letter of the code designates the meeting (For instance, F = Frontiers in Optics, L = Laser Science, J=Joint). The second element denotes the day of the week (Monday = M, Tuesday = Tu, Wednesday = W, Thursday = Th). The third element indicates the session series in that day (for instance, 1 would denote the first parallel sessions in that day). Each day begins with the letter A in the fourth element and continues alphabetically through a series of parallel sessions. The lettering then restarts with each new series. The number on the end of the code (separated from the session code with a period) signals the position of the talk within the session (first, second, third, etc.). For example, a presentation coded FW1A.4 indicates that this paper is part of the Frontiers in Optics Meeting and is being presented on Wednesday (W) in the first series of sessions (1), and is the first parallel session (A) in that series and the fourth paper (4) presented in that session.

Arizona Ballroom, Salons 1-6

JOINT FiO/LS

07:00–16:00 Annual OSA Student Chapter Leadership Conference (Invite Only), *Tucson Ballroom E & F*

12:00–18:30 Registration, *Arizona Ballroom Foyer*

16:00–18:30
JS1A • Symposium on the 50th Anniversary of Optical Sciences
Presider: Thomas L. Koch; Univ. of Arizona, USA

Welcoming remarks will be given by the Honorable Jonathan Rothschild, *Mayor of Tucson*

JS1A.1 • 16:20 Keynote
A Brief History of the College of Optical Sciences, James C. Wyant[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* This keynote presentation will discuss the history of the college of Optical Sciences at the Univ. of Arizona.

James C. Wyant is professor emeritus at the College of Optical Sciences at the University of Arizona, where he was Director (1999-2005), Dean (2005-2012), and a faculty member since 1974. He received a B.S. in physics from Case Western Reserve University and M.S. and Ph.D. in optics from the University of Rochester. He was a founder of the WYKO Corporation and served as its president and board chairman from 1984 to 1997 and he was a founder of the 4D Technology Corporation and currently serves as its board chairman. Wyant is a member of the National Academy of Engineering, a Fellow of OSA (The Optical Society), SPIE (International Society of Optics and Photonics), and the Optical Society of India, an honorary member of the Optical Society of Korea, and former editor-in-chief of the OSA journal Applied Optics. He was the 2010 president of OSA and the 1986 president of SPIE.

JS1A.2 • 16:45 Invited
Atoms and Photons: One Perspective on Quantum Optics at the College of Optical Sciences, Poul S. Jessen[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* Over the years quantum optics at the College of Optical Sciences has been shaped by theory and experiment alike. The modern era of atomic physics arrived in the 1990's, and has brought a variety of experiments including ultracold atoms, quantum information, and optical frequency metrology.

JS1A.3 • 17:00 Invited
The Force Law of Classical Electrodynamics: Lorentz versus Einstein and Laub, Masud Mansuripur[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* We discuss the advantages of the force law proposed by Einstein and Laub in 1908 over the standard force law of Lorentz. The Einstein-Laub law is consistent with Maxwell's equations, with the conservation laws, and with special relativity.

JS1A.4 • 17:15 Invited
Image Science at OSC, Harrison Barrett[1]; [1]*Univ. of Arizona, USA.* This talk will describe the image science at the College of Optical Sciences at the University of Arizona.

JS1A.5 • 17:30 Invited
Biomedical Optics at OSC, Jennifer K. Barton[1]; [1]*Biomedical Engineering, Univ. of Arizona, USA.* This presentation will discuss biomedical optics at the College of Optical Sciences at the University of Arizona.

JS1A.6 • 17:45 Invited
Semiconductor Physics at the Optical Sciences Center, Stephan W. Koch[1]; [1]*Philipps Universitat Marburg, Germany.* This talk reviews semiconductor physics experiments and theory at the Optical Sciences Center including optical bistability, femtosecond dynamics, as well as semiconductor laser applications.

JS1A.7 • 18:00 Invited
Photonics at OSC, Nasser Peyghambarian[1]; [1]*Univ. of Arizona, USA.* Research projects on photonics in communication and future Internet, photonics in computing, silicon photonics integration, fiber lasers, 3D holographic display, nanophotonic materials and devices including optical modulators, and polymeric optical materials and devices will be summarized.

JS1A.8 • 18:00 Invited
Fabrication & Metrology of Large Optics at OSC, James H. Burge[1]; [1]*Univ. of Arizona, USA.* In this presentation, fabrication and metrology of large optics at the College of Optical Science at the University of Arizona will be discussed.

18:30–20:00 Conference Welcome Reception, *Ania Terrace*

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12

FiO

07:00–18:00 Registration, *Arizona Ballroom Foyer*

08:00–12:00 JM1A • Joint FiO/LS Plenary Session and Awards Ceremony, *Arizona Ballroom, Salons 1-6*

09:40–10:00 Coffee Break, *Tucson and Arizona Ballroom Foyer*

12:30–15:25 LM2A • Laser Science Symposium on Undergraduate Reseach Poster Session, *Tucson Ballroom, Salon E*

13:30–15:00 OSA Optical Communications Technical Group Networking Event, *Arizona Ballroom, Salon G*

13:30–15:30
FM3A • Silicon Photonics
Presider: Shayan Mookherjea; Univ. of California San Diego, USA

FM3A.1 • 13:30 Invited
Large Scale and Low Power Photonic Circuits, Michael R. Watts[1]; [1]*MIT, USA.* We discuss the scaling trends and limits of low power and large scale silicon photonic circuits, addressing the questions of where we are today and where we need to be to meet future insertion points.

FM3A.2 • 14:00 Invited
Silicon Optical Switches for ROADM Applications, Shigeru Nakamura[1], Shigeyuki Yanagimachi[1], Hitoshi Takeshita[2], Tomoyuki Hino[2], Akio Tajima[2], Kiyoshi Fukuchi[2]; [1]*Green Platform Res. Labs, NEC Corporation, Japan;* [2]*Green Platform Res. Labs, NEC Corporation, Japan.* Silicon photonics has been applied to integrating many thermo-optical switch elements into one-chip 8 x 8 optical path switch device for CDC-ROADMs. High extinction ratio operation independently of polarization and ambient temperature has been demonstrated.

13:30–15:30
FM3B • Nonlinear Optics in Micro and Nano-Optical Structures I
Presider: Alexander Gaeta; Cornell Univ., USA

FM3B.1 • 13:30 Invited
Microwave Generation Using Nonlinear Optics in High-Q Resonators, Kerry J. Vahala[1]; [1]*California Inst. of Technology, USA.* High Q optical resonators can easily access nonlinear optical mechanisms at remarkably low power levels to produce frequency micro combs and stimulated Brillouin lasers. Progress towards stable microwave generation using these devices will be reviewed.

FM3B.2 • 14:00 Invited
Nanophotonic Structures for Extreme Nonlinearities On-Chip, Michal Lipson[1]; [1]*Cornell Univ., USA.* We show unprecedented strong nonlinear response from high confinement nanophotonic waveguides from the NIR to the Mid IR spectral range, by controlling the dispersion and the effective nonlinearities though novel nanofabrication techniques and novel materials.

13:30–15:30
FM3C • Frequency Comb Generation in Optical Fibers and Their Applications
Presider: Goëry Genty; Tampere Univ. of Technology, Finland

FM3C.1 • 13:30 Invited
Noise Inhibited Frequency Generation in Wideband Parametric Mixers, Stojan Radic[1]; [1]*Univ. of California San Diego, USA.* Generation of frequency combs in noise inhibited parametric mixers is reviewed. Fundamental impairment mechanisms and performance limits set by the physical platform are discussed in all-fiber and monolithic devices.

FM3C.2 • 14:00
Frequency-Variable Comb Light Source Using an Optical Frequency Shifter, Satoshi Seki[1], Tatsutoshi Shioda[2], Ken Kashiwagi[1], Yosuke Tanaka[1], Takashi Kurokawa[1,3]; [1]*Tokyo Univ. of Agriculture and Tech, Japan;* [2]*Saitama Univ., Japan;* [3]*National Astronomical Observatory of Japan, Japan.* We propose a frequency variable multi-gigahertz-comb light source whose modes are swept over its mode-spacing frequency. We successfully demonstrated a fine sweep of the laser frequency comb ranging from 1520 to 1565 nm.

13:30–15:30
FM3D • Coherence, Interference, and Polarization I
Presider: Andrew Forbes; CSIR National Laser Centre, South Africa

FM3D.1 • 13:30 Invited
Polarization Controlled Surface Plasmon Polariton Propagation: Physics and Applications, Federico Capasso[1], Jason Mueller[1]; [1]*School of Engineering and Applied Sciences, Harvard Univ., USA.* Structuring metallic surfaces with suitable couplers allows one to control the surface plasmon propagation direction with changing polarization. We present experiments including the demonstration of unidirectional coupling in long range surface plasmon waveguides.

FM3D.2 • 14:00
Polarization Singularities in Superposition of Counter-propagating Vector Laguerre-Gaussian Beams, Sunil Vyas[1], Yuichi Kozawa[2], Yoko Miyamoto[1], Shunichi Sato[2]; [1]*Inst. of Laser Science, The Univ. of Electro-Communications, Japan;* [2]*IMRAM, Tohoku Univ., Japan.* Polarization singular structures are studied in the superposition of two counter-propagating vector Laguerre-Gaussian beams. Stokes field is used to analyze the dynamics of the polarization singular points during the propagation of the field.

13:30–15:15
FM3E • Optical System Design for Information Optics
Presider: Michael Gehm; Duke Univ., USA

FM3E.1 • 13:30 Tutorial
Information Based Design for Compressive Imaging**,** Mark Allen Neifeld[1]; [1]*Univ. of Arizona, USA.* The talk will review design considerations for compressive imaging systems. Both static and adaptive imagers will be discussed with a focus on the use of information theoretic analysis/design metrics.

Mark A. Neifeld is a Professor in the Electrical and Computer Engineering Department and in the College of Optical Sciences at the University of Arizona. He received the B.S. degree from the Georgia Institute of Technology in 1985 and the M.S. and Ph.D. degrees from the California Institute of Technology in 1987 and 1991 respectively. Professor Neifeld's current research interests include computational imaging, free-space optical communications,

(continued on page 36)

Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon E
FiO	LS		

07:00–18:00 Registration, *Arizona Ballroom Foyer*

08:00–12:00 JM1A • Joint FiO/LS Plenary Session and Awards Ceremony, *Arizona Ballroom, Salons 1-6*

09:40–10:00 Coffee Break, *Tucson and Arizona Ballroom Foyer*

12:30–15:25 LM2A • Laser Science Symposium on Undergraduate Reseach Poster Session, *Tucson Ballroom, Salon E*

13:30–15:00 OSA Optical Communications Technical Group Networking Event, *Arizona Ballroom, Salon G*

13:30–15:30
FM3F • Symposium on Translational Biophotonics - Focus on Cancer
Presider: Melissa Skala, Vanderbilt Univ., USA

FM3F.1 • 13:30 Invited
Knowledge of the Principles of Oxygen Transport in Solid Cancers Enables Translational Decisions, Mark Dewhirst[1]; [1]*Duke Univ., USA.* This lecture will start with a brief overview of causes of tumor hypoxia and end with clinical data, showing that optical spectroscopy holds promise in predicting treatment response from oxygen dependent cancer therapies.

FM3F.2 • 14:00 Invited
Preclinical and Clinical Chemotherapy Response Monitoring with Diffuse Optical Technologies, Darren M. Roblyer[1], Raeef Istfan[1], Syeda Tabassum[1], Junjie Wu[2], David Waxman[2]; [1]*Biomedical Engineering, Boston Univ., USA;* [2]*Biology, Boston Univ., USA.* We will present initial data demonstrating that Spatial Frequency-Domain Imaging (SFDI) can be used to inform clinical translation by tracking chemotherapy-induced changes of both endogenous and exogenous optical markers of chemotherapy response in preclinical models.

13:30–15:30
LM3G • Semiconductor Nanooptics I
Presider: Stephan Koch; Philipps Universitat Marburg, Germany

LM3G.1 • 13:30 Invited
Ultrashort-pulse Generation Using VECSELs and MIXSELs, Ursula Keller[1]; [1]*ETH Zurich, Switzerland.* Latest results of high-power ultrafast semiconductor lasers are reviewed based on optically pumped VECSELs and MIXSELs. Power scaling with ps and fs pulses with the excellent noise performance makes them highly attractive for many applications.

LM3G.2 • 14:00 Invited
VCESL Theory & Experiment, Jerome V. Moloney[1], Isak Kilen[1], Joerg Hader[1], Stephan W. Koch[2]; [1]*College of Optical Sciences, Univ. of Arizona, USA;* [2]*Department of Physics, Marburg Univ., Germany.* Ultrafast nonequilibrium kinetic hole-burning in electron/hole carrier distributions dictates the outcome of short pulse generation in inverted semiconductor quantum wells, makes the traditional gain picture redundant and clarifies recent reported experimental record performances.

13:30–15:30
LM3H • Ultracold Gases I
Presider: Brian Anderson; Univ. of Arizona, USA

LM3H.1 • 13:30 Invited
Spin-dependent Gauge Fields in Atomic Gases, Ian B. Spielman[1]; [1]*Quantum Measurement, JQI, NIST and UMD, USA.* Gauge fields -- ubiquitous in Physics -- can depend on ``spin'' degrees of freedom, and in materials these are often manifest as spin-orbit coupling. Here I present our work synthesizing SOC for ultracold neutral atoms.

LM3H.2 • 14:00 Invited
Vortex Dynamics in Spin Orbit BECS, Alexander Fetter[1]; [1]*Physics, Stanford Univerity, USA.* Spin-orbit coupled condensates typically have two or more components. Each component has quantized circulation, but they need not be the same, leading to the possibility of half-quantized vortices with unit circulation in only one component.

15:45–16:45
LM3I • Laser Science Symposium on Undergraduate Research I

See separate program in registration bag for details.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12

FiO

FM3A • Silicon Photonics—Continued

Presentations selected for recording are designated with a ▶. Access these by visiting www.frontiersinoptics.com and clicking on the View Presentations button.

FM3A.3 • 14:30 Invited ▶

CMOS Integrated Ge Detectors, Jason Orcutt[1], John Ellis-Monaghan[2], Steve Shank[2], Marwan Khater[2], Ed Kiewra[2], Solomon Assefa[1], Frederick G. Anderson[2], Jonathan E. Proesel[1], Andreas Stricker[2], Mounir Meghelli[1], Yurii A. Vlasov[1], Will Green[1], Wilfried Haensch[1]; *[1]IBM TJ Watson Research Center, USA; [2]Microelectronics Division, IBM Systems & Technology Group, USA.* Methods for integrating germanium detectors within CMOS processes to form high performance integrated monolithic receivers will be reviewed. Focus will be on achieving fiber-coupled input sensitivity that meets or exceeds traditional ROSA approaches.

FM3B • Nonlinear Optics in Micro and Nano-Optical Structures I—Continued

FM3B.3 • 14:30 ▶

Control of Polariton Patterns in Semiconductor Microcavities, Y. Tse[1], P. Lewandowski[2], V. Ardizzone[3], N. Kwong[4,1], M. Luk[1], A. Luecke[2], M. Abbarchi[3,5], J. Bloch[5], E. Baudin[3], E. Galopin[5], A. Lemaitre[5], C. Tsang[1], K. Chan[1], P. Leung[1], Ph. Roussignol[3], Rolf Binder[4], J. Tignon[3], S. Schumacher[2]; *[1]Chinese Univ. of Hong Kong, China; [2]Univ. of Paderborn, Germany; [3]CNRS Paris, France; [4]Univ. of Arizona, USA; [5]CNRS Marcoussis, France.* Polaritons in semiconductor microcavities can form patterns analogous to conventional Turing patterns, including two-spot and hexagon far field patterns. We present theoretical concepts of pattern formation and control, together with experimental observations.

FM3C • Frequency Comb Generation in Optical Fibers and Their Applications—Continued

FM3C.3 • 14:15

Broadband Multi-Gigahertz-Spaced Frequency Comb for Near Infrared Doppler Instrument, Yasushi Okuyama[1], Ken Kashiwagi[1], Takayuki Kotani[2], Jun Nishikawa[2], Motohide Tamura[3,2], Takashi Kurokawa[2,1]; *[1]Tokyo Univ. of Agriculture and Tech, Japan; [2]National Astronomical Observatory of Japan, Japan; [3]The Univ. of Tokyo, Japan.* We have developed a laser frequency comb generator for the Earth-like exoplanet detection. We successfully generated a 12.5-GHz-spacing laser frequency comb ranging over 600 nm from 1070 to 1700 nm.

FM3C.4 • 14:30

Distance Measurement Using Temporal-Coherence Interferometer with Optical Frequency Comb and Fiber Etalons, Hirokazu Matsumoto[1], Kiyoshi Takamasu[1]; *[1]Univ. of Tokyo, Japan.* Absolute distance measuring method is developed by using temporal-coherence interferometry of optical frequency comb with 15-GHz fiber etalons, and a scanning stage. The fringe processing is automatically made with electric circuit.

FM3D • Coherence, Interference, and Polarization I—Continued

FM3D.3 • 14:15

Encoding High Order Cylindrically Polarized Light Beams, Jeffrey A. Davis[1], Ignacio Moreno[2], Don M. Cottrell[1], Ramiro Donoso[3]; *[1]Physics, San Diego State Univ., USA; [2]Óptica y Tecnología Electrónica, Universidad Miguel Hernández, Spain; [3]Departamento de Ciencias Físicas, Universidad de La Frontera, Chile.* Abstract: We generate cylindrically polarized and more complicated variations of polarized light beams using a liquid crystal spatial light modulator and a double-pass architecture by adding additional linear and quadratic phase shifts to the two circular polarization components.

FM3D.4 • 14:30

Guided-Mode Resonant Broadband Reflector in TE Polarization Using Subwavelength Two-Part Gratings, Mohammad J. Uddin[1], Tanzina Khaleque[1], Robert Magnusson[1]; *[1]Electrical Engineering, Univ. of Texas at Arlington, USA.* TE polarization broadband reflector using subwavelength two-part gratings and nanometric homogeneous layer of a-Si on quartz is reported. Representative reflector exhibits 99% reflectance over a 380-nm spectral range (1440-1820 nm). Experimental reflectance >90% is achieved over a ~360-nm bandwidth.

FM3E • Optical System Design for Information Optics—Continued

quantum key distribution, optical computing, and compressive sensing. He has coauthored more than 100 journal articles and more than 250 conference papers in the general areas of optical physics and engineering including optical imaging, communications and storage, information theory, coding, and signal processing. Professor Neifeld is a Fellow of the OSA and SPIE and frequently participates in conference organization/management for these societies. He recently completed a term as a DARPA/DSO Program Manager for which he was awarded the Secretary of Defense Medal for Exceptional Public Service.

FM3E.2 • 14:15 ▶

Optimal Point Spread Function Engineering for 3D Super-Resolution Imaging, Yoav Shechtman[1], Steffen J. Sahl[1], Adam S. Backer[1], W. E. Moerner[1]; *[1]Stanford Univ., USA.* We propose a framework for pupil plane engineering which produces optimal point spread functions (PSFs) in terms of theoretical information content. We generate and experimentally demonstrate maximally informative PSFs for high background 3D super-resolution imaging.

FM3E.3 • 14:30 ▶

Deep Subwavelength Imaging Using Multiple Correlated Narrow Slits, Yuecheng Shen[1], Lihong V. Wang[2], Jung-Tsung Shen[1]; *[1]Department of Electrical and Systems Engineering, Washington Univ. in St. Louis, USA; [2]Department of Biomedical Engineering, Washington Univ. in St. Louis, USA.* We numerically demonstrated an ultra-high resolution (wavelength/50~ 40nm at wavelength λ=2.08μm), high-throughout (~ 66%), and non-destructive optical lens, based on the notion of correlated nano-torches formed in a subwavelength metallic grating.

Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon E
FiO	LS		
FM3F • Symposium on Translational Biophotonics - Focus on Cancer—Continued	**LM3G • Semiconductor Nanooptics I—Continued**	**LM3H • Ultracold Gases I—Continued**	**LM3I • Laser Science Symposium on Undergraduate Research I—Continued**

Papers are available online for download. Visit www.frontiersinoptics.com and click on the Download Digest Papers button.

FM3F.3 • 14:30 Invited

What Can We Learn About Cancer Therapy from Single Cell Tracking, Charles P. Lin[1]; [1]*Massachusetts General Hospital, USA.* Small numbers of treatment-resistant cancer cells often persist after apparently successful therapy and eventually return to cause disease relapse. We are developing intravital microscopy techniques to uncover the habitat sheltering these residual cancer cells.

LM3G.3 • 14:30 Invited

Quantum Optical Experiments in Semiconductor Quantum Well Systems, Steven T. Cundiff[1,2], Andrew E. Almand-Hunter[1,2], Eric Martin[1,2], Hebin Li[1]; [1]*JILA, NIST & Univ. of Colorado, USA;* [2]*Department of Physics, Univ. of Colorado, USA.* Many-body excitations in semiconductors are probed by exploiting the mapping between quantum optical correlations and electron-hole correlations. The experimentally measured response to coherent states is projected to determine the effect of quantum optical statistics.

LM3H.3 • 14:30 Invited

Experiments with Bose-Einstein Condensates in a Spin-orbit Coupled Optical Lattice, Peter Engels[1]; [1]*Department of Physics and Astronomy, Washington State Univ., USA.* Ultracold quantum gases dressed by laser light are a powerful tool to investigate the dynamics of quantum mechanical Hamiltonians. This talk will describe experiments conducted with spin-orbit coupled Bose-Einstein condensates confined in optical lattices.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12

FiO

FM3A • Silicon Photonics—Continued

FM3A.4 • 15:00
A linear push-pull silicon optical modulator, Chi Xiong[1], Douglas Gill[1], Jessie Rosenberg[1], Marwan Khater[1], Tymon Barwicz[1], Solomon Assefa[1], Steve Shank[2], Carol Reinholm[2], Ed Kiewra[2], John Ellis-Monaghan[2], Swetha Kamlapurkar[1], Andreas Stricker[1], Will Green[1], Yurii A. Vlasov[1], Wilfried Haensch[1]; *[1]IBM T.J. Watson Research Center, USA; [2]IBM Systems & Technology Group, Microelectronics Division, USA.* We present a linear push-pull driven silicon modulator fabricated in IBM's CMOS9WG technology node. The Si modulator shows third order nonlinearity suppression 3 dB superior in comparison with a commercial lithium niobate modulator.

FM3A.5 • 15:15
Permanent, Post-fabrication Trimming of Polarization Diversity Silicon Circuits by Single fs Laser Pulses, Daniel Bachman[1], Zhijiang Chen[1], Jocelyn N. Westwood[2,3], Wayne K. Hiebert[2,3], Yves Painchaud[4], Michel Poulin[4], Robert Fedosejevs[4], Ying Y. Tsui[1], Vien Van[1]; *[1]Electrical and Computer Engineering, Univ. of Alberta, Canada; [2]Physics, Univ. of Alberta, Canada; [3]National Inst. for Nanotechnology, Canada; [4]TeraXion, Canada.* Single 400 nm femtosecond laser pulses were used to perform phase trimming of a polarization diversity, DPSK demodulator based on silicon photonics. The technique may be applied to tune any phase sensitive silicon circuit.

FM3B • Nonlinear Optics in Micro and Nano-Optical Structures I—Continued

FM3B.4 • 14:45
Sum and Difference Frequency Generation of Optical and Microwave Photons in a Whispering Gallery Mode Resonator, Florian Sedlmeir[1,2], Martin F. Schneidereit[1,2], Sascha Preu[3], Mario Mendéz-Aller[4], Antti Räisänen[5], Enrique Garcìa-Munoz[4], Gerd Leuchs[1,2], Harald G.L. Schwefel[1,2]; *[1]Max Planck Inst., Germany; [2]Inst. for Optics, Information and Photonics, Univ. of Erlangen, Germany; [3]TU Darmstadt, Germany; [4]Univ. Carlos III of Madrid, Spain; [5]Aalto Univ., Finland.* We present an all-resonant scheme within a very carefully tailored lithium niobate whispering gallery mode resonator to convert weak microwave signals to the optical domain via sum and difference frequency generation.

FM3B.5 • 15:00
Laterally Emitted Surface Second Harmonic Generation in a Single ZnTe Nanowire, Weiwei Liu[1], Kai Wang[1], Zhe Liu[1], Guozhen Shen[1], Peixiang Lu[1]; *[1]Huazhong Univ of Science and Technology, China.* We report surface second harmonic generation (SHG) in a single ZnTe nanowire. The SHG has a high efficiency of 5×10^(−6) and low divergence angle of 4°. Special polarization dependence is also observed in the experiment.

FM3B.6 • 15:15
Generation of Broadband Continuum in Spiral Photonic Microwire by Femtosecond Pulses for Infrared Nonlinear Applications, Amira Baili[1], Rim Cherif[1], Mourad Zghal[1]; *[1]GreS'Com Laboratory, Univ. of Carthage, Engineering School of Communication of Tunis (Sup'Com),, Tunisia; [2]Optoelectronics Research Centre, Univ. of Southampton, UK.* We numerically investigate supercontinuum generation in spiral photonic microwire pumped in the normal dispersion regime. A spectrum spanning more than two octaves is obtained in 5 mm propagation with low peak power pulses at 2.8μm.

FM3C • Frequency Comb Generation in Optical Fibers and Their Applications—Continued

FM3C.5 • 14:45
Ultrafast RGB Laser Source Based on Second Harmonic Generation from a Fiber Laser Driven Dual Zero Dispersion Wavelength Fiber Source, Yuhong Yao[1], Wayne H. Knox[1]; *[1]Univ. of Rochester, USA.* We demonstrate a novel ultrafast RGB source based on second harmonic generation using a dual zero dispersion wavelength fiber source. We achieve milli-Watt 425nm, 517nm, 630nm pulses and discuss the scalability potential of our approach.

FM3C.6 • 15:00 Invited
Frequency Combs in Telecommunications Applications, Nikola Alic[1]; *[1]Univ. of California San Diego, USA.* State of the art parametric combs for transmission systems are discussed. Implementation capable of maintaining coherence across thousands of generated lines at a fraction of dissipation of discrete lasers is fully compliant with transmission requirements.

FM3D • Coherence, Interference, and Polarization I—Continued

FM3D.5 • 14:45
Modulation of Rotationally Symmetric Mask on the Focusing of Azimuthally Polarized Beams, Peng Li[1]; *[1]Northwestern Polytechnic Univ., China.* We theoretically reveal the modulation of rotationally symmetric masks on the redistribution of focused azimuthally polarized beams by angular diffraction. By numerical method based on vector diffraction, we demonstrate our interpretation on those focusing behaviors.

FM3D.6 • 15:00
Radial and Azimuthal Polarized Vector Bessel Beams, Giovanni Milione[1]; *[1]CUNY City College, USA.* We experimentally investigate generation, self-healing, and application of radial and azimuthal polarized vector Bessel beams. Vector Bessel beams can self-heal their intensity and spatially inhomogeneous state of polarization. Applications in optical trapping are discussed.

FM3D.7 • 15:15
Unconventional Polarization States Applied to Aerosol Sensing, Brandon G. Zimmerman[1], Thomas G. Brown[1]; *[1]The Inst. of Optics, USA.* We discuss how one can carry out Mueller matrix polarimetry of particle suspensions using spatial polarization modulation of an illuminating beam created using a Nomarski prism and quarter wave plate

FM3E • Optical System Design for Information Optics—Continued

FM3E.4 • 14:45
Hyperspectral Compressive Imaging Based on Spectral Modulation in the Spectral Domain, Yitzhak August[1], Yaniv Oiknine[1], Adrian Stern[1], Dan G. Blumberg[1]; *[1]Electro-Optical Engineering, Ben Gurion Univ. of the Negev, Israel.* Recently we have proposed a new compressive spectral sensing method based on modulation in the spectral domain, without the need of diffractive or dispersive elements. Here, we expand the compressive sensing spectrometry to hyperspectral imaging.

FM3E.5 • 15:00
Compressive Holography using Fresnelet Based Sparsification of Input Complex Object Field, Prakash Ramachandran[1], Zachariah C. Alex[2], Anith Nelleri[1]; *[1]School of Electronics Engineering, VIT Univ. Chennai Campus, India; [2]School of Electronics Engineering, VIT Univ., India.* Compressive sensing is applied for classical phase shifting digital holography. The object wave is sparse in Fresnelet transform domain. The reconstructed image quality is satisfactory even when 50% of sensed data is used for processing.

15:30–16:00 Coffee Break, *Tucson and Arizona Ballroom Foyers*

Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon E
FiO	**LS**		
FM3F • Symposium on Translational Biophotonics - Focus on Cancer—Continued	**LM3G • Semiconductor Nanooptics I—Continued**	**LM3H • Ultracold Gases I—Continued**	**LM3I • Laser Science Symposium on Undergraduate Research I—Continued**

FM3F.4 • 15:00 Invited

Molecular and Metabolic Imaging of Tumors to Inform Therapeutic Interventions, Narasimhan Rajaram[1]; [1]*Duke Univ., USA.* This talk will focus on our efforts to combine endogenous and exogenous sources of molecular and metabolic contrast to guide tumor-specific therapy and reduce unnecessary treatment.

LM3G.4 • 15:00 Invited

Quantum Theory of Dropletons, Mackillo Kira[1]; [1]*Univ. Marburg, Germany.* A quantum theory is presented for the identification of dropletons as new quasiparticles in GaAs quantum wells. Dropletons consist of more than four electron-hole pairs in a liquid-like state and have quantized binding energy due to their small size.

LM3H.4 • 15:00 Invited

Simulating Many-Body Dynamics in Systems of Cold Atoms, Molecules, and Ions, Johannes Schachenmayer[1], Alexander Pikovski[1], Bihui Zhu[1], Murray Holland[1], Ana Maria Rey[1]; [1]*Univ. of Colorado at Boulder JILA, USA.* Experiments with cold atoms/molecules in optical lattices or trapped ions make it possible to observe quantum many-body dynamics with long-range interactions. We develop numerical techniques for these systems and explore connections between simulatability and entanglement.

15:30–16:00 Coffee Break, *Tucson and Arizona Ballroom Foyers*

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12
FiO				

16:00–18:00
FM4A • Integrated Nanophotonics

Presider: Jason Orcutt; IBM TJ Watson Reserach Center, USA

FM4A.1 • 16:00 Invited

Integrated Nanophotonics Technology for Optical Interconnects, Yurii A. Vlasov[1]; [1]*IBM TJ Watson Research Center, USA*. The IBM Silicon Nanophotonics technology enables cost-efficient optical links that connect racks, modules, and chips together with ultra-low power single-die optical transceivers. I will give an overview of its historical development, technology differentiators, current status and a roadmap

FM4A.2 • 16:30 Invited

Silicon Photonics: From Drawing Board to a Working IC , Pieter Dumon[1]; [1]*Universiteit Gent, Belgium*. This presentation will discuss silicon photonics including working IC.

16:00–17:45
FM4B • Nonlinear Optics in Micro and Nano-Optical Structures II

Presider: Alexander Sergienko, Boston Univ., USA

FM4B.1 • 16:00 Invited

Modelocking and Synchronization of Chip-Based Frequency Combs, Alexander L. Gaeta[1]; [1]*Cornell Univ., USA*. We describe our recent work on microresonator-based frequency combs and show that mode locking of such combs is analogous synchronization phenomena associated with Kuramoto-based systems.

FM4B.2 • 16:30 Invited

Interaction-free All-optical Switches for Quantum Applications, Yu-Ping Huang[1,2], Abijith S. Kowligy[1], Yu-Zhu Sun[2], Dmitry V. Strekalov[3], Prem Kumar[1,2]; [1]*EECS, Northwestern Univ., USA;* [2]*Physics and Astronomy, Northwestern Univ., USA;* [3]*Jet Propulsion Laboratory, USA*. We present a realization of all-optical switching in whispering-gallery-mode microcavities. Operating without the control and probe light beams overlapping in the cavity (in the asymptotic limit), such switches are ideal for use with quantum signals.

Join the conversation on Twitter. Use hashtag **#FiO14**.

16:00–18:00
FM4C • Fiber Frequency Combs and Mode-Locked Lasers

Presider: Nikola Alic; Univ. of California San Diego, USA

FM4C.1 • 16:00 Invited

Mean-field Numerical Modelling of Microresonator Frequency Combs, Miro J. Erkintalo[1], Stephane Coen[1]; [1]*Univ. of Auckland, New Zealand*. We review recent advances in computationally efficient numerical modelling of microresonator frequency combs. We discuss the characteristics and formation dynamics of Kerr frequency combs, emphasizing the link to passive fiber resonators and temporal cavity solitons.

FM4C.2 • 16:30

Widely-pulsewidth-tunable Ultrashort Pulse Generation from a Birefringent Carbon Nanotube Mode-locked Fiber Laser, Ya Liu[1], Xin Zhao[1], Jiansheng Liu[1], Guoqing Hu[1], Zheng Gong[1], Zheng Zheng[1]; [1]*School of Electronic and Information Engineering, Beihang Univ., China*. Through leveraging both the nonlinear hybrid mode-locking and the linear Lyot filtering effects, ultrashort puleses covering a nearly one order-of-magnitude pulsewidth range can be generated from a CNT mode-locked fiber laser with large cavity birefringence.

FM4C.3 • 16:45

Generation of Repetition-rate-tunable Ultrashort Pulses from a Mode-locked Fiber Laser with Large Polarization Mode Dispersion, Zheng Gong[1], Guoqing Hu[1], Xin Zhao[1], Ya Liu[1], Zheng Zheng[1]; [1]*School of Electronic and Information Engineering, Beihang Univ., China*. The repetition rate of mode-locked pulses from a fiber cavity with relatively large PMD could be tuned over a range proportional to the intracavity birefringence, without significant state-of-polarization modulation.

16:00–18:00
FM4D • Coherence, Interference, and Polarization II

Presider: Kevin Rolland-Thompson; Synopsys, Inc, USA

FM4D.1 • 16:00 Invited

The Polarization Ray Tracing Calculus**,** Russell A. Chipman[1]; [1]*Univ. of Arizona, USA*. The polarization ray tracing calculus facilitates the analysis of polarization dependent point spread functions and optical transfer functions, and can integrate many different polarization models including thin films, anisotropic materials, anisotropic multilayers, diffractive optics, and liquid crystals.

FM4D.2 • 16:30

Cloaked Nanowire Grid Polarizers, Matthew C. George[1], Stew Nielson[1], Eric Gardner[1]; [1]*Moxtek, Inc., USA*. This work presents experimental and optical modeling results on narrow-band, cloaked wire grid polarizers composed of nano-stacked metal and dielectric layers patterned over 200 mm diameter wafers for projection display applications.

FM4D.3 • 16:45

Generation of the Ring-shaped Optical Lattice Using Axially-symmetric Polarization Elements (II), Moritsugu Sakamoto[1], Keisaku Yamane[1,2], Naoshi Murakami[1], Ryuji Morita[1,2], Kazuhiko Oka[1]; [1]*Division of Applied Phisycs, Hokkaido Univ., Japan;* [2]*JST, CREST, Japan*. A novel optical system of a ring-shaped optical-lattice generator using axially-symmetric polarization elements is presented. A series of axially-symmetric polarization elements incorporated into the configuration enables generating any combination of vortices with even-numbered topological charges.

16:00–17:45
FM4E • Information Capacity of the Photon

Presider: Jason Fleischer; Princeton Univ., USA

FM4E.1 • 16:00 Invited

Compressive Quantum Sensing, John C. Howell[1]; [1]*Physics and Astronomy, Univ. of Rochester, USA*. We use compressive sensing to measure hitherto difficult quantum signals, high-dimensional entanglement and quantum images.

FM4E.2 • 16:30 Invited

High Information Capacity Image Recognition Using Correlated Orbital Angular Momentum (OAM) States, Alexander V. Sergienko[1,2], Nestor Uribe-Patarroyo[1], Andrew Fraine[1], Casey Fitzpatrick[1], David Simon[3,1], Olga Minaeva[4]; [1]*Dpet. of ECE, Boston Univ., USA;* [2]*Dept. of Physics, Boston Univ., USA;* [3]*Dept. of Physics and Astronomy, Stonehill College, USA;* [4]*Dept. of Biomedical Engineering, Boston Univ., USA*. We present a novel approach that allows object identification using fewer resources than in conventional pixel-by-pixel imaging by exploiting the enhanced sensitivity of correlated orbital angular momentum states to multiple azimuthal Fourier coefficients.

Tucson Ballroom Salon A

FiO

16:00–18:00
FM4F • Novel Methods for Tissue Imaging and Therapy
Presider: Nozomi Nishimura; Cornell Univ., USA

FM4F.1 • 16:00
In Vivo Fluorescence Imaging for Folate-Targeted Kinetics, Kevin J. Webb[1], Esther Tsai[1], Brian Bentz[1], Venkatesh Chelvam[2], Vaibhav Gaind[1], Philip Low[1]; [1]*Purdue Univ., USA;* [2]*Department of Chemistry, Indian Inst. of Technology Indore, India*. We demonstrate the in vivo imaging of a mouse tumor using fluorescence optical diffusion tomography and the extraction of kinetic information from a compartment model, yielding the first folate drug release kinetics inside cancer cells.

FM4F.2 • 16:15 Invited
Multiscale Optical Imaging for Detection of Oral Cancer, Kristen C. Maitland[1]; [1]*Biomedical Engineering, Texas A&M Univ., USA*. Confocal microscopy provides high resolution optical sectioning of epithelial tissue, but with limited field of view. Fluorescence lifetime imaging is employed for macroscopic guidance with biochemical contrast to complement the microscopic morphologic imaging of reflectance confocal microscopy.

FM4F.3 • 16:45
Autofocus Optimization for Tracking Tissue Surface Topography in Large-Area Mosaicking Structured Illumination Microscopy, Tyler C. Schlichenmeyer[1,2], Mei Wang[1], Carola Wenk[2], J. Quincy Brown[1]; [1]*Biomedical Engineering, Tulane Univ., USA;* [2]*Computer Science, Tulane Univ., USA*. Mosaic imaging of large tissues with structured illumination microscopy (SIM) presents a need for rapid autofocus algorithms for tracking tissue surface topography. We present a novel SIM autofocus function based on the projected pattern modulation, and compare to established functions.

Tucson Ballroom Salon B

LS

16:00–18:00
LM4G • DLS Dissertation Award Session
Presider: David Reitze; California Inst. of Tech., USA

LM4G.1 • 16:00 Invited
Squeezing Quantum Noise in a Full Scale Gravitational Wave Interferometer, Sheila E. Dwyer[1]; [1]*LIGO Hanford Observatory, Caltech, USA*. We have demonstrated sensitivity improvement in a full scale interferometric gravitational wave detector using squeezed states. Our results indicate that squeezing is a technically feasible and astrophysically promising early upgrade to Advanced LIGO.

LM4G.2 • 16:30 Invited
Probing Delocalization in Photosynthetic Antenna Complexes with Femtosecond Chiral Two-Dimensional Spectroscopy, Andrew Fidler[1], Ved P. Singh[2], Phil D. Long[3], Peter Dahlberg[3], Gregory S. Engel[2]; [1]*Los Alamos National Labratory, USA;* [2]*Department of Chemistry, Inst. for Biophysical Dynamics, James Franck Inst., The Univ. of Chicago, USA;* [3]*Program in the Biophysical Sciences, Inst. for Biophysical Dynamics, The Univ. of Chicago, USA*. We present a chiral two-dimensional mapping of light harvesting complex 2. This methodology allows us to follow femtosecond changes in the chirality of the electronic structure, providing detailed insights into the excitation energy transfer events.

Tucson Ballroom Salon C

LS

16:00–18:00
LM4H • Ultracold Gases II
Presider: Peter Engels; Washington State Univ., USA

LM4H.1 • 16:00 Invited
Coherent Optics of Magnon Waves in a Spinor Bose-Einstein Condensate, Dan M. Stamper-Kurn[1,2]; [1]*Physics, Univ. of California Berkeley, USA;* [2]*Materials Sciences Division, Lawrence Berkeley National Laboratory, USA*. Using optical pulses, we create coherent magnon waves in spinor Bose-Einstein condensates of rubidium and utilize magnon interferometry to measure their energy and visualize topological defects. Magnon thermometry, cooling, and thermodynamics will be described.

LM4H.2 • 16:30 Invited
Monopoles in Spinor Bose-Einstein Condensates, David Hall[1], Michael W. Ray[1], Emmi Ruokokoski[2], Konstantin Tiurev[2], Saugat Kandel[1], Mikko Möttönen[2,3]; [1]*Physics and Astronomy, Amherst College, USA;* [2]*Applied Physics, Aalto Univ., Finland;* [3]*Low Temperature Laboratory, Aalto Univ., Finland*. We describe the creation and observation of Dirac monopoles in a synthetic magnetic field, and also provide evidence of isolated topological point defects in the order parameter of a spinor Bose-Einstein condensate.

Tucson Ballroom Salon E

LS

17:00–18:00
LM4I • Laser Science Symposium on Undergraduate Research II

See separate program in registration bag for details.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12
FiO				
FM4A • Integrated Nanophotonics—Continued	**FM4B • Nonlinear Optics in Micro and Nano-Optical Structures II—Continued**	**FM4C • Fiber Frequency Combs and Mode-Locked Lasers—Continued**	**FM4D • Coherence, Interference, and Polarization II—Continued**	**FM4E • Information Capacity of the Photon—Continued**
FM4A.3 • 17:00 Invited **Filters and Spectrum Analyzers, and Their Applications in Classical and Quantum Telecommunications,** Shayan Mookherjea[1]; *[1]Univ. of California San Diego, USA*. We present examples of using silicon photonic components to perform multi-wavelength optical spectral measurements and multi-channel add/drop functionality in data-center networks, and for manipulating the quantum spectrum of photons generated by spontaneous four-wave mixing.	**FM4B.3 • 17:00** **Retrieving the Complex Intracavity Pump Field of a Kerr Comb from the Through Port Data,** Xiaoxiao Xue[1], Yi Xuan[1,2], Yang Liu[1], Pei-Hsun Wang[1], Steven Chen[1], Jian Wang[1,2], Daniel E. Leaird[1], Minghao Qi[1,2], Andrew M. Weiner[1,2]; *[1]School of Electrical and Computer Engineering, Purdue Univ., USA; [2]Birck Nanotechnology Center, Purdue Univ., USA*. A method of retrieving the complex intracavity pump field from the through port is proposed, and verified through characterizing the time-domain waveform of a mode-locked comb related to dark soliton formation in a normal-dispersion microresonator.	**FM4C.4 • 17:00** **Simultaneous Operation of a Carbon Nanotube Hybrid Mode-locked Laser Under Different Mode-locking Regimes,** Ya Liu[1], Xin Zhao[1], Jiansheng Liu[1], Zheng Gong[1], Guoqing Hu[1], Zheng Zheng[1]; *[1]School of Electronic and Information Engineering, Beihang Univ., China*. Simultaneous oscillation of pulses with vastly different pulse widths in a carbon nanotube mode-locked fiber ring cavity is observed, as the intravity birefringence results in different pulse formation mechanisms under both nonlinear and linear regimes.	**FM4D.4 • 17:00** **Modeling Depolarization Effects in Highly Scattering Media,** Sajad Ghatrehsamani[1], Graham Town[1]; *[1]Macquarie, Australia*. The propagation of polarized light through micro-structured materials such as air-polymer composites was modeled using a Monte-Carlo algorithm, and the effect of material parameters on light diffusion and depolarization determined, especially at large scattering angles.	**FM4E.3 • 17:00** **Quantitative Phase Imaging using Entangled Photon Pairs,** Chien-Hung Lu[1], Jason W. Fleischer[1]; *[1]Princeton Univ., USA*. We experimentally demonstrate phase imaging using entangled photons and transport-of-intensity methods. We show that the reconstruction of an unknown phase object from quantum light is more sensitive and less noisy than that of classical illumination.
	FM4B.4 • 17:15 **Measuring Optical Phases of Kerr Frequency Combs,** Aurélien Coillet[1], Pascal Del'Haye[1], William Loh[1], Katja Beha[1], Scott B. Papp[1], Scott A. Diddams[1]; *[1]NIST Boulder, USA*. We present two methods for measuring the optical phases of the spectral lines of microresonator-based frequency combs, and use these phase sensitive measurements to study novel phase-locked comb states.	**FM4C.5 • 17:15** **All-fiber Mode-locking Using a Two Concentric Core Fiber Saturable Absorber,** Elham Nazemosadat[1], Arash Mafi[1]; *[1]Department of Electrical Engineering and Computer Science, Univ. of Wisconsin-Milwaukee, USA*. An all-fiber mode-locking element which operates based on nonlinear switching in a novel two concentric core fiber structure is designed. This multicore cylindrically symmetric structure can be easily fabricated.	**FM4D.5 • 17:15** **Ray Theory of Wave for Particle Scattering,** Kuan F. Ren[1]; *[1]Universite de Rouen, France*. By introducing the curvature of the wave front in the ray model, Ray Theory of Wave permits to describe with good precision the scattering of large and arbitrarily shaped objects with a smooth surface.	**FM4E.4 • 17:15** **High-dimensional Quantum Key Distribution with Photonic Orbital Angular Momentum,** Mohammad Mirhosseini[1], Omar S. Magana Loaiza[1], Malcolm O'Sullivan[1], Brandon Rodenburg[1], Mehul Malik[2], Martin Lavery[3], Miles Padgett[3], Daniel Gauthier[4], Robert W. Boyd[1,5]; *[1]The Inst. of Optics, Univ. of Rochester, USA; [2]Inst. for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Austria; [3]Department of Physics, Univ. of Glasgow, UK; [4]Department of Physics, Duke Univ., USA; [5]Department of Physics, Univ. of Ottawa, Canada*. We experimentally demonstrate a quantum cryptography system based on photonic orbital angular momentum. The system achieves a channel capacity of 2.1 bits per sifted photon through the use of a 7-dimensional alphabet for encoding information.
FM4A.4 • 17:30 **Sub-wavelength Critical Coupling for Densely Integrated Nano-photonics,** Michael Mrejen[1], Haim Suchowski[1], Taiki Hatakeyama[1], Chihhui Wu[1], Liang Feng[1], Yuan Wang[1], Xiang Zhang[1,2]; *[1]NSF Nano-scale Science and Engineering Center (NSEC), Univ. of California, Berkeley, USA; [2]Materials Science Division, Lawrence Berkeley National Laboratory, USA*. We experimentally demonstrate a novel approach for densely packed coupled waveguides, based on adiabatic elimination scheme, allowing control of the inherent coupling between waveguides. At the nano-scale, zero coupling between the waveguides can be achieved.	**FM4B.5 • 17:30** **Second Harmonic Generation by Metamagnetics: Interplay of Electric and Magnetic Resonances,** Rohith Chandrasekar[1], Naresh Emani[1], Alexei Lagutchev[1], Vladimir M. Shalaev[1], Alexander Kildishev[1], Cristian Ciraci[2,3], David R. Smith[2]; *[1]Electrical and Computer Engineering, Purdue Univ., USA; [2]Electrical and Computer Engineering, Duke Univ., USA; [3]Istituto Italiano di Tecnologia, Italy*. We present the first experimental study of the interplay of electric and magnetic resonances in a metamaterial to measure their independent contributions to second-harmonic generation. Experiments indicate evident contribution to SHG from fundamental magnetic field.	**FM4C.6 • 17:30** Invited **Efficient Broadband Vacuum-Ultraviolet Generation in Gas-Filled Hollow-Core Photonic Crystal Fibers,** John C. Travers[1], Alexey Ermolov[1], Federico Belli[1], Ka Fai Mak[1], Michael Frosz[1], Francesco Tani[1], Amir Abdolvand[1], Philip St.J Russell[1]; *[1]Russell Division, Max Planck Inst. for the Science of Light, Germany*. We report two techniques for the efficient generation of tunable ultrafast pulses in the vacuum-ultraviolet, covering at least 117-200 nm, by pumping gas-filled kagomé-style photonic crystal fibers with few-μJ, 35 fs, 800 nm laser pulses.	**FM4D.6 • 17:30** **Observation of Spectral Interference for Any Path Difference in an Interferometer,** Luis Jose Salazar Serrano[1,2], Alejandra Valencia[2], Juan P. Torres[1,3]; *[1]ICFO -The Inst. of Photonic Sciences, Spain; [2]Quantum Optics Laboratory, Universidad de los Andes, Colombia; [3]Dept. of Signal Theory and Communications, Universitat Politecnica de Catalunya, Spain*. We report experimental observation of spectral interference in a Michelson interferometer, regardless of the relationship between the temporal path difference and the spectral width of an input pulse, by using a weak value amplification scheme.	**FM4E.5 • 17:30** **Compressive Direct Measurement of the Transverse Photonic Wavefunction,** Mohammad Mirhosseini[1], Omar S. Magana Loaiza[1], Seyed Mohammad Hashemi Rafsanjani[2], Robert W. Boyd[1,3]; *[1]The Inst. of Optics, Univ. of Rochester, USA; [2]Department of Physics, Univ. of Rochester, USA; [3]Department of Physics, Univ. of Ottawa, Canada*. We generalize the method of direct measurement and combine it with compressive sensing. Using our method, we measure a 19200-dimensional state using only 20% of the total required measurements.

Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon E
FiO	LS		

FM4F • Novel Methods for Tissue Imaging and Therapy—Continued

FM4F.4 • 17:00
Quantitative Autofluorescence Imaging Measures Early Response to Head and Neck Cancer Treatment In Vivo, Amy Shah[1], Alex Walsh[1], Paula Pohlmann[2], Melissa Skala[1]; [1]*Biomedical Engineering, Vanderbilt Univ., USA;* [2]*Medicine, Georgetown Univ., USA.* Fluorescence intensity and lifetime imaging of NADH and FAD measure metabolic shifts in vivo at an early time-point after treatment with chemotherapy, a targeted inhibitor, and combination treatment in head and neck cancer xenografts.

FM4F.5 • 17:15
Trough-Focus OTF Based Optical Quality Testing of Whole Slide Scanners for Digital Pathology, Mojtaba Shakeri[1], Bas Hulsken[2], Lucas van Vliet[1], Sjoerd Stallinga[1]; [1]*Department of Imaging Physics, Delft Univ. of Technology, Netherlands;* [2]*Philips Digital Pathology, Netherlands.* We measure the through-focus OTF of whole slide scanners for optical quality testing and monitoring. Analysis of the OTF data gives a system level evaluation of astigmatism, field curvature, chromatic aberrations, coma and spherical aberration.

FM4F.6 • 17:30 Invited
Acoustic Radiation Force Optical Coherence Elastography, Zhongping Chen[1]; [1]*Univ. of California Irvine, USA.* An acoustic radiation force optical coherence elastography (ARF-OCE) system was developed that combines high speed ARF with high resolution of phase resolved optical coherence tomography to image and quantify tissue biomechanical properties.

LM4G • DLS Dissertation Award Session—Continued

LM4G.3 • 17:00 Invited
Shaping Light in Complex Settings, Ido Kaminer[1,2], Maor Mutzafi[2], Gal Harari[2], Hanan Herzig Sheinfux[2], Amir Levy[1], Scott Skirlo[1], Jonathan Nemirovsky[2], Mordechai Segev[2]; [1]*Physics, MIT, USA;* [2]*Physics, Technion Israel Inst. of Technology, Israel.* My thesis presents new classes of accelerating beams in nonlinear optics and electromagnetism. These ideas apply to any wave system, recently leading to accelerating wavepackets of Dirac's fermions, revealing intriguing phenomena in relativistic quantum mechanics.

LM4G.4 • 17:30 Invited
Characterization and Application of Isolated Attosecond Pulses, Michael Chini[1]; [1]*Univ. of Central Florida, USA.* Attosecond transient absorption spectroscopy, using ultrabroadband isolated attosecond pulses characterized using the PROOF (phase retrieval by omega oscillation filtering) technique, is demonstrated as a powerful tool for capturing the sub-laser-cycle dynamics in laser-dressed atoms.

LM4H • Ultracold Gases II—Continued

LM4H.3 • 17:00 Invited
Lightspeed at a Snail's Pace: Relativity Meets Ultracold Physics, Lincoln Carr[1], Laith H. Haddad[1], Christopher M. Weaver[1], Kenneth M. O'Hara[2]; [1]*Physics, Colorado School of Mines, USA;* [2]*Physics, Pennsylvania State Univ., USA.* Bose-Einstein condensates in crystals of light with honeycomb geometry give rise to nonlinear Dirac equations and relativistic linear stability equations supporting a zoo of long-lived relativistic vortices, skyrmions, and solitons.

LM4H.4 • 17:30 Invited
Probing Quantum Many-body Physics with Bright Matter-wave Solitons and Ultracold Polar Molecules, Simon Cornish[1]; [1]*Univ. of Durham, UK.* We report the realisation of bright matter-wave solitons and the creation of ultracold 87RbCs molecules using quantum degenerate gases in combination with magnetically tunable Feshbach resonances with a view to exploring applications in many-body physics.

LM4I • Laser Science Symposium on Undergraduate Research II

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12

FiO

FM4A • Integrated Nanophotonics—Continued

FM4A.5 • 17:45
Stimulated Brillouin Scattering in High Index-Contrast Optical Waveguides: Energy, Forces and Symmetries, Christian Wolff[1], Michael J. Steel[2], Benjamin J. Eggleton[3], Christopher G. Poulton[1]; [1]*School of Mathematical Sciences, Univ. of Technology, Sydney, Australia;* [2]*School of Physics, Macquarie Univ., Australia;* [3]*Inst. of Photonics and Optical Science (IPOS), School of Physics, Univ. of Sydney, Australia*. We theoretically investigate the important physical processes for Stimulated Brillouin Scattering in high-contrast optical waveguides. We explore the relevant forces and scattering mechanisms, their symmetry properties and their relationships based on the conservation of energy.

FM4C • Fiber Frequency Combs and Mode-Locked Lasers—Continued

FM4D • Coherence, Interference, and Polarization II—Continued

FM4D.7 • 17:45
Induced Transparency and Pulse Delay Using Orthogonally Polarized Whispering-Gallery Modes of a Single Microresonator, Khoa V. Bui[1], Albert T. Rosenberger[1]; [1]*Physics, Oklahoma State Univ., USA*. Induced transparency and pulse delay are observed in the throughput from a single microresonator via the superposition of two coresonant modes of orthogonal polarization. The effect is demonstrated using a hollow-bottle microresonator.

17:30–19:00 Meet OSA's Journal Editors, *Ania Terrace*

17:30–19:00 Minorities and Women in OSA (MWOSA) Networking Reception, *Tucson Ballroom, Salons I & J*

19:00–20:00 Environmental Sensing Special Talk: AFOSR Program on Imaging and Beam Control Through Deep Turbulence, *Arizona Ballroom, Salon 11*

19:00–22:00 OSA Student Member Reception, *Starr Canyon River, JW Marriott Tucson Starr Pass Resort*

19:00–21:00 OSA President's Reception (Invitation Only), *Catalina Barbeque Co., located at Starr Pass Country Club, JW Marriott Tucson Starr Pass Resort*

Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon E
FiO	LS		
FM4F • Novel Methods for Tissue Imaging and Therapy—Continued	LM4G • DLS Dissertation Award Session—Continued	LM4H • Ultracold Gases II—Continued	LM4I • Laser Science Symposium on Undergraduate Research II

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Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12

FiO

07:00–17:30 Registration, *Arizona Ballroom Foyer*

08:00–09:30 VIP Industry Leaders Networking Event: Connecting OSA Corporate Executives, Recent Graduates and Students, *Tucson Ballroom, Salon F*

08:00–10:00
FTu1A • Integrated Quantum Optics I

Presider: Paolo Villoresi; Universita degli Studi di Padova, Italy

FTu1A.1 • 08:00 Invited

Ultrafast and Fault-Tolerant Quantum Communication over Long Distances, Liang Jiang[1], Sreraman Muralidharan[2], Jungsang Kim[3], Norbert Lutkenhaus[4], Mikhail Lukin[5]; [1]*Dept. of Applied Physics, Yale Univ., USA;* [2]*Dept. of Electrical Engineering, Yale Univ., USA;* [3]*Dept. of Electrical and Computer Engineering, Duke Univ., USA;* [4]*Inst. of Quantum Computing, Univ. of Waterloo, Canada;* [5]*Dept. of Physics, Harvard Univ., USA.* We investigate quantum repeaters using small encoding blocks to correct both operational and photon loss errors, which can send quantum information over long distances at a rate only limited by local gate speed.

08:00–10:00
FTu1B • Optical Interconnections for Data Centers

Presider: Masaaki Hirano; Sumitomo Electric Industries Ltd, Japan

FTu1B.1 • 08:00 Invited

Optical Innovations in Data-centers Interconnects and Networking, Loukas Paraschis[1]; [1]*Cisco Systems, Inc., USA;* [2]*Cox, USA.* Review recent innovations in optical interconnects, and network architectures, that allow data-center to cost-effectively scale to the cloud-era requirements for flatter networks, with more flexible provisioning, and higher capacity.

08:00–10:00
FTu1C • Coherence, Interference, and Polarization III

Presider: Byoungho Lee; Seoul National Univ., South Korea

FTu1C.1 • 08:00 Invited

Controlling Light's Handedness Inside Laser Resonators, Andrew Forbes[1], Darryl Naidoo[1]; [1]*CSIR National Laser Centre, South Africa.* We will give an overview of various approaches to create orbital angular momentum carrying beams directly from a laser resonator, highlighting our recent approach to creating general Poincare beams using non-homogeneous polarization optics.

08:00–10:00
FTu1D • Modulators

Presider: Shigeru Nakamura; NEC Corp., Japan

FTu1D.1 • 08:00 Invited

Enhancing the Electrooptic Effect Using Modulation Instability, Bahram Jalali[1], David Borlaug[1], Peter Devore[1], Ozdal Boyraz[1], Ali Rostrami[1]; [1]*Univ. of California Los Angeles, USA.* The high-frequency increase in modulator half-wave voltage contradicts the reduction in voltage swing of electronics. We show a solution whereby modulation side-bands are amplified, at the expense of the carrier, using controlled modulation instability.

08:00–10:00
FTu1E • Materials for Plasmonics

Presider: Robert Norwood; Univ. of Arizona, USA

FTu1E.1 • 08:00

Observation of Strong Coupling Between Graphene Plasmons and THz Surface Optical Phonons, Choon How Gan[1], Isaac Luxmoore[1], Qiang Liu[2], Federico Valmorra[2], Penglei Li[1], Jerome Faist[2], Geoffrey Nash[1]; [1]*College of Engineering, Mathematics and Physical Sciences, Univ. of Exeter, UK;* [2]*Inst. for Quantum Electronics, ETH Zurich, Switzerland.* Spectral measurements of electrically-gated graphene nanoribbons deposited on silicon dioxide reveals the dispersion of four branches of surface-phonon-plasmon polaritons. Consistent with calculations, strong coupling via long-range Frölich interactions in the lowest THz branch is observed.

FTu1E.2 • 08:15

Surface Plasmon Polaritons and Visible Light Coupling via Photorefractive Phase Gratings in Indium Tin Oxide Coated Iron-doped $LiNbO_3$ Crystal Slabs, Hao Wang[1], Hua Zhao[1], Guangwei Hu[1], Jingwen Zhang[1]; [1]*Harbin Inst. of Technology, China.* 2D diffraction patterns without external feedback, 89% total reflectivity, visible reconfigurable waveguides formed on the slab of ITO coated iron-doped $LiNbO_3$ hinted that photorefractive phase gratings are responsible for the excitation of SPPs and strong coupling with light beams.

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Tucson Ballroom Salon A	Tucson Ballroom Salon B	Tucson Ballroom Salon C	Tucson Ballroom Salon D
FiO		LS	

07:00–17:30 Registration, *Arizona Ballroom Foyer*

08:00–09:30 VIP Industry Leaders Networking Event: Connecting OSA Corporate Executives, Recent Graduates and Students, *Tucson Ballroom, Salon F*

08:00–10:00
FTu1F • Optical Trapping and Manipulation

Presider: Alvaro Casas-Bedoya; Univ. of Sydney, Australia

FTu1F.1 • 08:00

Volume holographic microscopy for holographic 3D particle manipulation, Yuan Luo[1]; [1]*National Taiwan Univ., Taiwan*. Here we demonstrate a 3D real-time interactive optical manipulating system using holographic optical tweezers incorporating with volume holographic microscope. Intensity information about trapped objects at multiple depths can be captured in a single measurement.

FTu1F.2 • 08:15 Invited

Optical Trapping, Stretching, and Self-Assembly for Biological Measurements, Roshni Biswas[1], Eric Jaquay[1], Mehmet Solmaz[1], Luis J. Martinez[1], Ningfeng Huang[1], Camilo A. Mejia[1], Shao-Hua Wu[1], Jing Ma[1], Shalene Sankhagowit[1], Noah Malmstadt[1], Michelle L. Povinelli[1]; [1]*Univ. of Southern California, USA*. We describe two optical trapping techniques. We used a dual-beam optical trap to measure membrane mechanical properties. We trapped periodic arrays of nanoparticles using a photonic crystal, a method called light-assisted, templated self assembly.

08:00–10:00
FTu1G • General Optical Sciences I

Presider: Christian Reimer; INRS-EMT, Canada

FTu1G.1 • 08:00

Two-Stage Optical Parametric Amplification for Generation of Ultrashort 5-μm Pulses in ZnGeP2, Scott Wandel[1], Guibao Xu[1], Igor Jovanovic[1]; [1]*Penn State Univ., USA*. We present a design and preliminary performance of a 5-μm source utilizing two-stage optical parametric amplification in ZnGeP2 pumped by 2-μm millijoule-level ultrafast pulses.

FTu1G.2 • 08:15

Effect of Forbidden Light on Subsurface IC Imaging, Aydan Uyar[1], Abdulkadir Yurt[2], Berkin T. Cilingiroglu[1], Bennett B. Goldberg[4,1], Selim M. Ünlü[1,3]; [1]*Department of Electrical and Computer Engineering, Boston Univ., USA;* [2]*Division of Material Science and Engineering, Boston Univ., USA;* [3]*Department of Biomedical Engineering, Boston Univ., USA;* [4]*Department of Physics, Boston Univ., USA*. Forbidden light, the cone of high-angle light formed above critical angle, plays a critical role in near-interface high numerical aperture imaging. We investigate its effect in subsurface imaging in aplanatic solid immersion microscopy on ICs.

08:00–10:00
LTu1H • Ultracold Gases III

Presider: David Hall; Amherst College, USA

LTu1H.1 • 08:00 Invited

Quantum Hydrodynamics and Turbulence in Atomic Bose-Einstein Condensates, Makoto Tsubota[1]; [1]*Osaka City Univ., Japan*. We discuss quantum hydrodynamics and turbulence in atomic Bose-Einstein condensates (BECs). A brief review of the issues is followed by the theoretical and numerical studies on quantum turbulence in multi-component BECs.

08:00–10:00
LTu1I • Semiconductor Nanooptics II

Presider: Sander Zandbergen; Univ. of Arizona, USA

LTu1I.1 • 08:00 Invited

Ge Nanowire THz Dynamics, Theodore B. Norris[1], P. Springer[2], Mackillo Kira[2]; [1]*Univ. of Michigan, USA;* [2]*Dept. of Physics, Philipps-Universität Marburg, Germany*. Optical-pump THz-probe time-domain spectroscopy is applied to the study of carrier dynamics in oriented Ge and Si/Ge core/shell nanowires. We discuss the extraction of various relaxation processes, including intraband, interband, and momentum scattering, as well as the possibility for observing indirect exciton formation.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12

FiO

FTu1A • Integrated Quantum Optics I—Continued

FTu1A.2 • 08:30 Invited

Deterministic Creation and Strong Purcell Enhancement of Long-lived Nitrogen-Vacancy Spin Qubits in Diamond Photonic Crystal Cavities, Tim Schröder[1], Luozhou Li[1], Edward H. Chen[1], Michael Walsh[1], Igal Bayn[1], Jordan Goldstein[1], Ophir Gaathon[1], Matthew E. Trusheim[1], Ming Lu[2], Jacob Mower[1], Mircea Cotlet[2], Matthew L. Markham[3], Daniel Twitchen[3], Dirk Englund[1]; *[1]MIT, USA; [2]Dept. of Electrical Engineering, Columbia Univ., USA; [3]Center for Functional Nanomaterials, Brookhaven National Laboratory, USA; [4]College of Nanoscale Science and Engineering, Univ. of New York, USA; [5]Element Six Ltd., UK.* We demonstrate the deterministic creation of nitrogen-vacancy spin qubits at the mode maximum of diamond photonic crystal cavities, enhancement of the zero-phonon-line spontaneous emission rate greater than 60, and NV spin phase coherence times exceeding 200μs.

FTu1A.3 • 09:00

Solid State Nonlinear Optics for Entangled Coherent States, Andrew Fraine[1], Olga Minaeva[2], Abu Thomas[1], Alexander V. Sergienko[1,3]; *[1]Department of Electrical and Computer Engineering, Boston Univ., USA; [2]Department of Biomedical Engineering, Boston Univ., USA; [3]Department of Physics, Boston Univ., USA.* Highly nonlinear solid-state systems are discussed as solutions for the generation of phase entangled coherent states. Such states are necessary for many quantum optical information applications including a newly proposed quantum key distribution protocol.

FTu1B • Optical Interconnections for Data Centers—Continued

FTu1B.2 • 08:30 Invited

Record Small and Low Loss Slow Light Delay Lines and Dispersion Compensators, Misha Sumetsky[1]; *[1]Aston Univ., UK.* Record small and low loss slow light optical signal processing devices are proposed and demonstrated using the recently invented Surface Nanoscale Axial Photonics (SNAP) technology.

FTu1B.3 • 09:00 Invited

Advanced Modulation Techniques for Optical Interconnects, Idelfonso Tafur Monroy[1]; *[1]Danmarks Tekniske Universitet, Denmark.* This talk will discuss advanced modulation techniques for optical interconnects.

FTu1C • Coherence, Interference, and Polarization III—Continued

FTu1C.2 • 08:30

Propagation of Partially Coherent Electromagnetic Beams through Multilayered Stratified Media, Mayukh Lahiri[1], Emil Wolf[1,2]; *[1]Physics and Astronomy, Univ. of Rochester, USA; [2]Inst. of Optics, Univ. of Rochester, USA.* We present a theory of propagation of electromagnetic beams of any state of coherence and polarization through a stratified medium. We illustrate how coherence and polarization properties of a beam may change on such propagation.

FTu1C.3 • 08:45

Increasing the Coherence Time in a Magnetically Sensitive Stimulated Raman Transition in Rb85, Sara DeSavage[1], Danielle Braje[2], Jon Davis[1], Frank Narducci[1]; *[1]EO Sensors Division, Naval Air Systems Command, USA; [2]MIT Lincoln Laboratory, USA.* we experimentally study the Ramsey, spin echo and CPMG pulse sequences of a magnetically sensitive transition of a cold Rb85 gas. We can increase the coherence time by up to a factor of 10 by using CPMG pulse sequences as compared to Ramsey or spin echo.

FTu1C.4 • 09:00 Invited

Miniature Steerable Optical Sources Beaming Photons with Angular Momentum, Guanghao Rui[1], Qiwen Zhan[1]; *[1]Electro-Optics Program, Univ. of Dayton, USA.* We demonstrate the design, fabrication and testing of miniature steerable optical sources that are capable of beaming photons with spin and orbital angular momentum through coupling nanoscale emitters to plasmonic waveguide and antenna structures.

FTu1D • Modulators—Continued

FTu1D.2 • 08:30 Invited

Electro-optic Effects in Silicon Waveguides, Heinrich Kurz[1]; *[1]AMO GmbH, Germany.* The linear electro-optic effect in silicon waveguides introduced by strain gradients is analyzed. The symmetry of silicon is broken by specific Silicon-Nitride claddings resulting in remarkable high second order optical nonlinearties comparable to Lithium Niobate.

FTu1D.3 • 09:00

Gigahertz Microring Electro-Optical Modulator in Hybrid Silicon and Lithium Niobate, Li Chen[1], Qiang Xu[1], Michael Wood[1], Ronald M. Reano[1]; *[1]Ohio State Univ., USA.* We present a gigahertz electro-optical modulator based on a hybrid silicon and lithium niobate microring resonator. Digital modulation with an extinction ratio greater than 3 dB is demonstrated up to 9 Gb/s.

FTu1E • Materials for Plasmonics—Continued

FTu1E.3 • 08:30

Surface Plasmon Polaritons and Visible Radiation Coupling in Dye Doped Liquid Crystal Cells with ZnSe Interlayers, Tingyu Xue[1], Hua Zhao[1], Cuiling Meng[1], Jiayin Fu[1], Jingwen Zhang[1]; *[1]Harbin Inst. of Technology, China.* Surface plasmon polaritons excited in PM-597 doped 5CB liquid crystal cells sandwiched with ZnSe coated ITO glass plates proved to be responsible for several intriguing observations we made. Tentative physical picture of SPPs mediation based on electrostatic modification was proposed in this study.

FTu1E.4 • 08:45

Orthogonal and parallel lattice plasmons in the SiO2/Au core-shell nanorod arrays, Linhan Lin[1], Yasha Yi[1]; *[1]Univ. of Michigan, USA.* SiO2/Au core-shell nanorod arrays (NRAs) with high aspect ratio are reported, which support different lattice plasmon modes (LPMs). The diffraction induced dipolar coupling for these LPMs are studied here.

FTu1E.5 • 09:00

Platinum Germanides for Long-wavelength Infrared Plasmonics, Nima Nader[1,2], Shiva Vangala[1,2], Daniel M. Wasserman[3], William Streyer[3], Joshua Hendrickson[2], Justin Cleary[2]; *[1]Solid State Scientific Corporation, USA; [2]Sensors Directorate, Air Force Research Laboratory, USA; [3]Electrical and Computer Engineering, Univ. of Illinois, USA.* PtxGe1-x compositions were formed by thermal-annealing. Plasmonic characteristics such as propagation length, loss, and mode confinement were determined from measured complex permittivities. Fabricated grating structures were characterized via LWIR reflection taken at multiple incident angles.

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FiO

FTu1F • Optical Trapping and Manipulation—Continued

FTu1F.3 • 08:45
Micro-rotation Through Indirect Manipulation of Absorbing Objects, Catherine Herne[1], Michael A. Senatore[2]; [1]*Physics and Astronomy, SUNY New Paltz, USA;* [2]*Physics and Astronomy, Colgate Univ., USA.* We show the enhanced rotation of opaque graphite through adhesion with optically trapped silica spheres. Absorbing graphite is rotated through orbital angular momentum transfer from a Laguerre-Gauss mode and trapped due to the refracting spheres.

FTu1F.4 • 09:00
Asymmetric Imaging of a Linear Diode Bar for an Optical Cell Stretcher, Kevin B. Roth[1], Keith B. Neeves[1], Jeff Squier[2], David W M Marr[1]; [1]*Chemical and Biological Engineering Department, Colorado School of Mines, USA;* [2]*Department of Physics, Colorado School of Mines, USA.* To simplify optical cell stretcher implementation, we demonstrate a novel anamorphic imaging technique for linear diode laser sources. With this, observed red blood cell stretch is comparable to values found with traditional high-NA optics.

FTu1G • General Optical Sciences I—Continued

FTu1G.3 • 08:30
Can extreme UV optical superoscillations be delivered through a dielectric medium?, Yaniv Eliezer[1], Alon Bahabad[1]; [1]*Physical Electronics, Tel-Aviv Univ., Israel.* We show theoretically and numerically that propagating a superoscillatory signal containing extreme-uv superoscillations through the absorbing resonance of an optically thick dielectric medium leads to ordered revivals of the superoscillation.

FTu1G.4 • 08:45
Stabilized Semiconductor Optical Frequency Comb with Programmable Intracavity Dispersion Compensation, Anthony Klee[1], Kristina Bagnell[1], Peter Delfyett[1]; [1]*Univ. of Central Florida, CREOL, USA.* We demonstrate a mode-locked semiconductor laser producing a stabilized frequency comb. An intracavity spectral processor allows for programmable spectral phase adjustment for maximum bandwidth while maintaining a Pound-Drever-Hall lock to an intracavity Fabry-Pérot etalon.

FTu1G.5 • 09:00
Beam Deflection Measurements of Transient Nonlinear Refraction from Coherent Rotational Revivals in Air, Matthew Reichert[1], Peng Zhao[1], Jennifer M. Reed[1], Trenton R. Ensley[1], David J. Hagan[1], Eric W. Van Stryland[1]; [1]*Univ. of Central Florida, CREOL, USA.* We apply the beam deflection technique to measure the transient nonlinearity of air well below filamentation threshold with unprecedented sensitivity at 1atm. Rotational contributions of N_2 and O_2 were resolved over 300 ps of delay.

LS

LTu1H • Ultracold Gases III—Continued

LTu1H.2 • 08:30 Invited
Clusters and Cascades: Vortex Motion in 2D Quantum Turbulence, Ashton Bradley[1]; [1]*Univ. of Otago, New Zealand.* Two-dimensional quantum vortex motion provides a minimal system exhibiting fluid turbulence. Quantum analogues of the classical inverse energy cascade and macroscopic energy condensation processes in 2d will be presented and linked to recent experimental work.

LTu1H.3 • 09:00 Invited
Phase Slips and Weak Links: Experiments with Superfluid Atom Circuits, Gretchen K. Campbell[1]; [1]*Joint Quantum Inst., NIST and the Univ. of Maryland, USA.* In recent experiments with a ring-shaped Bose Einstein condensate, we have directly measured resistive flow across a weak link. In addition, we have also developed a new technique to directly measure the current-phase relationship of weak links.

LTu1I • Semiconductor Nanooptics II—Continued

LTu1I.2 • 08:30 Invited
Semiconductor Quantum Light Sources for Integrated Quantum Photonic Applications, Peter Michler[1]; [1]*Inst. of Semiconductor Optics and Functional Interfaces, Univ. of Stuttgart, Germany.* We present a quantum dot based on-demand source of indistinguishable and entangled photon pairs. Furthermore, monolithic on-chip integration of semiconductor waveguides, beamsplitters and single-photon sources is demonstrated.

LTu1I.3 • 09:00 Invited
Optical Control of Electron and Nuclear States, Duncan G. Steel[1]; [1]*Physics/EECS, Univ. Michigan, USA.* Data shows that coherent optical interactions can control both the electronic and nuclear spin states in single and coupled quantum dots to. Measurements report on various quantum parameters associated with these states and their interaction.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12
FiO				

FTu1A • Integrated Quantum Optics I—Continued

FTu1A.4 • 09:15
Macroscopic entanglement based on weak Kerr nonlinearties, Tian Wang[1,2], Farid Ghoobadi[1], Honwai Lau[1], Christoph Simon[1]; *[1]Physics and Astronomy, Univ. of Calgary, Canada; [2]Physics, Cornell Univ., USA.* We proposed and analyzed a new class of macroscopic entangled states base on weak cross Kerr phase shift, which is robust under noisy conditions, and has the potential to be verified experimentally.

FTu1A.5 • 09:30
Phase Matching and Frequency Mixing of Contra-propagating Electromagnetic Waves in Carbon Nanoforest, Alexander K. Popov[1], Sergey A. Myslivets[2], Igor S. Nefedov[3]; *[1]Birck Nanotechnology Center, Purdue Univ., USA; [2]Coherent Optics, L.V. Kirensky Inst. of Physics, Siberian Branch of the Russian Academy of Sciences, Russian Federation; [3]Aalto Univ., Finland.* We show that particular spatial distributions of carbon nanotubes enables extraordinary nonlinear-optical propagation processes commonly attributed to negative-index metamaterials. The possibility of great enhancement of frequency conversion is demonstrated with numerical simulations.

FTu1A.6 • 09:45
Multi-mode fibre correction for applications in optomechanics using a digital micromirror device, Miguel A. Preciado[1], Michael Mazilu[1], Kishan Dholakia[1]; *[1]School of Physics and Astronomy, Univ. of St Andrews, UK.* We discuss the development of a digital micromirror based adaptive optical system that corrects for the propagation of coherent light through multimode fibres with the aim to achieve optical trapping in vacuum.

FTu1B • Optical Interconnections for Data Centers—Continued

FTu1B.4 • 09:30 Invited
Efficient Interconnection for Modern Computing Systems, Odile Liboiron-Ladouceur[1]; *[1]Electrical and Computer Engineering, McGill Univ., Canada.* Direct replacement of point-to-point electrical links with optics in servers and large computing systems (e.g., datacenters) is not necessarily energy-efficient. Alternative approaches and recent experimental development will be discussed towards more efficient interconnection networks.

FTu1C • Coherence, Interference, and Polarization III—Continued

FTu1C.5 • 09:30
Trajectory-based unveiling of angular momentum of photons, Yongnan Li[1], Lingjun Kong[1], Zhicheng Ren[1], Chenghou Tu[1], Huitian Wang[1,2]; *[1]School of physics, Nankai Univ., China; [2]National Laboratory of Solid State Microstructures, Nanjing Univ., China.* In this talk, we devote to explore the the average photon trajectories (APTs) under the paraxial circumstance. The results reveal that the SAM and the OAM result both in the helical three-dimensional APTs.

FTu1C.6 • 09:45
Measurement of orbital angular momentum and topological charge in optical vortices with shaped vortex cores, Anderson M. Amaral[1], Edilson L. Falcão-Filho[1], Cid B. de Araújo[1]; *[1]Universidade Federal de Pernambuco, Brazil.* Optical vortices (OV) with shaped vortex cores can extend the applicability of OV, but are not well characterized by usual methods. We describe and experimentally demonstrate how shaped OV may be characterized, based on the definitions of classical orbital angular momentum and topological charge.

FTu1D • Modulators—Continued

FTu1D.4 • 09:15
Broadband Low-power Optical Modulator Based on Electro-optic Polymer Infiltrated Silicon Slot Photonic Crystal Waveguide, Xingyu Zhang[1], Amir Hosseini[2], Harish Subbaraman[2], Jingdong Luo[3], Alex Jen[3], Robert Nelson[4], Ray T. Chen[1]; *[1]Univ. of Texas at Austin, USA; [2]Omega Optics, Inc., USA; [3]Univ. of Washington, USA; [4]Air Force Research Laboratory, USA.* We demonstrate a broadband, low-dispersion, sub-volt and compact optical modulator based on electro-optic polymer infiltrated silicon slot photonic crystal waveguide. Modulation up to 43GHz, Vπ×L=0.282V×mm, and optical bandwidth of 8nm are experimentally demonstrated.

FTu1D.5 • 09:30
Ultralow switching energy germanium electro-optical modulator, Julian Sweet[1,2], Joshua Hendrickson[1], Richard Soref[3]; *[1]Air Force Research Laboratory, USA; [2]Wyle, USA; [3]Department of Physics & Engineering Program, Univ. of Massachusetts Boston, USA.* A lateral p-n junction nanobeam electro-optic modulator for the 8 micron regime is presented. Owing to a strong free-carrier absorption effect, an ultralow switching energy is achieved, while utilizing a small footprint, monolithic, and VLSI-compatible implementation.

FTu1D.6 • 09:45
Semiconductor-Based Linear Intensity Modulator with Spur Free Dynamic Range of 105 dB.Hz2/3, Edris Sarailou[1], Abhijeet Ardey[1], Peter Delfyett[1]; *[1]Univ. of Central Florida, CREOL, USA.* A 105 dB.Hz2/3 spur free dynamic range (SFDR) is achieved from a semiconductor-based intensity modulator. This has been realized by introducing an injection-locked passively mode-locked laser into one of the arms of a Mach-Zehnder interferometer.

FTu1E • Materials for Plasmonics—Continued

FTu1E.6 • 09:15
Anomalous Transmission of Ag/ZnO Nanocomposites Prepared by a Magneto-sputtering, Igor V. Melnikov[1,2], Joseph W. Haus[3], Dmitry Gromov[1], Alexey Shuliatyev[1], Andrey Mironov[2], Andrey Machnev[1], Vladimir Mitrokhin[4]; *[1]Electronic Materials, National Research Univ. of Electronic technology, Russian Federation; [2]Electrical and Computer Engineering, Univ. of Illinois, USA; [3]LADAR and Optical Communications Inst., Univ. of Dayton, USA; [4]Research center for Photochemistry of the RAS, Russian Federation.* Nanostructures formed as a single layer and double layers of Ag clusters covered with ZnO are produced by subsequent magneto-sputtering and annealing procedures. All annealed samples display both surface plasmon resonance and anomalous transmission from near- through mid-IR.

FTu1E.7 • 09:30
Ultrathin and Smooth Silver Film by Aluminum-doping and Applications in Plasmonics and Meta-materials, Cheng Zhang[1], Long Chen[1], L. Jay Guo[1]; *[1]Univ. of Michigan, USA.* Wetting-layer-free, ultra-thin and smooth Silver film is achieved by doping Aluminum in Ag film deposition. Hyperbolic meta-material using Al-doped Ag films shows high transmittance and homogeneous response.

FTu1E.8 • 09:45
Femtosecond nonlinear optical response of metal - oxide hybrid nanosystems, Hayk Harutyunyan[1], Gary Wiederrecht[1]; *[1]Argonne National Laboratory, USA.* By designing and fabricating metal-oxide hybrid nanosystems with ultra-high field enhancements we demonstrate femtosecond dynamics of Kerr-type nonlinear optical response.

10:00–10:30 Coffee Break and Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*

10:00–16:00 Exhibit Open, *Arizona Ballroom, Salons 1-7*

FiO

FTu1F • Optical Trapping and Manipulation—Continued

FTu1F.5 • 09:15
Force Spectroscopy in the Bloodstream of Live Embryonic Zebrafish with Optical Tweezers, Bryce W. Schroder[1], Brennan M. Johnson[1], Deborah M. Garrity[2], Lakshmi P. Dasi[1,3], Diego Krapf[1,4]; *[1]School of Biomedical Engineering, Colorado State Univ., USA; [2]Department of Biology, Colorado State Univ., USA; [3]Department of Mechanical Engineering, Colorado State Univ., USA; [4]Department of Electrical and Computer Engineering, Colorado State Univ., USA.* Fluid forces in vivo are difficult to measure and key to understanding the mechano-biology of cardiovascular development. Optical tweezers force spectroscopy has been implemented in live zebrafish embryos during the first stages of blood circulation.

FTu1F.6 • 09:30 Invited
Do Holographic Optical Tweezers Work for Large Swimming Micro-Organisms?, Monika A. Ritsch-Marte[1]; *[1]Innsbruck Medical Univ., Austria.* Trapping increasingly large particles by holographic optical tweezers requires more laser power, ultimately causing problems for biological specimens. We show how living micro-organisms can be handled safely and precisely by combining optical and acoustic forces.

FTu1G • General Optical Sciences I—Continued

FTu1G.6 • 09:15
Measurement of the Second Order Coherence of Pseudo-Thermal Light in the Azimuthal Degree of Freedom, Robert M. Cross[1], Omar S. Magana Loaiza[2], Mohammad Mirhosseini[2], Robert W. Boyd[2,3]; *[1]Department of Physics & Astronomy, Univ. of Rochester, USA; [2]The Inst. of Optics, Univ. of Rochester, USA; [3]Department of Physics, Univ. of Ottawa, Canada.* Using an angular version of the Hanbury Brown Twiss interferometer, we show for the first time second-order interference in the azimuthal degree of freedom, which exhibits higher resolution fringes than if coherent light were used.

FTu1G.7 • 09:30
Rotation-induced Asymmetry of Far-field Emission from Optical Microcavities, Li Ge[1,2], Raktim Sarma[3], Hui Cao[3]; *[1]Engineering Science and Physics, College of Staten Island, CUNY, USA; [2]The Graduate Center, CUNY, USA; [3]Department of Applied Physics, Yale Univ., USA.* We study rotation-induced asymmetry of far-field emission from optical microcavities, based on which a new scheme of rotation detection may be developed. It is free from the ``dead zone" caused by the frequency splitting of standing-wave resonances at rest, in contrast to the Sagnac effect.

FTu1G.8 • 09:45
Davydov splitting in triplet excitons of tetracene single crystals, Heinrich Schwoerer[1], Zephania Birech[1,2]; *[1]Laser research Inst., Department of physics, Univ. of Stellenbosch, South Africa; [2]Physics, Univ. of Nairobi, Kenya.* This work reports room temperature Davydov splitting of 0.04 eV (286 cm -1) in triplet transitions of tetracene single crystals obtained through femtosecond transient absorption spectroscopy with polarized probing of the (ab) face of a 300 nm thick crystal.

LS

LTu1H • Ultracold Gases III—Continued

LTu1H.4 • 09:30 Invited
Quantum Vortex Microscope for Observing Two-dimensional Vortex Dynamics in Bose-Einstein Condensates, Kali E. Wilson[1], Joseph Lowney[1], Zachary Newman[1], Brian P. Anderson[1]; *[1]College of Optical Sciences, Univ. of Arizona, USA.* We have demonstrated in-situ detection of two-dimensional vortex distributions in a single-component Bose-Einstein condensate. We discuss development of the next generation quantum vortex microscope and implications for observations of superfluid dynamics.

LTu1I • Semiconductor Nanooptics II—Continued

LTu1I.4 • 09:30 Invited
Quantum-dot Microcavity Lasers with Superradiant Coupling and Non-classical Light Emission, Frank Jahnke[1]; *[1]Inst. for Theoretical Physics, Univ. of Bremen, Germany.* For the light emission of an ensemble of semiconductor quantum dots inside a three-dimensional optical resonator we identify superradiant coupling effects leading to a giant photon bunching. Results are confirmed within a direct theory-experiment comparison.

10:00–10:30 Coffee Break and Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*

10:00–16:00 Exhibit Open, *Arizona Ballroom, Salons 1-7*

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12
FiO				
10:30–12:00 **FTu2A • Integrated Quantum Optics II** *Presider: Liang Jiang; Yale Univ., USA*	**10:30–12:00** **FTu2B • Optical Fiber Sensors I** *Presider: Fabrizio Di Pasquale; Scuola Superiore Sant Anna di Pisa, Italy*	**10:30–12:15** **FTu2C • Wavefront Sensing and Adaptive Optics** *Presider: John Koshel; Univ. of Arizona, USA*	**10:30–12:00** **FTu2D • Integrated Photonic Quantum Circuits** *Presider: Heinrich Kurz; AMO GmbH, Germany*	**10:30–12:00** **FTu2E • Parity-time Symmetry and Photonic Lattices** *Presider: Mahmoud Rasra; Bell Labs, Alcatel-Lucent, USA*
FTu2A.1 • 10:30 Invited **Experimental Boson Sampling with Integrated Photonics,** Fabio Sciarrino[1]; [1]*Universita degli Studi di Roma La Sapienza, Italy.* A Boson Sampling device is a specialized quantum computer that solves a problem which is strongly believed to be computationally hard for classical computers. We report its implementation and validation with integrated photonics.	**FTu2B.1 • 10:30** Invited **Bragg Grating Sensors for Extreme Temperature Applications,** John Canning[1]; [1]*Univ. of Sydney, Australia.* Fibre Bragg gratings for high temperature operation are reviewed. The role of thermal stabilization and regeneration are discussed. The operating temperature can be fine tuned by a variety of processes ultimately all connected by the control of relaxation processes on a sub-micron scale.	**FTu2C.1 • 10:30** Invited **Transverse Translation Diversity in Image-Based Wavefront Sensing,** James R. Fienup[1], Dustin Moore[1]; [1]*Univ. of Rochester, USA.* Translation diversity provides an alternative to traditional defocus-diverse image-based wavefront sensing. Both methods are accurate and require little additional hardware, but translation diversity, also called ptychography, is sometimes more readily available and robust.	**FTu2D.1 • 10:30** Invited **Laser-written Integrated Photonic Quantum Circuits,** Rene Heilmann[1], Markus Gräfe[1], Armando Perez-Leija[1], Stefan Nolte[1], Alexander Szameit[1]; [1]*Inst. of Applied Physics, Friedrich Schiller Univ., Germany.* We report on integrated photonic quantum circuits using laser-written waveguides with complex three-dimensional waveguide architectures for using multiple degrees of freedom, such as diffraction control and birefringence.	**FTu2E.1 • 10:30** Invited **PT Symmetry in Optics,** Demetrios N. Christodoulides[1], Mohammad-Ali Miri[1], Hossein Hodaei[1], Matthias Heinrich[1], Mercedeh Khajavikhan[1]; [1]*Univ. of Central Florida, USA.* Optical parity-time (PT)-symmetric structures utilize gain and loss in a balanced fashion in order to achieve a desired functionality. Here, we review recent developments in the newly emerging fields of PT-symmetric and supersymmetric optics.
FTu2A.2 • 11:00 **Direct Generation of Orthogonally Polarized Photon Pairs via Spontaneous Non-Degenerate FWM on a Chip,** Christian Reimer[1], Lucia Caspani[1], Yoann Jestin[1], Matteo Clerici[1,2], Marcello Ferrera[1,2], Marco Peccianti[1,3], Alessia Pasquazi[1,3], Brent Little[4], Sai Chu[5], David Moss[6], Roberto Morandotti[1]; [1]*INRS-EMT, Canada;* [2]*School of Engineering and Physical Sciences, Heriot-Watt Univ., UK;* [3]*Department of Physics and Astronomy, Univ. of Sussex, UK;* [4]*Xi'an Inst. of Optics and Precision Mechanics, Chinese Academy Of Sciences, China;* [5]*Department of Physics and Material Science, City Univ. of Hong Kong, China;* [6]*School of Electrical and Computer Engineering, RMIT Univ. Melbourne, Australia.* Orthogonally polarized photon pairs are directly generated on a CMOS-compatible chip via spontaneous non-degenerate four-wave-mixing between orthogonally polarized pumps, enabled by suppressing stimulated processes. Photon coincidences and optical parametric oscillation are measured.	**FTu2B.2 • 11:00** **In-Line Fiber-Optic Viscometer for Internal Combustion Engine Lubricant Oils,** Maira Alejandra Calle Casas[2], Yamile Cardona Maya[1], Cesar Isaza[3], Pedro Torres[1]; [1]*Escuela de Física, Universidad Nacional de Colombia, Colombia;* [2]*Escuela de Ingeniería de Sistemas, Universidad Nacional de Colombia, Colombia;* [3]*Escuela de Materiales y Minerales, Universidad Nacional de Colombia, Colombia.* In this work we present an in-line fiber-optic viscometer for internal combustion engine lubricant oils. The sensing probe is a SM-SM fiber configuration formed by splicing two sections of uncoated SM fibers with a lateral offset.	**FTu2C.2 • 11:00** **Extending the Capture Range of Phase Retrieval through Random Starting Parameters,** Dustin Moore[1], James R. Fienup[1]; [1]*Univ. of Rochester, USA.* Probability of convergence of a high noise wavefront sensing experiment is assessed statistically to understand the capture range, ensemble convergence properties and behavior with respect to the degrees of freedom allowed during the search.	**FTu2D.2 • 11:00** Invited **Development of Photon Pair Sources Using Periodically Poled Lithium Niobate (PPLN) Waveguides and Fiber Optic Components,** Lee Oesterling[1], Don Hayford[1], David Nippa[1], Rick Wolterman[1]; [1]*Battelle Memorial Inst., USA.* We developed a photon pair source that consists of fiber optic components and a periodically poled lithium niobate crystal with integrated waveguides. Photon pair coincidence count experiments were performed, and a heralding efficiency of 68% was measured.	**FTu2E.2 • 11:00** **Observation of self-trapping and rotation of higher-gap quadruple-like lattice solitons,** Shiqiang Xia[1], Yuanyuan Zong[1], Daohong Song[1], Liqin Tang[1], Zhigang Chen[1,2]; [1]*TEDA Applied Physics Inst. and School of Physics, Nankai Univ., China;* [2]*Department of Physics and Astronomy, San Francisco State Univ., USA.* We demonstrate self-trapping and self-rotation of quadruple-like gap solitons by single-site excitation in 2D photonic lattices under self-focusing nonlinearity. Such a self-trapped soliton cluster resides in the 2nd Bragg reflection band gap.

Tucson Ballroom Salon A

Tucson Ballroom Salon B

Tucson Ballroom Salon C

Tucson Ballroom Salon D

FiO

10:30–12:00
FTu2F • General Optics in Biology and Medicine I

Presider: Zhongping Chen; Univ. of California Irvine, USA

FTu2F.1 • 10:30

Optically Detected Magnetic Resonance of Blinking Nanodiamonds Under a Polarisation Microscope, Martina Barbiero[1], Xiangping Li[1], Ye Chen[1], Stefania Castelletto[2,1], Min Gu[1]; [1]*Faculty of Science, Engineering and Technology, Swinburne Univ. of Technology, Australia;* [2]*School of Aerospace, Mechanical and Manufacturing Engineering, RMIT Univ., Australia.* We report on the investigation of optically detected magnetic resonance of nitrogen-vacancy centres in nanodiamonds exhibiting fluorescence intermittence through polarization microscopy. Applying this feature for super-resolution imaging of nanodiamond incorporated HeLa cells has been demonstrated.

FTu2F.2 • 10:45

Application of computer vision technique with fluorescence imaging spectroscopy to differentiate citrus diseases, Caio Bruno Wetterich[1], Luis G. Marcassa[1], José B. Junior[2]; [1]*Instituto de Física de Sao Carlos, Universidade de Sao Paulo, Brazil;* [2]*Departamento de Fitopatologia e Nematologia, Universidade de Sao Paulo, Brazil.* We have used fluorescence imaging spectroscopy to investigate citrus diseases. Texture features were extracted and used as input into classifier. Results show that it is possible differentiate the diseases that have similar symptoms.

FTu2F.3 • 11:00

Optical Coherence Tomography and Scanning Laser Ophthalmoscopy: Approaches to Dual-channel Retinal Tissue Imaging, Manuel J. Marques[1], Adrian Bradu[1], Adrian G. Podoleanu[1]; [1]*Applied Optics Group, School of Physical Sciences, Univ. of Kent, UK.* We report a Talbot bands-based optical coherence tomography (OCT) system capable of producing longitudinal B-scan OCT images and en-face scanning laser ophthalmoscopy (SLO) images of the human retina in-vivo, with various degrees of simultaneity.

10:30–12:00
FTu2G • General Optical Sciences II

Presider: Igor Jovanovic; Pennsylvania State Univ., USA

FTu2G.1 • 10:30

Spectral Changes Induced by a Phase Modulator Acting as a Time Lens, Brent Plansinis[1], William R. Donaldson[2], Govind Agrawal[1]; [1]*Inst. of Optics, Univ. of Rochester, USA;* [2]*Laboratory for Laser Energetics, Univ. of Rochester, USA.* We show that a phase modulator, acting as a time lens inside a temporal imaging system, can induce spectral broadening, narrowing, or shifts depending on the phase of sinusoidal clock, without requiring any nonlinear effects.

FTu2G.2 • 10:45

Elliptic Light Absorber: Trapping Light Between Two Foci, Ludmila J. Prokopeva[1,2], Alexander Kildishev[1]; [1]*Purdue Univ., USA;* [2]*Novosibirsk State Univ., Russian Federation.* We propose a class of omnidirectional cylindrical concentrators collecting light between two foci. Our ray-tracing and full-wave simulations of elliptic cylinder absorbers show flawless perfor-mance at all acceptance angles. Extension to spheroidal geometry is possible.

FTu2G.3 • 11:00

Electrical Detection of Photonic Spin Hall Effect on Metasurfaces, Xingjie Ni[1], Sui Yang[1,2], Jun Xiao[1], Yuan Wang[1], Xiang Zhang[1,2]; [1]*Nanoscale Science and Engineering Center, Univ. of California, Berkeley, USA;* [2]*Materials Science Division, Lawrence Berkeley National Laboratory, USA.* Strong spin-orbit interaction can be induced by light-bending metasurfaces. We show that the resulting photonic spin Hall effect can be detected electrically on a conductive metasurface by measuring the electrical current transverse to light bending direction.

LS

10:30–12:00
LTu2H • Attosecond Science I

Presider: Ming-Chang Chen; National Tsing Hua Univ., Taiwan

LTu2H.1 • 10:30 Invited

Probing Atomic and Molecular Processes by Intense Attosecond Pulses, Katsumi Midorikawa[1]; [1]*RIKEN Center for Advanced Photonics, Japan.* Two-photon dissociative ionization processes of simple molecules are investigated by attosecond nonlinear Fourier transformation spectroscopy. The frequency resolved momentum images of the fragment ions reveal ultrafast dissociative ionization dynamics of molecules.

LTu2H.2 • 11:00 Invited

Attosecond Electronic Band Dynamics, Stephen R. Leone[1]; [1]*Univ. of California Berkeley, USA.* High harmonic extreme ultraviolet pulses are used to investigate time dynamics in oxide materials and conduction bands by probing the metal edges following pulsed visible excitation of carriers across the band gap.

10:30–12:00
LTu2I • Quantum Information I

Presider: Francisco Becerra Chavez; Univ. of New Mexico, USA

LTu2I.1 • 10:30 Invited

Raman Memories for Synchronized Quantum Photonics, Joshua Nunn[1]; [1]*Physics, Univ. of Oxford, UK.* Optical memories based on Raman scattering operate at room temperature, with high bandwidths, and could enable active synchronization of probabilistic operations in a photonic quantum computer. Here we review progress towards quantum-limited Raman memories.

LTu2I.2 • 11:00 Invited

Practical Limits of an Optimized Quantum Receiver, Christoph Marquardt[1,2], Christian R. Müller[1,2], Gerd Leuchs[1,2]; [1]*Max Planck Inst. for the Science of Light, Germany;* [2]*Department of Physics, Univ. of Erlangen-Nuremberg, Germany.* We present a quantum receiver for the discrimination of quadrature phase-shift keyed signals that approaches the Helstrom bound for any signal power and discuss the influence of practical limitations.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12

FiO

FTu2A • Integrated Quantum Optics II—Continued

FTu2A.3 • 11:15
Plasmonic Metasurfaces for the Generation of Optical Orbital Angular Momentum, Sebastian A. Schulz[1], Ebrahim Karimi[1], Israel De Leon[1], Frederic Bouchard[1], Hammam Qassim[1], Jeremy Upham[1], Robert W. Boyd[1,2]; *[1]Department of Physics, Univ. of Ottawa, Canada; [2]Inst. of Optics, Univ. of Rochester, USA.* We demonstrate the generation of optical orbital angular momentum at visible wavelengths through spin-to-orbit coupling in an ultrathin plasmonic metasurface. Such metasurfaces enable the efficient generation and control of structured light in compact geometries.

FTu2A.4 • 11:30
Second Optical Harmonic Generation in Photonic Crystal Structures Infiltrated with NaNO2, Kirill I. Zaytsev[1], Egor Yakovlev[1], Gleb M. Katyba[1], Irina N. Fokina[1], Stanislav O. Yurchenko[1]; *[1]Bauman Moscow State Technical Univ., Russian Federation.* Enhanced second harmonic generation (SHG) in photonic crystals (PC) is shown via numerical simulation of the light interactions with the PC and verified experimentally by studying of SHG in synthetic opal PC infiltrated with NaNO2.

FTu2A.5 • 11:45
On-Chip Nonlinear Injection Locking for Stable Frequency Comb Generation, Abhijeet Ardey[1], Edris Sarailou[1], Peter Delfyett[1]; *[1]CREOL, Univ. of Central Florida, USA.* On-chip stabilization of a novel orthogonally coupled monolithic CPM semiconductor laser is presented with more than 14-times reduction in the RF linewidth and almost 5-times reduction in the optical linewidth of the CPM slave laser.

FTu2B • Optical Fiber Sensors I—Continued

FTu2B.3 • 11:15
Fiber Optic Methane Sensor Utilizing Ag/CNT Thin Films, Satyendra K. Mishra[1], Sandeep N. Tripathi[2], Veena Chaudhary[2], Banshi D. Gupta[1]; *[1]Indian Inst. of Technology, Delhi, India; [2]2Centre for Polymer Science and Engineering, Indian Insititute of Technology, India.* Fabrication and characterization of a surface plasmon resonance based fiber optic methane sensor using films of silver and carbon nanotube have been carried out. The sensor works up to 100 ppm concentration of the gas.

FTu2B.4 • 11:30 Invited
Distributed Fibre Optic Sensing Techniques for Soil Slope Monitoring, Luigi Zeni[1,3], Luciano Picarelli[2], Biagio Avolio[2], Agnese Coscetta[1], Raffaele Papa[2], Giovanni Zeni[3], Caterina Di Maio[4], Roberto Vassallo[4], Aldo Minardo[1]; *[1]Industrial & Information Engineering, Second Univ. of Naples, Italy; [2]DICDEA, Second Univ. of Naples, Italy; [3]Inst. for Electromagnetic Sensing of the Environment, National Research Council - CNR, Italy; [4]School of Engineering, Univ. of Basilicata, Italy.* Distributed optical fiber sensors, based on Brillouin scattering, are exploited to directly measure the deformation profiles of soil and to realize innovative inclinometers to monitor the stability of slopes and identify early symptoms of landslides.

FTu2C • Wavefront Sensing and Adaptive Optics—Continued

FTu2C.3 • 11:15
Optimization of Nonlinear Phase Retrieval, Jen-Tang Lu[1], Chien-Hung Lu[1], Jason W. Fleischer[1]; *[1]Department of Electrical Engineering, Princeton Univ., USA.* We optimize the performance of phase retrieval using spatial nonlinearity. We find an experimentally measurable convergence criterion, given by a nonlinear strength in which the correlation between linear and nonlinear output amplitude is zero.

FTu2C.4 • 11:30
Design and Actuator-Position Optimization for a Large-Scale Adaptive Grating, Jie Qiao[1], Xiang Liu[2]; *[1]Center for Imaging Science, Rochester Inst. of Technology, USA; [2]Inst. of Optics, Univ. of Rochester, USA.* The design and optimization of the actuator layout for a 1.5-meter scale adaptive grating was performed using an integrated finite-element-analysis and genetic-optimization model. The optimization process, criteria, and an optimized design will be presented.

FTu2C.5 • 11:45 Invited
Beaconless Tomographic Wave-Front Sensing, Michael Hart[1], James G. Nagy[2]; *[1]Univ. of Arizona, USA; [2]Emory Univ., USA.* We describe a technique to sense the 3-dimensional structure of wave-front aberrations introduced by a volume effect such as atmospheric turbulence. The method images a scene through a microlens array and requires no cooperative beacons.

FTu2D • Integrated Photonic Quantum Circuits—Continued

FTu2D.3 • 11:30
Control of non-classical interference in a 3D multipath interferometer on a chip, Zachary J. Chaboyer[1], Thomas Meany[1], Luke G. Helt[1], Michael J. Steel[1], Michael J. Withford[1]; *[1]Macquarie Univ., Australia.* We present the first demonstration of quantum interferometry in an integrated, 3D interferometer. We control single and multi-photon interferences in the device using a thermo-optic phase shifter and predict Fisher information approaching a theoretical maximum.

FTu2D.4 • 11:45
An elegant length tolerant design of waveguide arrays for the generation of N-partite two photon W state, Surajit Paul[1], Krishna Thyagarajan[1]; *[1]Indian Inst. of Technology, Delhi, India.* An elegant design of a waveguide array consisting of (2N-1) identical single mode optical waveguides is introduced to create 'N' partite two photon W state that illustrates much enhanced tolerance to the fabrication conditions and experimental perturbations.

FTu2E • Parity-time Symmetry and Photonic Lattices—Continued

FTu2E.3 • 11:15
Observation of supersymmetric dynamics in photonic lattices, Mohammad-Ali Miri[1], Simon Stuetzer[2], Matthias Heinrich[1], Ramy El-Ganainy[3], Stefan Nolte[2], Demetrios N. Christodoulides[1], Alexander Szameit[2]; *[1]Univ. of Central Florida, USA; [2]Inst. of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universit at Jena, Germany; [3]Max Planck Inst. for the Physics of Complex Systems, Germany.* We present the first experimental realization of supersymmetric optical structures based on laser-written photonic lattices. We show that a supersymmetric ladder of optical waveguides can be used for efficient mode conversion.

FTu2E.4 • 11:30
Adiabatical Optical Transition in Longitudinally Modulated Photonic Lattices, Bin Han[1,2], Lei Xu[1,2], Yiling Dou[1,2], Jingjun Xu[1,2], Guoquan Zhang[1,2]; *[1]School of Physics, Nankai Univ., China; [2]TEDA Applide Physics Inst., Nankai Univ., China.* We found that, at a specific resonant condition, novel effects such as negative refraction and adiabatical optical transition between different bands can be achieved in longitudinally modulated photonic lattices.

FTu2E.5 • 11:45
Topological Optical Network in Honeycomb Lattice, Guanquan Liang[1], Yidong Chong[2]; *[1]Independent researcher, USA; [2]School of Physical and Mathematical Sciences, Nanyang Technological Univ., Singapore.* We demonstrate the simulation of optical analog of topological edge states in honeycomb lattice composed of ring resonators. Three kinds of edges, zig-zag, armchair, and beard, support edge states for the same working frequency.

12:00–13:30 Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*
JTu3A • Joint Poster Session I, *Arizona Ballroom, Salons 1-7*

12:00–16:00 "Mission IYL" OSA Student Chapter Competition, *Arizona Ballroom, Salons 1-7*

12:30–14:00 OSA Fellow Members Lunch, *Tucson Ballroom, Salons G-I*

FiO

FTu2F • General Optics in Biology and Medicine I—Continued

FTu2F.4 • 11:15
Quantification of Adipocyte Area at Invasive Breast Tumor Margins and in Benign Stroma, Jessica Dobbs[1], Dongsuk Shin[1], Henry Kuerer[2], Savitri Krishnamurthy[2], Wei Yang[2], Rebecca Richards-Kortum[1]; *[1]Bioengineering, Rice Univ., USA; [2]The Univ. of Texas M.D. Anderson Cancer Center, USA.* We performed quantitative measurement of adipocyte area in confocal microscopy images to evaluate adipocyte phenotype adjacent to and 2 mm (a narrow resection margin) away from invasive breast carcinoma and benign, fibrous breast tissue.

FTu2F.5 • 11:30
Gigapixel Whole-Body Microphotography, Daniel L. Marks[1], Jack G. Anderson[1], Zachary F. Phillips[1], Scott T. McCain[2], David J. Brady[1,2]; *[1]Duke Univ., USA; [2]Aqueti, Inc., USA.* Time-series whole-body microphotography may potentially be used for diagnosing skin disease, telemedicine, surgical field registration, and epidemiological studies. We demonstrate the technology by imaging a volunteer at 0.25 gigapixel resolution in a snapshot.

FTu2F.6 • 11:45
Study for the Clinical Implantation of Photodynamic Therapy applied to Squamous Cell Carcinoma, Irene Salas-Garcia[1], Felix Fanjul-Velez[1], Mihail Zverev[1], Jose L. Arce-Diego[1]; *[1]Universidad de Cantabria, Spain.* This work presents the application of a predictive tool to assess and adjust the current Photodynamic Therapy dosimetry in order to support its future clinical implantation for the treatment of squamous cell carcinoma.

FTu2G • General Optical Sciences II—Continued

FTu2G.4 • 11:15
Light-in-flight Imaging in Free-space Using Arrayed Single-photon Detector Technologies, Genevieve Gariepy[1], Nikola Krstajic[2], Robert Henderson[2], Chunyong Li[1], Robert Thomson[1], Gerald S. Buller[1], Jonathan Leach[1], Daniele Faccio[1]; *[1]Inst. of Photonics and Quantum Sciences, Heriot-Watt Univ., UK; [2]Inst. for Integrated Micro and Nano Systems, Univ. of Edinburgh, UK.* For the first time, light-in-flight measurements are made of laser pulses propa- gating in free space, using an array of Si CMOS single-photon avalanche diode detectors with picosecond timing resolution.

FTu2G.5 • 11:30
Polarization Dependent Optical Forces on Chiral Microresonators, Maria Grazia Donato[1], J. Hernandez[2], Alfredo Mazzulla[3], Clementina Provenzano[2], Rosalba Saija[4], Maria Antonia Iati[1], Alessandro Magazzu[1,4], Pasquale Pagliusi[2,3], Roberto Bartolino[2,3], Pietro G. Gucciardi[1], Onofrio M. Marago'[1], Gabriella Cipparrone[2,3]; *[1]Istituto per i Processi Chimico-Fisici, CNR-IPCF, Italy; [2]Physics Department, Univ. of Calabria, Italy; [3]Istituto per i Processi Chimico-Fisici (UOS Cosenza), CNR-IPCF, Italy; [4]Dipartimento di Fisica e Scienze della Terra, Università di Messina, Italy.* We perform an investigation of the simultaneous optical trapping and rotation of chiral microparticles. The coupling of linear and angular momentum, mediated by light spin and particle chiral reflectance, allows for fine tuning of chirality-induced optical forces and torques.

FTu2G.6 • 11:45
Null-field Radiationless Sources, Elisa Hurwitz[1], Gregory J. Gbur[1]; *[1]Optical Science and Engineering, UNC Charlotte, USA.* It is shown that it is in principle possible to produce radiationless electric-magnetic sources with any of the four microscopic or macroscopic electromagnetic fields exactly zero. Implications for invisibility optics are discussed.

LS

LTu2H • Attosecond Science I—Continued

LTu2H.3 • 11:30
Attosecond Probing of Charge Transfer Reactions in Polyatomic Molecules, Henry Timmers[1], Marc Bourgeois[1], Niranjan Shivaram[1], Arvinder Sandhu[1], Zheng Li[2], Robin Santra[2], Oriol Vendrell[2]; *[1]Physics, Univ. of Arizona, USA; [2]Center for Free-Electron Laser Science, DESY, Germany.* We investigate the coherent motion of an electron hole wavepacket near a conical intersection in CO2. These results demonstrate the sensitivity of attosecond, XUV sources in probing and controlling charge transfer dynamics occurring in nature.

LTu2H.4 • 11:45
Attosecond Transient Absorption: Spectral Lineshapes in Laser-dressed Atoms and Molecules, Chen-Ting Liao[1], Henry Timmers[2], Arvinder Sandhu[1,2]; *[1]College of Optical Sciences, Univ. of Arizona, USA; [2]Department of Physics, Univ. of Arizona, USA.* We experimentally investigated the laser-dressed excited states of atoms and molecules via attosecond XUV transient absorption. We observed the lineshapes evolution and modifications due to the laser-imposed phases, as well as the macroscopic propagation effects.

LTu2I • Quantum Information I—Continued

LTu2I.3 • 11:30 Invited
Bidirectional and Efficient Conversion Between Microwave and Optical Light, Cindy Regal[1], Reed Andrews[1], Robert Peterson[1], Thomas Purdy[1], Katarina Cicak[2], Raymond Simmonds[2], Konrad Lehnert[1,2]; *[1]Univ. of Colorado at Boulder JILA, USA; [2]NIST, USA.* We demonstrate efficient mechanically-mediated transduction between microwave and optical signals using a micromechanical SiN membrane. This interface has the potential to transform information between these vastly different frequencies while maintaining a fragile quantum state.

12:00–13:30 **Unopposed Exhibit Only Time,** *Arizona Ballroom, Salons 1-7*
JTu3A • Joint Poster Session I, *Arizona Ballroom, Salons 1-7*

12:00–16:00 **"Mission IYL" OSA Student Chapter Competition,** *Arizona Ballroom, Salons 1-7*

12:30–14:00 **OSA Fellow Members Lunch,** *Tucson Ballroom, Salons G-I*

12:00–13:30
JTu3A • Joint Poster Session I

JTu3A.1
Generation and Detection of Terahertz Waves by Photoconductive Antennas, Andres F. Escobar Mejia[1], Jorge O. Tocho[1]; [1]*Centro de Investigaciones Opticas, Argentina.* The point where laser focus on the photoconductive antennas is an important factor to getting the best signal to noise ratio when THz waves must be generated or detected. Experimental results are compared with different models for the antennas, including two back side Schottky diodes.

JTu3A.2
Transient Newton rings in dielectrics upon fs laser ablation, Mario Garcia Lechuga[1], Jan Siegel[1], Javier Hernandez-Rueda[1], Javier Solis[1]; [1]*Laser Processing Group, Instituto de Optica. CSIC, Spain.* We report the first observation of transient Newton rings in dielectrics (LiNbO3, sapphire and lead-oxide glass) during ablation with single fs laser pulses, which has important consequences for the comprehension of the ablation mechanisms in dielectrics.

JTu3A.3
Withdrawn.

JTu3A.4
Free Falling Trojan-like Wavepackets on Triangular Orbits in Magnetic and Electromagnetic Fields, Matt Kalinski[1]; [1]*Utah State Univ., USA.* We discover that under the fine parameters tuning the free fall of the electron in the Coulomb, magnetic and the polarized electromagnetic fields results in the existence of non-dispersing wave packets moving on triangular trajectories.

JTu3A.5
Withdrawn.

JTu3A.6
Chirped Pulse Phase Conjugation, Alex Okulov[1]; [1]*A.M. Prokhorov General Physics Inst RAS, Russian Federation.* Phase-locking of fiber laser set is analyzed. We formulate requirements to optical materials suitable for large mode area Yb photonic crystal fiber amplifiers and ultrafast wavefront reversing mirror for spatial combination of chirped optical pulses

JTu3A.7
Probing Atomic Structure with Carrier-Envelope Phase-Stable Few-Cycle Pulses in the Infrared, Henning Geiseler[1], Nobuhisa Ishii[1], Keisuke Kaneshima[1], Teruto Kanai[1], Jiro Itatani[1]; [1]*The Inst. for Solid State Physics, The Univ. of Tokyo, Japan.* We constructed a light source for infrared carrier-envelope phase-stabilized few-cycle pulses. The application to strong-field ionization facilitates diffraction spectroscopy in broad energy ranges, which is demonstrated by extracting the elastic backscattering cross section of xenon.

JTu3A.8
Ultraviolet and Visible Laser Calorimetry of Single Crystal Microwave-assisted CVD Diamonds, Ying Chen[1], Scott Webster[1], Giorgio Turri[1], Seyfollah Toroghi[1], Pieter G. Kik[1], Benjamin Wickham[2], Andrew Bennett[2], Michael Bass[1]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*Element Six Ltd., UK.* The absorption of single crystal diamond in the visible and near ultra violet using laser calorimetry and spectrophotometry is reported.

JTu3A.9
Single Crystals of L-alanine for Raman Laser, Yuanyuan Wang[1], YAN REN[1], Zeliang Gao[1], Xu-Tang Tao[1]; [1]*SHANDONG UNIV., China.* The bulk single crystals of L-alanine with high optical quality have been grown by slow cooling of the aqueous solution. Pumped by a picosecond 532 nm laser source, a lasing from the first-order Raman shift at 633 nm is obtained.

JTu3A.10
Diffraction of Laguerre-Gauss vortex beams by regular polygons, Anindya Ambuj[1], Reeta Vyas[1], Surendra Singh[1]; [1]*Department of Physics, Univ. of Arkansas, USA.* Diffraction of Laguerre-Gauss vortex beams by regular polygons is studied theoretically and experimentally. Novel features that depend on the orbital angular momentum index, aperture and beam size ratio, and aperture position relative to beam waist are described.

JTu3A.11
Observation of cross polarization of linearly polarized Airy beam, Sean Nomoto[1], A. Aadhi[2], Shashi Prabhakar[2], R. P. Singh[2], Reeta Vyas[1], Surendra Singh[1]; [1]*Department of Physics, Univ. of Arkansas, USA;* [2]*Theoretical Physics Division, Physical Research Laboratory, India.* Linear and cross polarization intensity profiles of an Airy beam produced by a spatial light modulator were observed for various aperture coefficients and compared with theoretical profiles.

JTu3A.12
Laser Pulse Temporal Profile Distortions in Multi-pass Amplifiers, Olga Vadimova[1], Ivan Mukhin[1], Oleg Palashov[1]; [1]*Inst. of Applied Physics, Russian Federation.* The laser pulse amplification was investigated numerically with accounting of temporal and spatial profiles under various pulse parameters. It was shown that using of multi-pass amplifiers allows increasing efficiency and reducing temporal profile distortion.

JTu3A.13
Two Color Laser Pumping of Alkali-Noble Gas Atomic Lasers, Andrey Mironov[1], Gary J. Eden[1]; [1]*Univ of Illinois at Urbana-Champaign, USA.* Two color optical pumping of the Rb D2-laser(780nm) through the RbXe excimer has been realized. By simultaneously photoexciting the D2-blue(760nm) and the red satellite of the D1 transition, lasing efficiency is more than doubled.

JTu3A.14
Precision spectroscopy of the optical clock transition in laser cooled neutral Hg, Christian Lytle[1], Justin Paul[1], Tsung-Han Wu[1], R. Jason Jones[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* We demonstrate cooling, trapping, and precision spectroscopy of the (1S0- 3P0) "clock" transition of neutral Hg. A novel room temperature fiber based amplifier system for the cooling laser light is also demonstrated.

JTu3A.15
Time Evolution of Global Quantum Discord in Three Coupled Quantum Dots interacting with a Quantized Cavity Field, Willa Rawlinson[1], Reeta Vyas[1]; [1]*Department of Physics, Univ. of Arkansas, USA.* Evolution of Global Quantum Discord for three-coupled quantum dots interacting with a quantized light field in a lossless cavity is studied and its correlations with probabilities of the dots in the entangled states are explored.

JTu3A.16
Percolation in Segregated Binary Bose-Einstein Condensates, Yumiko Mizuno[1], Kentaro Dehara[1], Hiromitsu Takeuchi[1]; [1]*Department of Physics, Osaka City Univ., Japan.* Percolation is theoretically applied to pattern formation in segregated binary Bose- Einstein condensates. The percolation transition occurs when the ratio of the particle number of a component to the total particle number is around 0.5.

JTu3A.17
Distribution of spin vortices in turbulence of spin-1 ferromagnetic spinor Bose-Einstein condensate, Kazuya Fujimoto[1], Makoto Tsubota[1,2]; [1]*Department of Physics, Osaka City Univ., Japan;* [2]*The OCU Advanced Research Inst. for Natural Science and Technology, Japan.* We numerically study spatial distribution of spin vortices in turbulence of spin-1 ferromagnetic spinor Bose-Einstein condensate, finding that cluster structure grows as the correlation of spin and superflow velocity exhibits some power laws.

JTu3A.18
Stability of a Soliton in Counter-propagating Two-component Bose-Einstein Condensates with Rabi Coupling, Ayaka Usui[1], Hiromitsu Takeuchi[1]; [1]*Osaka City Univ., Japan.* We show that a soliton is stable as a depression of densities with localized relative velocity in two-component Bose-Einstein condensates with Rabi coupling in quasi-one-dimension. Stability phase diagram of the single soliton is obtained numerically.

JTu3A.19
Thermo-optical Properties of Metallic Nanoparticles in Colloidal Systems, Marco Ferreira[1], G. Martinez[1], M. Caetano[1], L. Echevarria[2], V. Piscitelli; [1]*Universidad Central de Venezuela, Venezuela, Bolivarian Republic of;* [2]*Departamento de Química, Universidad Simón Bolívar, Venezuela, Bolivarian Republic of.* Spherical nanoparticles of different metals (gold, silver and iron), obtained by laser ablation, were characterized using thermal lens spectroscopy pumping at 532 nm with a 10 ns pulse laser-Nd-YAG system.

JTu3A.20
Mid-IR supercontinuum generation in an integrated liquid-core optical fiber filled with CS_2, Dmitriy Churin[1], Thanh Nam Nguyen[1], Khanh Q. Kieu[1], Robert Norwood[1], Nasser Peyghambarian[1]; [1]*Univ. of Arizona, USA.* We report mid-infrared supercontinuum generation in an integrated liquid-core optical fiber filled with carbon disulfide and pumped by a compact mode-locked fiber laser at 1910nm.

JTu3A.21
Self-referenced Third-order Nonlinearities Measurements Using Nonlinear Ellipse Rotation, Maria L. Miguez[1], Emerson C. Barbano[1], Sérgio C. Zilio[1], Lino Misoguti[1]; [1]*Universidade de Sao Paulo, Brazil.* We report on self-referenced third-order nonlinear optical properties determination method by measuring the nonlinear ellipse rotation (NER) angles. Here, using a dual-phase lock-in, we were able to measure precisely the NER on glasses and liquids.

JTu3A • Joint Poster Session I—Continued

JTu3A.22
Numerical simulations of enhancement cavity dynamics driven by femtosecond frequency combs, Gregory Jacob[1], David R. Carlson[1], Tsung-Han Wu[1], R. Jason Jones[1], Ewan M. Wright[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* Numerical simulations of a frequency comb resonant with an enhancement cavity are performed to study nonlinear dynamics resulting from intracavity ionization. Results highlight the critical role played by transverse spatial effects, previously excluded in simulations.

JTu3A.23
Planar focusing of a three-dimensional image by using the coherence as an informative parameter strongly degenerate optical field, alexander larkin[1], Alexander Zarubin[1]; [1]*mephi, Russian Federation.* We observed a new effect - "Flat focusing image formed by coherent function as informative parameter of powerfully degenerated radiation". In paper we demonstrate the experimental results and physical explanation of this new effect.

JTu3A.24
Wave Optics Simulations of a Focused Plenoptic System, Massimo Turola[1], Steve Gruppetta[1]; [1]*Optometry and Visual Science, City Univ. London, UK.* A wave optics numerical simulation of focused Plenoptic systems using Fresnel propagation is presented. This shows the dependence on the lenslet array parameters of the real optical resolution of this system at the diffraction limit.

JTu3A.25
Comparison of sensitive nonlinear saturable absorption of topological insulator Bi2Te3 powders and nanosheets, Che-Min Chou[1], Hsuan-Yin Chen[1], Jin-Long Xu[2], Chao-Yang Tu[2], Chuck Lee[1]; [1]*Department of Photonics, National Sun Yat-Sen Univ., Taiwan;* [2]*Key Laboratory of Optoelectronic Materials Chemistry and Physics of CAS, Fujian Inst. of Research on the Structure of Matter, Chinese Academic of Sciences, China.* The saturable absorption properties of two sizes of Bi2Te3, namely large powders prepared by commercial crystals and small sheets by further hydrothermal exfoliation, have been compared under low-intensity laser excitation at 1.0 and 2.0 um.

JTu3A.26
Quantum Imaging of High-Dimensional Hilbert Spaces with Radon Transform, Laszlo Gyongyosi[1,2]; [1]*Budapest Univ. of Techolology and Economic, Hungary;* [2]*Hungarian Academy of Sciences, Hungary.* We introduce a post-processing method for quantum imaging that is based on the Radon transform. We show that the entropic separability bound is violated considerably more strongly in comparison to the standard setting.

JTu3A.27
Constraints in Collective State Atomic Interferometry Due to Inhomogeneities in Laser Intensity and Atomic Velocity, Resham Sarkar[1], May E. Kim[1], Renpeng Fang[1], Selim Shahriar[1]; [1]*Northwestern Univ., USA.* We show that in a collective state atomic interferometer, the signal amplitude depends significantly on the transverse spatial variation of laser intensity, and the spread in Doppler shifts due to velocity distribution in the atoms.

JTu3A.28
Unitary two-axis-twisting spin squeezing induced by entanglement swapping, Mingfeng Wang[1], Weizhi Qu[1], Pengxiong Li[1], Han Bao[1], Yanhong Xiao[1]; [1]*Fudan Univ., China.* We present a scheme for realizing two-axis-twisting spin-squeezing of an atomic ensemble. The squeezing is produced by a triple pass of a linearly polarized coherent laser beam through an atomic ensemble under a magnetic field.

JTu3A.29
Second Harmonic Generation Inside Microcavities: On the Existence of a Threshold, Serge Gauvin[1], Marc Collette[1], Normand Beaudoin[1]; [1]*Département de physique et d'astronomie, Université de Moncton, Canada.* The anomalous commutation relation [Ueda, M. and Imoto, N., Phys. Rev. A, 50(1), 89-92 (1994)] is used to demonstrate the existence of a threshold for second harmonic generation when it occurs from inside microcavities. This is an unexpected result.

JTu3A.30
Strong squeezing via phonon mediated spontaneous generation of photon pairs, Kenan Qu[1]; [1]*Department of Physics, Oklahoma State Univ., USA.* We propose a scheme producing squeezed light in a double cavity optomechanical system by using the spontaneously generated photons pairs.

JTu3A.31
Humidity Sensing Using SbSI Nanophotodetectors, Krystian Mistewicz[1], Marian Nowak[1], Piotr Szperlich[1], Andrzej Nowrot[1]; [1]*Inst. of Physics - Center for Science and Education, Silesian Univ. of Technology, Poland.* This paper shows usability of antimony sulfoiodide (SbSI) nanowires as photoconductive humidity sensors. Qualitatively different photoconductivity transient characteristics for low, and high humidity have been observed. Desorption of H2O from SbSI nanowires surface is reported.

JTu3A.32
In inhomogeneously broadened lasers, spontaneous & stimulated emitting atoms participate in Doppler Effects differently, Chandra Roychoudhuri[1]; [1]*Physics, Univ. of Connecticut, USA.* Internal QM frequency for the same transition levels being fixed; spontaneously emitting source & stimulated emitting detecting atoms in an inhomogeneously broadened gas laser reveal different processes behind Doppler Effect.

JTu3A.33
Wide-Range Third-Harmonic Generation in a Step-Index Tellurite Fiber, Weiqing Gao[1,2], Tonglei Cheng[1], Dinghuan Deng[1], Xiaojie Xue[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Research Center for Advanced Photon Technology, Toyota Technological Inst., Japan;* [2]*School of Electronic Science & Applied Physics, Hefei Univ. of Technology, China.* Tunable third-harmonic generation (THG) is demonstrated in a step-index tellurite fiber. The tunable spectral range from 524 to 1043 nm covers almost one octave. The far-field patterns of the TH signals are presented.

JTu3A.34
Photovoltaic properties of p-i-n InGaAs/GaAs heterostructures, Marianna Kovalova[1], Serhiy Kondratenko[1]; [1]*Physics, Taras Shevchenko National Univ. of Kyiv, Ukraine.* Photovoltaic properties in heterostructure with quantum wires were research in the temperature range from 77 K to 290 K. The introduction of quantum wires leads to increased efficiency, the expansion of the spectral range photosensitivity and decrease the lifetime of nonequilibrium charge carriers.

JTu3A.35
Mid-infrared soliton generation in a tapered As2S5 microstructured optical fiber, Tonglei Cheng[1], Ryo Usaki[1], Xiaojie Xue[1], Dinghuan Deng[1], Yasuhire Kanou[1], Morio Matsumoto[2], Takashi Misumi[2], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*ofmlab, Japan;* [2]*Furukawa Denshi Co., Ltd., Japan.* Mid-infrared soliton is obtained when the tapered As2S5 microstructured optical fiber is pumped by an optical parametric oscillator at 1900 nm. At the same time a blue-shift dispersive wave is emitted by the soliton.

JTu3A.36
Flattened supercontinuum generation in a tellurite hybrid microstructured optical fiber, Hoang Tuan Tong[1], Zhongchao Duan[1], Dinghuan Deng[1], Tonglei Cheng[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Optical Functional Materials Laboratory, Toyota Technological Inst., Japan.* A broad SC generation spanning from 800 to 2400 nm with 5-dB spectral flatness (1060 nm of spectral span) in a tellurite highly nonlinear fiber with 3 zero-dispersion wavelengths is reported for the first time.

JTu3A.37
Analysis of spatially multiplexed optical channels using radial quantum number, Syed H. Murshid[1], Saud Alanzi[1], Rayan Enaya[1], Ibrahim Barka[1], Abhijit Chakravarty[2], Gurinder Parhar[2], Bilas Chowdhury[1], Gregory Lovell[1]; [1]*Electrical and Computer Engineering, Florida Inst. of Technology, USA;* [2]*R&D, Emcore Corporation, USA.* Spatially multiplexed optical communications output channels are analyzed using simulated radial quantum number. Experimental results are also compared to the simulated results.

JTu3A.38
Tunable Broadband in Supercontinuum Spectrum Based on Polarization Effects, Juan Carlos Hernandez-Garcia[1], Julian M. Estudillo-Ayala[2], Baldemar Ibarra-Escamilla[1], Olivier Pottiez[3], Roberto Rojas-Laguna[2], Evgene Kuzin[1], Rosa J. Perez-Chimal[2]; [1]*Optical department, Instituto Nacional de Astrofisica, Optica y Electronica, Mexico;* [2]*Department of Electronic, Universidad de Guanajuato, Mexico;* [3]*Photonics, Centro de Investigaciones en Optica, Mexico.* We demonstrated that the bandwidth control in supercontinuum source is possible through polarization effects induced on a PCF. The spectral width obtained can be selected from 740 nm-1430 nm while it maintains a good flatness.

JTu3A.39
All-fiberized Superfluorescent Source with Distributed Side-coupled Cladding-pumped Fiber, Yingye An[1], Zhihe Huang[1], Jianqiu Cao[1], Shaofeng Guo[1], Jinbao Chen[1]; [1]*National Univ. of DefenseTechnology, China.* An all-fiberized broadband superfluorescent source based on a distributed side-coupled cladding-pumped Yb-doped fiber is demonstrated. 11.4-W combined output power is obtained with a flat power spectrum. The bandwidth (FWHM) is larger than 30 nm.

JTu3A.40
Sensitivity Enhancement of Aluminium Doped Zinc Oxide (AZO) Coated Lossy Mode Resonance (LMR) Fiber Optic Sensors Using Additional Layer of Oxides, Nidhi Paliwal[1], Joseph John[1]; [1]*Electrical Engineering, Indian Inst. of Technology Bombay, India.* Theoretical results for an AZO coated LMR fiber optic sensor with enhanced sensitivity using additional oxide layer overlay are presented for two oxides, viz. TiO_2 and Cu_2O. The maximum sensitivity was achieved for AZO/TiO_2 combination.

JM3A.41
Observation of Spatial-modulation Instability Due to Quintic Nonlinearity, Albert Reyna Ocas[2,1], Cid B. de Araújo[2]; [1]*OSA Student Chapter Recife, Brazil;* [2]*Departamento de Física, Universidade Federal de Pernambuco, Brazil.* We observed spatial-modulation-instability in a colloid with suppressed cubic nonlinearity and positive quintic nonlinearity. This experiment illustrates a procedure for nonlinearity management of metal-dielectric nanocomposites that can be extended to investigate other effects.

Arizona Ballroom Salon 8

Arizona Ballroom Salon 9

Arizona Ballroom Salon 10

Arizona Ballroom Salon 11

Arizona Ballroom Salon 12

FiO

JOINT FiO/LS

13:30–15:30
FTu4A • Quantum Communications

Presider: Jian-Wei Pan; USTC, China

FTu4A.1 • 13:30 Invited

Manipulation of Photons and Cold Atoms: Scalable Quantum Communication, Computation and Simulation, Jian-Wei Pan[1]; [1]*USTC, China*. This presentation will disucss the manipulation of photons and cold atoms.

FTu4A.2 • 14:00

Alignment-free QKD along a free-space channel combining spinorial and orbital angular momentum, Giuseppe Vallone[1], Vincenzo D'Ambrosio[2], Anna Sponselli[1], Sergei Slussarenko[3], Lorenzo Marrucci[3], Fabio Sciarrino[2,4], Paolo Villoresi[1]; [1]*Universita' degli Studi di Padova, Italy;* [2]*Sapienza Universita' di Roma, Italy;* [3]*Universita' di Napoli Federico II and CNR - SPIN, Italy;* [4]*Istituto Nazionale di Ottica (INO-CNR), Italy.* OAM in combination with polarization allows to encode by-means-of a Q-plate rotation-invariant photonic states, so as to guarantee full independence of the communication from the local reference frames of the transmitting and receiving units.

13:30–15:30
FTu4B • Optical Fiber Sensors II

Presider: Michel Digonnet; Stanford Univ., USA

FTu4B.1 • 13:30 Tutorial

Fiber Optic Sensors for Structural Monitoring, Eric Udd[1]; [1]*Columbia Gorge Research, LLC, USA*. Fiber optic sensors have been developed to support structural health monitoring applications in aerospace, defense, civil structure and other applications. Detection rates vary from sub-hertz to more than a GHz.

Eric Udd, President of Columbia Gorge Research has been deeply involved with fiber optic sensors since 1977 at McDonnell Douglas, Blue Road Research and Columbia Gorge Research. He helped pioneer early work on fiber optic gyros, fiber optic smart structures, acoustic, pressure, temperature and strain sensors. Mr. Udd has 48 issued US Patents and more pending on fiber optic technology, has written and presented over 150 papers and has chaired more than 30 international conferences on fiber optic sensor technology. He has edited the books *Fiber Optic Sensors: An Introduction for Engineers and Scientists*, 2nd edition, Wiley, 2011 and *Fiber Optic Smart Structures*, Wiley, 1995. Mr. Udd is a Fellow of SPIE, OSA and McDonnell Douglas. He has been awarded the Richardson Medal for 2009 by The Optical Society for his work on fiber optic sensors and the field of fiber optic smart structures.

13:30–15:30
FTu4C • Coherence, Interference, and Polarization IV

Presider: Byoungho Lee; Seoul National Univ., South Korea

FTu4C.1 • 13:30 Invited

Demonstration of an Optical Nano Beacon for Controlled Directional Emission and Coupling, Gerd Leuchs[1,2], Martin Neugebauer[1,2], Thomas Bauer[1,2], Peter Banzer[1,2]; [1]*Max-Planck Inst. for the Science of Light, Germany;* [2]*Dept. of Physics, Univ. of Erlangen-Nuremberg, Germany.* We investigate the polarization dependent directional emission of a dipole-like nanoparticle in close proximity to a planar interface. The dipole moment can be tuned by position dependent excitation with a tightly focused vector-beam under normal incidence.

FTu4C.2 • 14:00

Encoding Fresnel diffraction over positive and negative distances onto a spatial light modulator, Jeffrey A. Davis[1], Ignacio Moreno[2], Don M. Cottrell[1], Cassidy A. Berg[1], Christopher L. Freeman[1]; [1]*Department of Physics, San Diego State Univ., USA;* [2]*, Óptica y Tecnología Electrónica, Universidad Miguel Hernández, Spain.* We demonstrate encoding of positive and negative Fresnel diffraction onto a spatial light modulator. This allows the capability to study a propagating beam without moving the detector plane.

13:30–15:30
FTu4D • Integrated Optics

Presider: Ronald Reano; Ohio State Univ., USA

FTu4D.1 • 13:30 Tutorial

III-V and Silicon Photonic Integrated Circuit Technologies, Thomas L. Koch[1]; [1]*Univ. of Arizona, USA*. Photonic Integrated Circuits are transitioning to a role as the only viable technology for many emerging photonics solutions. This tutorial reviews the status of InP and Si PIC technologies, including strengths and application domains of each.

Thomas L. Koch is Dean of the College of Optical Sciences at the University of Arizona. Previously he held Vice President positions in research and development at SDL, Lucent, and Agere Systems. Prof. Koch was an early pioneer in photonic integration technology at Bell Labs, including applications in WDM and the first operating balanced coherent heterodyne receiver PIC. Koch has received the IEEE Sumner Award, the IEEE LEOS William Streifer Award, and is a Fellow of Bell Labs, the OSA, the IEEE, and a member of the National Academy of Engineering.

13:30–15:30
JTu4E • Novel Intense Attosecond Sources I

Presider: Laszlo Veisz; Max-Planck-Institut fur Quantenoptik, Germany

JTu4E.1 • 13:30 Tutorial

Plasma Mirrors as Attosecond Light Sources, Fabien Quéré[1]; [1]*CEA Saclay, France*. Plasma mirrors can specularly reflect ultraintense femtosecond laser pulses, thereby generating attosecond pulses of light of great potential for ultrafast science. I will describe the state-of-the-art in the understanding, control and performances of this process.

During his PhD, received in 2000 from Paris 6 university, Fabien Quéré studied the mechanisms of optical breakdown of dielectric solids in the femtosecond regime. He was then a post-doctoral fellow in Prof.Corkum's group, where he worked on the development of methods for the temporal measurement of attosecond pulses of light. In 2003, he became a tenure researcher at CEA Saclay, where he made further significant contributions to attosecond metrology. He then focused on the study of new sources of attosecond pulses of light, in particular on high-harmonic generation from plasmas at ultrahigh laser intensities. In 2010, he received a grant from the European Research Council to support his research on this topic. This remains of his main subjects of interest, together with the metrology of spatio-temporal couplings of high-power femtosecond laser beams and their use for the control of high-intensity interactions.

Tucson Ballroom Salon A

Tucson Ballroom Salon B

FiO

13:30–15:30
FTu4F • Fibers for Biomedical Applications
Presider: Monika Ritsch-Marte; Innsbruck Medical Univ., Austria

FTu4F.1 • 13:30
Colonoscopic laser surgery applied to controlled tumoral tissue removal, Felix Fanjul-Velez[1], Irene Salas-Garcia[1], Mihail Zverev[1], Jose L. Arce-Diego[1]; [1]*Universidad de Cantabria, Spain.* Endoscopic laser surgery provides minimally invasive, non-contact, highly specific tissue resection. Colonoscopic tumoral tissue removal by optical sources is analysed by a predictive approach, as an alternative to conventional surgery, radiotherapy or chemotherapy.

FTu4F.2 • 13:45 Invited
Multimodality Fiber-based Endoscopes for Cancer Detection, Jennifer K. Barton[1]; [1]*Biomedical Engineering, Univ. of Arizona, USA.* Combined anatomical (optical coherence tomography) and functional (fluorescence) optical imaging can facilitate early detection of cancerous lesions. We have demonstrated multimodality imaging in the colon and ovary, and are building miniature (0.7- 2.0mm diameter) endoscopes.

13:30–15:15
FTu4G • Relativistic Light Sources
Presider: Igor Jovanovic, Penn.State Univ., USA

FTu4G.1 • 13:30 Invited
Tunable, Quasi-monoenergetic X-rays from Thomson Scattering with Laser-driven Electrons, Stefan Karsch[1,2], Johannes Wenz[2], Konstantin Khrennikov[2], Matthias Heigoldt[2], Alexander Buck[1], Jiancai Xu[1], Antonia Popp[2], Andreas Maier[4], Nathaniel Kajumba[2], Florian Grüner[4], Simone Schleede[3], Laszlo Veisz[1], Franz Pfeiffer[3]; [1]*Max-Planck-Institut fur Quantenoptik, Germany;* [2]*Universität München, Germany;* [3]*TU München, Germany;* [4]*Universität Hamburg, Germany.* We present the first quasi-monochromatic and energy-tunable Thomson-backscattering X-ray source created by colliding laser-driven electron beams with a laser pulse. Tunability between 10 keV and 40 keV is achieved by varying the electron energy.

FTu4G.2 • 14:00 Invited
Bright X-ray Pulse Generation by Laser Thomson-Backscattering and Traveling Wave Optical Undulators, Ulrich Schramm[1,2], Michael Bussmann[1], Jurjen Couperus[1], Tom Cowan[1,2], Alexander Debus[1], Arie Irman[1], Axel Jochmann[1], Richard Pausch[2], Roland Sauerbrey[1,2], Klaus Steiniger[1]; [1]*Inst. of Radiation Physics, Helmholtz-Zentrum Dresden-Rossendorf, Germany;* [2]*Technische Universität Dresden, Germany.* Measured Thomson-backscattering X-ray spectra recorded as a function of the observation angle and quantitatively reproduced in simulations are presented. A traveling wave scheme is proposed to increase the yield and may allow for all-optical free-electron laser operation.

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Tucson Ballroom Salon C

Tucson Ballroom Salon D

LS

13:30–15:30
LTu4H • Resonators and Photonic Crystals I
Presider: Yong-Hee Lee; Korea Advanced Inst of Science & Tech, South Korea

LTu4H.1 • 13:30 Invited
Cavity QED in Quantum Dot-photonic Crystal Nanocavity Coupled Systems, Yasuhiko Arakawa[1]; [1]*Univ. of Tokyo, Japan.* We discuss solid-state cavity QED with quantum-dots embedded in high-Q photonic crystal nanocavities for advanced quantum-dot light sources, including single artificial atom lasers, nano-cavity-based self-frequency conversion lasers, and spontaneous two photon emitters.

LTu4H.2 • 14:00 Invited
Waveguides Arrays in Hexagonal Photonic Crystals, C. Martijn de Sterke[1], Hannah Moore[1], J. Scott Brownless[1], Felix Lawrence[1], Sahand Mahmoodian[1], Kokou Dossou[2], Lindsay Botten[3]; [1]*School of Physics, The Univ. of Sydney, Australia;* [2]*School of Mathematical Sciences, Univ. of Technology Sydney, Australia;* [3]*National Computational Infrastructure, Australian National Univ., Australia.* We show that coupled photonic crystal waveguides in hexagonal lattices offer very wide flexibility for the steering of single and multiple beams, and for diffraction management.

13:30–15:30
LTu4I • Semiconductor Nanooptics III
Presider: Mackillo Kira; Emory Univ., USA

LTu4I.1 • 13:30 Invited
Terahertz Experiments on Microcavities, Yun-Shik Lee[1], Joseph L. Tomaino[1], Andrew D. Jameson[1], Galina Khitrova[2], Hyatt M. Gibbs[2], Christoph Böttge[3], Mackillo Kira[3], Stephan W. Koch[3]; [1]*Physics, Oregon State Univ., USA;* [2]*Optical Science Center, Univ. of Arizona, USA;* [3]*Fachbereich Physik and Material Sciences Center, Philips Univ., Germany.* Strong THz pulses induce pronounced nonlinear optical effects in a QW microcavity, resonantly driving exction-polariton polarizations coupled to an optically dark 2p-exciton polarization. The coherent coupling between the polarizations dephases within a few picoseconds.

LTu4I.2 • 14:00 Invited
Coherent Bloch Oscillations Driven by Ultrastrong THz Excitation, Matthias Hohenleutner[1], Olaf Schubert[1], Fabian Langer[1], Benedikt Urbanek[1], Christoph Lange[1], Ulrich Huttner[2], Daniel Golde[2], Torsten Meier[3], Stephan W. Koch[2], Mackillo Kira[2], Rupert Huber[1]; [1]*Department of Physics, Univ. of Regensburg, Germany;* [2]*Department of Physics, Univ. of Marburg, Germany;* [3]*Department of Physics, Univ. of Paderborn, Germany.* The carrier wave of high-intensity phase-locked multi-THz pulses controls dynamical Bloch oscillations and interband polarization in bulk semiconductors, leading to the emission of all-coherent high-order harmonics covering 12.7 optical octaves from THz to VIS regimes.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12
FiO				JOINT FiO/LS

FTu4A • Quantum Communications—Continued

FTu4A.3 • 14:15
Vacuum Suppression in Gain-tuned Continuous-Variable Quantum Teleportation of a Single Photon by Conditioning on Sender, Maria Fuwa[1], Shunsuke Toba[1], Shuntaro Takeda[1], Petr Marek[2], Ladislav Mista[2], Radim Filip[2], Peter van Loock[3], Akira Furusawa[1]; *[1]The Univ. of Tokyo, Japan; [2]Optics, Palacky Univ., Czech Republic; [3]Physics, Johannes Gutenberg-Universitat Mainz, Germany.* We experimentally demonstrate bolstering the strength of gain-tuned continuous variable quantum teleportation of a single photon by conditioning on the sender's measurement results to eliminate excess vacuum contamination in the output.

FTu4A.4 • 14:30
Quantum Communications with Overlapping Time Modes: Optimal Receiver Capable of Dispersion Compensation, Julia Larikova[1,2], Vesselin Velev[3], Prem Kumar[1,3], Yu-Ping Huang[1,3]; *[1]Center for Photonic Communication and Computing, Department of Electrical Engineering and Computer Science, Northwestern Univ., USA; [2]Coriant GmbH & Co. K, USA; [3]Center for Photonic Communication and Computing, Department of Physics and Astronomy, Northwestern Univ., USA.* We study fiber-transmission impairments of overlapping time-frequency modes for quantum communications in high-dimensional Hilbert space, and propose a class of optical receivers with built-in capability of overcoming such impairments.

FTu4A.5 • 14:45
Efficient sorting of single-photon wave packets by temporal-mode interferometry, Dileep V. Reddy[1], Michael G. Raymer[1], Colin J. McKinstrie[2]; *[1]Physics, Univ. of Oregon, USA; [2]Applied Communication Sciences, USA.* We propose a highly efficient method to decompose and analyze photons into copolarized, transverse-mode matched, temporally and spectrally overlapping, but field-orthogonal, longitudinal temporal modes. The method uses cascaded nonlinear-optical quantum frequency conversion.

FTu4B • Optical Fiber Sensors II—Continued

FTu4B.2 • 14:15
Armored Fiber Bragg Grating Sensor for Wall Intrusion Detection, Bo Lin[1], Wen Bin Ji[1], Swee Chuan Tjin[1], Jianzhong Hao[2]; *[1]School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore; [2]RF, Antenna and Optical Department, Inst. for Infocomm Research, Singapore.* We propose a newly designed fiber Bragg grating (FBG) sensor with protective armored cable. The packaged FBG array is bonded on a specially designed arc-shape structure mounted on a wall for intrusion detection for the first time.

FTu4B.3 • 14:30
Multicore Optical Fiber Point Sensors, Amy Van Newkirk[1], Guillermo Salceda-Delgado[1,2], J. Enrique Antonio-Lopez[1], Rodrigo Amezcua-Correa[1], Axel Schulzgen[1]; *[1]CREOL, Univ. of Central Florida, USA; [2]CIO, Centro de Investigaciones en Optica, Mexico.* A novel point sensor utilizing multicore fiber is demonstrated. We show the ability to make distributed measurements while operating in both a transmissive and reflective mode, with low cost, simple fabrication, and high stability.

FTu4B.4 • 14:45
Six-Fold Temperature and Strain Sensitivity Improvement of Brillouin Based Distributed Sensor, Victor Lambin Iezzi[1]; *[1]Polytechnique Montreal, Canada.* We show how a novel all-fiber sensor system can be used to increase the Brillouin scattering temperature and strain sensitivity by the order of the stimulated Stokes wave used for distributed sensing in optical fiber.

FTu4C • Coherence, Interference, and Polarization IV—Continued

FTu4C.3 • 14:15
Zero Order Diffraction Suppression in a Phase-only Spatial Light Modulator via the GS Algorithm, Wynn Dunn Gil Improso[1], Paul Leonard Atchong C. Hilario[1], Giovanni A. Tapang[1]; *[1]National Inst. of Physics, Univ. of the Philippines-Diliman, Philippines.* A phase shifted beam was calculated using the Gerchberg Saxton algorithm for an annulus around a target in a spatial light modulator in order to suppress the zeroth order diffraction pattern using destructive interference.

FTu4C.4 • 14:30
Measuring spatial coherence through the shadow of small obstacles, Katelynn Sharma[1], James K. Wood[1], Thomas G. Brown[1], Miguel A. Alonso[1]; *[1]Inst. of Optics, Univ. of Rochester, USA.* We present a simple method to measure the spatial coherence of a partially coherent field by analyzing measurements of the radiant intensity with and without a well-known obscuration. Our results are consistent with theoretical predictions.

FTu4C.5 • 14:45
Image Formation and Halo Removal in Diffraction Phase Microscopy with Partially Coherent Illumination, Christopher A. Edwards[1], Tan Nguyen[1], Gabriel Popescu[1], Lynford Goddard[1]; *[1]Univ. of Illinois at Urbana-Champaign, USA.* We present a quantitative model which describes the observed phase reductions and halo-effect in quantitative phase imaging systems under partial spatial coherence and provide a practical method to eliminate the halo and obtain accurate topography.

FTu4D • Integrated Optics—Continued

FTu4D.2 • 14:15 Invited
Integrated Photonics for Space-Division Multiplexing, Nicolas K. Fontaine[1]; *[1]Alcatel-Lucent Bell Labs, USA.* The success of spatial multiplexing depends on highly integrated and cost effective components. We compare the strengths and weaknesses of several SDM components including 3D waveguides, silicon photonics, all-fiber devices, and free-space wavelength selective switches.

FTu4D.3 • 14:45
Low-Stress Silicon Nitride Platform for Broadband Mid-Infrared Microphotonics, Pao T. Lin[1,4], Vivek Singh[1], Hao-Yu Lin[2], Tom Tiwald[3], Lionel C. Kimerling[1], Dawn T. H. Tan[4], Anuradha M. Agarwal[1]; *[1]MIT, USA; [2]Harvard, USA; [3]J. A. Woollam Co., Inc., USA; [4]Singapore Univ. of Technology and Design, Singapore.* We experimentally demonstrate a sophisticated mid-IR microphotonics platform adopting engineered Si-rich and low-stress silicon nitride thin films where an extensive infrared transparency up to λ = 8.5 μm and optical loss less than 0.2 dB/cm is achieved.

JTu4E • Novel Intense Attosecond Sources I—Continued

JTu4E.2 • 14:15 Invited
Production of Intense Isolated Attosecond Pulses for Non-linear XUV-XUV Pump-probe Experiments with 100 eV Photons, Boris Bergues[1], Daniel Rivas[1], Matthew Weidmann[1], Hartmut Schröder[1], Gilad Marcus[1,2], Wolfram Helml[1], Xun Gu[1], Tibor Wittmann[1], Reinhard Kienberger[1,3], Paraskevas Tzallas[4], Dimitris Charalambidis[4,5], Ferenc Krausz[1,6], Laszlo Veisz[1]; *[1]Max-Planck-Institut für Quantenoptik, Germany; [2]The Hebrew Univ. of Jerusalem, Israel; [3]Technische Universität München, Germany; [4]Foundation for Research and Technology - Hellas, Inst. of Electronic Structure & Laser, Greece; [5]Univ. of Crete, Greece; [6]Ludwig Maximilians Universität, Germany.* Intense isolated attosecond pulses with >100 eV photon energy are produced via high-order-harmonic generation using 80mJ sub-5 fs laser pulses. The generation of these attosecond pulses and their application to non-linear XUV-XUV pum-probe experiments is discussed.

JTu4E.3 • 14:45 Invited
High Photon Flux Atto-second Sources at the Lund Laser Centre, Anne Harth[1], Filippo Campi[1], Esben W. Larsen[1], Chen Guo[1], Linnea Rading[1], Eleonora Lorek[1], Christoph Heyl[1], Piotr Rudawski[1], Arthur Losquin[1], Miguel Miranda[1], Bastian Manschwetus[1], Johan Mauritsson[1], Cord L. Arnold[1], Anne L'Huillier[1], Per Johnsson[1]; *[1]Lunds Universitet, Sweden.* We provide an update on our high photon flux atto-second sources: an XUV source with ~10^{11} photons/pulse for nonlinear atto-second experiments and a 200 kHz XUV source with ~10^{11} photons/second for electron-imaging and coincidence experiments.

FiO

FTu4F • Fibers for Biomedical Applications —Continued

FTu4F.3 • 14:15

Spatial Location Tracking Using Optical Coherence Tomography-Proof Of Concept For Gynecology, Megha Acharya[1], Ashok Gowda[1], Kathy Vincent[2], Massoud Motamedi[2]; [1]*Biotex Inc, USA;* [2]*Univ. of Texas Medical Branch, USA.* We demonstrated the feasibility for spatial location tracking with OCT in location mapping of cervix. Electromagnetic tracking sensors were coupled with Time Domain OCT and fused with colposcopic imaging to provide real time position tracking.

FTu4F.4 • 14:30

Multiphoton imaging with compact femtosecond fiber lasers, Khanh Q. Kieu[1], Soroush Mehravar[1], Bhaskar Banerjee[1], Nasser Peyghambarian[1]; [1]*Univ. of Arizona, USA.* We discuss the development of compact, affordable multiphoton microscopes using robust femtosecond fiber lasers as the excitation source. Application in brain imaging and Barrett's cancer imaging will be presented.

FTu4F.5 • 14:45

Optical Coherence Tomography and Multispectral Fluorescence Imaging Falloposcope, Molly Keenan[1], Tyler Tate[2], Elizabeth Swan[2], John Black[3], Urs Utzinger[1,2], Jennifer K. Barton[1,2]; [1]*Biomedical Engineering, The Univ. of Arizona, USA;* [2]*Optical Sciences, The Univ. of Arizona, USA;* [3]*Glannaventa, Inc, USA.* We are combining multispectral fluorescence imaging (MFI) and optical coherence tomography (OCT) into a 0.6mm diameter endoscope. This size allows access to the fallopian tubes transvaginally, creating a minimally-invasive screening method for high risk women.

FTu4G • Relativistic Light Sources—Continued

FTu4G.3 • 14:30 Invited

Extreme Light: Driver for a Table-Top Electron Accelerator and Tunable Narrowband Hard X-Ray Light Source, Donald P. Umstadter[1]; [1]*Univ. of Nebraska Lincoln, USA.* Two high intensity laser pulses from a single laser system are used to both accelerate electrons (<0.5-GeV) and generate narrowband (50%) tunable (0.07-9 MeV) x-rays by means of inverse Compton scattering.

LS

LTu4H • Resonators and Photonic Crystals I—Continued

LTu4H.3 • 14:30 Invited

Towards Few-photon Optoelectronics with Photonic Crystal Devices, Arka Majumdar[1,2], Armand Rundquist[4], Sonia Buckley[4], Jonghwan Kim[5], Sanfeng Wu[2], Michal Bajcsy[4,6], Feng Wang[5], Xiaodong Xu[2,3], Jelena Vuckovic[4]; [1]*Electrical Engineering, Univ. of Washington, Seattle, USA;* [2]*Physics Department, Univ. of Washington, Seattle, USA;* [3]*Material Science, Univ. of Washington, Seattle, USA;* [4]*E.L. Ginzton Lab, Stanford Univ., USA;* [5]*Physics Department, Univ. of California, USA;* [6]*Inst. for quantum computer, Univ. of Waterloo, Canada.* We report several devices based on the photonic crystal platform integrated with new optical materials, namely quantum dots and 2D-materials, to enable few-photon optoelectronics.

LTu4I • Semiconductor Nanooptics III—Continued

LTu4I.3 • 14:30 Invited

Probing Electron-Phonon Interactions at the Saddle Point in Graphene, Adam T. Roberts[1,2], Rolf Binder[1], N. Kwong[1], Dh. Golla[1], D. Cormode[1], B. LeRoy[1], Henry Everitt[2], Arvinder Sandhu[1]; [1]*Univ. of Arizona, USA;* [2]*US Army, USA.* High frequency differential transmission spectroscopy of graphene, probing near the M-point, is performed and analyzed theoretically. Electron-phonon coupling is identified as the chief mechanism for renormalization with an effective acoustic deformation potential of approximately 5eV.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12
FiO				JOINT FiO/LS

FTu4A • Quantum Communications—Continued

FTu4A.6 • 15:00
Identifying Nonclassicality of Multiphoton and Multimode Quantum States Directly from Experimental Detector Outcomes, Tim J. Bartley[1], Gaia Donati[1], Xian Min Jin[1], Animesh Datta[1], Marco Barbieri[1], Ian A. Walmsley[1]; [1]*Univ. of Oxford, UK.* We show experimentally how nonclassical statistics arise directly from the joint outcomes of multiplexed on-off detectors on two-mode, multiphoton optical states. This identifies a possible route to an entanglement witness using this scheme.

FTu4A.7 • 15:15
Demonstration of Single-Photon Three-Qubit Quantum Logic with Spatial Light Modulators, Kumel Kagalwala[1], Giovanni Di Giuseppe[1,2], Ayman F. Abouraddy[1], Bahaa E. Saleh[1]; [1]*CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA;* [2]*School of Science and Technology, Physics Division, Univ. of Camerino, Italy.* We experimentally demonstrate linear, deterministic, single-photon three-qubit quantum gates implemented by a spatial light modulator and using polarization and spatial-parity qubits. We also prepare single-photon three-qubit GHZ and W states and present tomographic measurements.

FTu4B • Optical Fiber Sensors II—Continued

FTu4B.5 • 15:00
Fast Brillouin Optical Time Domain Analysis Sensor based on Adaptive Linear Prediction and Cyclic Pulse Coding, Yonas S. Muanenda[1], Mohammad Taki[1], Fabrizio Di Pasquale[1]; [1]*Scuola Superiore di Studi Universitarie di Perfezionamento Sant' Anna di Pisa, Italy.* We propose and experimentally demonstrate a Brillouin Optical Time Domain Analysis sensor combining adaptive linear prediction with cyclic pulse coding for fast and accurate strain measurement over 10km standard singlemode fiber with meter-scale spatial resolution.

FTu4B.6 • 15:15
Enhanced Detection Accuracy and Figure of Merit of Surface Plasmon Resonance Based Fiber Optic Sensor for Blood-Glucose Sensing, Akhilesh Kumar Mishra[1], Satyendra K. Mishra[2], Gadi Eisenstein[1], Banshi D. Gupta[2]; [1]*Electrical Engineering, Technion—Israel Inst. of Technology, Israel;* [2]*Physics Department, Indian Inst. of Technology, Delhi, India.* Indium tin oxide-silver coated surface plasmon resonance based fiber optic probe for sensing of blood glucose is proposed. Theoretical simulation based on ray optics predicts enhancement in sensor's detection accuracy and figure of merit.

FTu4C • Coherence, Interference, and Polarization IV—Continued

FTu4C.6 • 15:00
Nonlinear Reference Phases in Synthetic Optical Holography, Bradley M. Deutsch[1], Martin Schnell[2], Rainer Hillenbrand[2], P. Scott Carney[1,3]; [1]*Beckman Inst. for Advanced Science and Technology, Univ. of Illinois at Urbana-Champaign, USA;* [2]*IKERBASQUE, Basque Foundation for Science, Spain;* [3]*Department of Electrical and Computer Engineering, Univ. of Illinois at Urbana-Champaign, USA.* Synthetic optical holography permits the use of arbitrary reference waves in digital holography, with each requiring an accompanying inversion algorithm. We consider, for example, a sinusoidal reference phase, resulting in an analog to pseudo-heterodyne interferometry.

FTu4C.7 • 15:15
Non-Bayesian noise reduction methods in digital holography, Pasquale Memmolo[1,2], Vittorio Bianco[1], Melania Paturzo[1], Bahram Javidi[3], Pietro Ferraro[1]; [1]*CNR - Istituto Nazionale di Ottica, Italy;* [2]*Center for Advanced Biomaterials for HealthCare@CRIB, Istituto Italiano di tecnologia, Italy;* [3]*ECE Department, Univ. of Connecticut, USA.* In digital holography, bayesian denoising approaches reduce the incoherent noise, but prior information are needed about the noise statistics. We propose and compare two strategies of holograms denoising without exploiting noise statistics.

FTu4D • Integrated Optics—Continued

FTu4D.4 • 15:00
Dispersion-Engineered Silicon Nitride Waveguide for Supercontinuum Generation at Visible Wavelengths, Wei Yu[1], Lin Zhang[2], Lionel C. Kimerling[1,2], Jurgen Michel[2]; [1]*Department of Materials Science and Engineering, MIT, USA;* [2]*Microphotonics Center, MIT, USA.* We propose a dispersion-engineered silicon nitride slot waveguide for nonlinear applications at the visible wavelength range. We show that an on-chip octave-spanning supercontinuum can be generated from 480 nm to 1200 nm.

FTu4D.5 • 15:15
Post-fabrication trimming on silicon nitride photonic Bragg grating add-drop filter, Sangsik Kim[1], Minghao Qi[1]; [1]*Purdue Univ., USA.* We study the post-fabrication trimming effect on a silicon nitride photonic Bragg grating add-drop filter for the realization of practical CWDM network system.

JTu4E • Novel Intense Attosecond Sources I—Continued

JTu4E.4 • 15:15
Macroscopic Manipulation of High-Harmonic-Generation Through Bound-State Coherent Control, Itai Hadas[1], Alon Bahabad[1]; [1]*Tel Aviv Univ., Israel.* It is theoretically shown that coherent control of atomic bound states can achieve macroscopic control over the process of High-order Harmonic Generation. In particular purely temporal Quasi-Phase-Matching is numerically demonstrated.

15:30–16:00 Coffee Break and Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*

15:30–17:00 Meet the APS Journal Editors, *Ania Terrace*

16:00–17:30 Exhibitor Appreciation Reception, *Arizona Ballroom, Salons 1-7*

Tucson Ballroom Salon A

FiO

FTu4F • Fibers for Biomedical Applications —Continued

FTu4F.6 • 15:00
High Resolution Microendoscopy with Structured Illumination for Evaluation of Breast Cancer Architecture, Jessica Dobbs[1], Matthew Kyrish[1], Noah Bedard[2], Ben Grant[1], Savitri Krishnamurthy[3], Wei Yang[3], Tomasz Tkaczyk[1], Rebecca Richards-Kortum[1]; [1]*Bioengineering, Rice Univ., USA;* [2]*Univ. of California-San Francisco, USA;* [3]*The Univ. of Texas M.D. Anderson Cancer Center, USA.* We compare images acquired with high resolution microendoscopy (HRME), HRME with structured illumination (SI-HRME), and confocal microscopy. Gray-level co-occurrence matrix-based contrast shows improved rejection of out-of-focus light with SI-HRME relative to HRME images.

FTu4F.7 • 15:15
Evaluation of Volume Holographic Images Obtained Through an Endoscope for in-vivo Medical Applications, Isela D. Howlett[1], Michael Gordon[1], Gabriel Orsinger[1], John Brownlee[1], Kenneth Hatch[1], Marek Romanowski[1], Jennifer K. Barton[1], Raymond K. Kostuk[1]; [1]*Univ. of Arizona, USA.* We present a process of evaluating images from volume holographic imaging (VHI) systems. In particular, a VHI endoscope is evaluated and a set of image processing and analysis techniques suitable for clinical environments is discussed.

Tucson Ballroom Salon B

FiO

FTu4G • Relativistic Light Sources—Continued

FTu4G.4 • 15:00
Enhanced Proton Acceleration by an Ultrashort Laser Interaction with Structured Dynamic Plasma Targets, Elad Schleifer[1], Eyal Nahum[1], Shmuel Eisenmann[1], Arie Zigler[1]; [1]*Hebrew Univ. of Jerusalem, Israel.* We experimentally and numerically demonstrate an order of magnitude enhanced acceleration of protons to high energy by relatively modest ultrashort laser pulses and structured dynamical plasma targets.

Tucson Ballroom Salon C

LS

LTu4H • Resonators and Photonic Crystals I—Continued

LTu4H.4 • 15:00 Invited
Title to be Announced, Marko Loncar[1]; [1]*Harvard Univ., USA.* Abstract not available.

Tucson Ballroom Salon D

LS

LTu4I • Semiconductor Nanooptics III—Continued

LTu4I.4 • 15:00
Time and Energy Resolved Probing of Many-body Interactions in Graphene and Heterostructures, Dheeraj Golla[1], Adam T. Roberts[2], Rolf Binder[3], N. Kwong[3], Mathew Yankowitz[1], D. Cormode[1], B. LeRoy[1], Henry Everitt[2], Arvinder Sandhu[1,3]; [1]*Department of Physics, Univ. of Arizona, USA;* [2]*U.S. Army Aviation and Missile Research, Development, and Engineering Center, USA;* [3]*College of Optics, Univ. of Arizona, USA.* We studied the electron-phonon and electron-electron interactions in graphene and its heterostructures using pump-probe spectroscopy. Graphene on hexa-Boron Nitride undergoes band structure modification, which affects the relaxation mechanisms of the hot carriers.

LTu4I.5 • 15:15
Terahertz Induced Transparency in Single-Layer Graphene, Michael J. Paul[1], Byounghwak Lee[1], Jenna L. Wardini[1], Zack J. Thompson[1], Andrew D. Stickel[1], Ali Mousavian[1], Ethan D. Minot[1], Yun-Shik Lee[1]; [1]*Physics, Oregon State Univ., USA.* We demonstrate THz-induced transparency in two types of single-layer CVD graphene samples utilizing high-field THz pulses. The nonlinear THz transmission depends on the local conductivity of the samples and dynamically varies in the time domain.

15:30–16:00 Coffee Break and Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*

15:30–17:00 Meet the APS Journal Editors, *Ania Terrace*

16:00–17:30 Exhibitor Appreciation Reception, *Arizona Ballroom, Salons 1-7*

Arizona Ballroom Salon 8

16:00–17:30
FTu5A • Quantum Electronics I
Presider: Yu-Ping Huang; Northwestern Univ., USA

FTu5A.1 • 16:00
Time-delayed, coherent feedback control of a many-body cavity QED system, Andrew Parkins[1], Arne Grimsmo[2], Bo-Sture Skagerstam[2]; [1]*Univ. of Auckland, New Zealand;* [2]*The Norwegian Univ. of Science and Technology, Norway.* We propose a time-delayed, coherent feedback scheme for open quantum-optical systems that can dramatically speed up convergence to steady state. We apply the scheme to a cavity QED implementation of the open Dicke model.

FTu5A.2 • 16:15
Observation of parity-time symmetry in an optical system formed by moving atoms, Peng Peng[1]; [1]*Physics, Fudan Univ., China.* We report the first experimental implementation of parity-time symmetry in an optical system using atoms. Coupling of two optical modes is realized by coherent diffusion of atomic coherence. Theoretical model and experiment results are presented.

FTu5A.3 • 16:30
Broadening the Sub-Standard-Quantum-Limit Region in Quantum Noise Limited Sensitivity for Gravitational Wave Detectors, Minchuan Zhou[1], Selim Shahriar[1,2]; [1]*Department of Physics and Astronomy, Northwestern Univ., USA;* [2]*Department of EECS, Northwestern Univ., USA.* We present schemes for gravitational wave detectors that incorporate anomalous dispersion in signal recycling, exhibiting a broad region below the standard quantum limit in the quantum noise limited sensitivity curves, which corresponds to opto-mechanical resonance.

Arizona Ballroom Salon 9

16:00–17:15
FTu5B • Optical Fiber Sensors III
Presider: John Canning; Univ. of Sydney, Australia

FTu5B.1 • 16:00 Tutorial
Fiber Optic Gyroscopes: Past and Present, Michel J. Digonnet[1]; [1]*Stanford Univ., USA.* This tutorial will review the principles, performance, and limitations of conventional fiber optic gyroscopes utilizing broadband light, and the promising advances made recently in fiber optic gyroscopes interrogated with a laser.

Dr. Digonnet earned his doctorate in fiber optics at Stanford University. Since then, he has spent most of his professional career at Stanford University's Department of Applied Physics supervising the research activity of Ph.D. students and carrying out his own research in photonics. Dr. Digonnet has made several key contributions to his field, including the invention of the fiber optic amplifier, a component that amplifies light inside a fiber and enabled the telecommunication revolution of the mid-1990s, in particular, the high-speed Internet. He has also been extensively involved in the development of the fiber optic gyroscope, now a critical part of the equipment airlines use to guide passenger planes safely. Dr. Digonnet is currently exploring new implications in the consideration of slow and fast light. Formerly thought to be constant, it now appears that light can be sped up or slowed, with profound ramifications for the interaction of matter and light.

Arizona Ballroom Salon 10

16:00–17:30
FTu5C • Coherence and Polarization I
Presider: Laura Waller; Univ. of California Berkeley, USA

FTu5C.1 • 16:00 Invited
Engineering Spatial Coherence of Lasers for Speckle-Free Imaging, Hui Cao[1], Brandon Redding[1], Michael Choma[2]; [1]*Applied Physics, Yale Univ., USA;* [2]*Diagnostic Radiology and Pediatrics, Yale School of Medicine, USA.* We showed that random lasers can be engineered to provide low spatial coherence. By exploiting the low spatial coherence of specifically-designed random lasers, we demonstrated speckle-free full-field imaging in the setting of intense optical scattering.

FTu5C.2 • 16:30
Complete Representation of a Correlation Singularity in a Partially Coherent Beam, Gregory J. Gbur[1], Charlotte Stahl[1]; [1]*Univ of North Carolina at Charlotte, USA.* The complete structure of a correlation singularity of a partially coherent vortex beam is studied and its propagation characteristics described. The singularity undergoes non-trivial evolution on propagation.

Arizona Ballroom Salon 11

16:00–17:30
FTu5D • Microresonators
Presider: Nicolas Fontaine; Alcatel-Lucent Bell Labs, USA

FTu5D.1 • 16:00
Trapping Light by Mimicking Gravitational Lensing, Hui Liu[1], Chong Sheng[1], Shining Zhu[1], Dentcho Genov[2]; [1]*School of Physics, Nanjing Univ., China;* [2]*College of Engineering and Science, Louisiana Tech Univ., USA.* We propose a distorted optical waveguide around a microsphere to mimic curved spacetimes caused by the "gravitational fields". Gravitational lensing effects analogues are experimentally demonstrated and this can be used to prospective light harvesting.

FTu5D.2 • 16:15
PT-symmetric microring lasers, Mohammad-Ali Miri[1], Hossein Hodaei[1], Matthias Heinrich[1], Mercedeh Khajavikhan[1], Demetrios N. Christodoulides[1]; [1]*Univ. of Central Florida, USA.* We show that a multimode laser cavity when accompanied by an identical but lossy partner can lase at a single longitudinal mode. Our experimental results demonstrate this mode-selective effect in parity-time (PT) symmetric micro-rings lasers.

FTu5D.3 • 16:30
A Discrete Resonance, All-Order Dispersion Engineering Method for Microcavity Design for Four-wave Mixing, Cale M. Gentry[1], Xiaoge Zeng[1], Milos Popovic[1]; [1]*Univ. of Colorado at Boulder, USA.* We propose a rigorous method for tailoring the dispersion of azimuthally-symmetric microresonators for four-wave mixing applications and show example designs. The method implicitly includes momentum conservation and directly reveals phase mismatch via resonance detuning, avoiding Taylor expansions.

Arizona Ballroom Salon 12

16:00–17:15
FTu5E • Novel Image and Information Analysis Methods
Presider: Lei Tian; Univ. of California, Berkeley, USA

FTu5E.1 • 16:00 Invited
Label-free Assessment of Mitochondrial Organization in three-dimensional Tissues, Irene Georgakoudi[1], Dimitra Pouli[1], Antonio Varone[1], Joanna Xylas[1], Kyle Quinn[1], Margaret McLaughlin-Drubin[2], Karl Munger[2]; [1]*Biomedical Engineering, Tufts Univ., USA;* [2]*Medicine, Brigham and Women's Hospital, Harvard Medical School, USA.* A Fourier-based method can be used to analyze endogenous NADH two-photon excited fluorescence images to characterize quantitatively mitochondrial organization. This optical biomarker is sensitive to metabolic changes that may occur at the onset of disease.

FTu5E.2 • 16:30
Morphological analysis framework of living cells by digital holography, Pasquale Memmolo[1,2], Francesco Merola[1], Lisa Miccio[1], Maria Iannone[2], Maurizio Ventre[3], Paolo A. Netti[2], Andrea Finizio[1], Melania Paturzo[1], Cosimo Distante[4], Pietro Ferraro[1]; [1]*CNR - Istituto Nazionale di Ottica, Italy;* [2]*Center for Advanced Biomaterials for HealthCare@CRIB, Istituto Italiano di tecnologia, Italy;* [3]*Department of Materials and Production Engineering Univ. of Naples Federico II, Italy;* [4]*CNR - Istituto Nazionale di Ottica, Italy.* Identification and measurements of region of interest in quantitative phase contrast maps of biological cells by digital holographic microscopy is investigated, with the aim to analyze the 3D positions and 3D morphology together.

FiO

16:00–17:30
FTu5F • General Optics in Biology and Medicine II

Presider: Kristen Maitland; Texas A&M Univ., USA

FTu5F.1 • 16:00
Optimal Design of Miniature Wide-Angle Computational Cameras for Retinal Prostheses and Wearable Visual Aids, Furkan E. Sahin[1], Patrick J. Nasiatka[1], James D. Weiland[2], Mark S. Humayun[2], Armand R. Tanguay[3]; [1]*Electrical Engineering - Electrophysics, Univ. of Southern California, USA;* [2]*Ophthalmology and Biomedical Engineering, Univ. of Southern California, USA;* [3]*Electrical Engineering-Electrophysics, Chemical Engineering and Materials Science, Biomedical Engineering, Ophthalmology, Physics and Astronomy, and Neuroscience Graduate Program, Univ. of Southern California, USA.* An imaging system design procedure for miniature wide-angle cameras with software correction of distortion is presented. Analysis of the effect of distortion on the software-corrected, final image during optical design allows for optimized dewarped final images.

FTu5F.2 • 16:15
Imaging Gold Nanorod Diffusion in Mucus Using Polarization Sensitive OCT, Richard Blackmon[1], Raghav Chhetri[1], David Hill[1], Brian Button[1], Amy L. Oldenburg[1]; [1]*Univ of North Carolina at Chapel Hill, USA.* We demonstrate using PS-OCT to sense changes in the diffusion rate of gold nanorods (GNRs) in actively transporting pulmonary mucus in normal and disease-like states. This novel approach may lead to advances in monitoring pathogenesis and treatment dosimetry in real-time.

FTu5F.3 • 16:30 Invited
Colloidal Quantum Dots for Photo-sensing and Neuron Stimulation, Lih Y. Lin[1]; [1]*Electrical Engineering, Univ. of Washington, USA.* Colloidal quantum dots have high quantum efficiency, unique optical and chemical properties, which allow various new applications. We discuss their potential in high-sensitivity photodetection and facilitating efficient optical stimulation of neurons.

JOINT FiO/LS

16:00–17:30
JTu5G • Novel Intense Attosecond Sources II

Presider: Zenghu Chang; Univ. of Central Florida, CREOL, USA

JTu5G.1 • 16:00 Invited
High gain Frequency Domain Optical Parametric Amplification, Philippe Lassonde[1], Maxime Boivin[1], Ladan Arissian[2], Bruno Schmidt[1,3], François Légaré[1]; [1]*INRS-Energie Mat & Tele Site Varennes, Canada;* [2]*Univ. of New Mexico, USA;* [3]*few-cycle Inc., Canada.* Optical parametric amplification (OPA) in the frequency domain rather than in time domain circumvents phase mismatch and damage threshold limitations. This approach enables amplification of few-cycle pulses, and nJ to microJ in a single stage.

JTu5G.2 • 16:30 Invited
Generation of High-power Isolated Attosecond Pulses by an Infrared Two-color Gating, Eiji J. Takahashi[1]; [1]*Extreme Photonics Research Group, RIKEN, Japan.* We propose and demonstrate two methods for generating high-energy isolated attosecond pulse: one is an infrared two-color laser field synthesis and the other is an infrared double optical gating. These methods enable us to perform a nonlinear optics experiment.

LS

16:00–17:30
LTu5H • Chemical and Biological Sensing I

Presider: King-Chuen Lin; National Taiwan Univ., Taiwan

LTu5H.1 • 16:00 Invited
The Making of 3D Multi-Resolution Motion Pictures for the Microscopic World, Haw Yang[1]; [1]*Princeton Univ., USA.* We outline the development of the 3D multi-resolution microscopy (10-nm localization precision in XYZ and 10 microsecond time resolution, integrated with micron / seconds confocal imaging), as well its applications in drug delivery and energy biosciences.

LTu5H.2 • 16:30 Invited
Bio-light for Optical Sensing, Seok-Hyun A. Yun[1]; [1]*Wellman Center for Photomedicine, Harvard Medical School, USA.* Laser and fluorescence-based sensing is promising for medical applications. Here, we present new approaches to enable efficient light delivery into the body and to generate light from biomolecules -- biological light -- for optical sensing and therapy.

16:00–17:30
LTu5I • Quantum Information II

Presider: Joshua Nunn; Univ. of Oxford, UK

LTu5I.1 • 16:00 Invited
Squeezing Enhanced Quantum Operation, Ulrik L. Andersen[1], Lars S. Madsen[1]; [1]*Danmarks Tekniske Universitet, Denmark.* In this talk we will present a new application of squeezed light. We demonstrate that the efficiency of mapping a quantum state from one mode to another can be enhanced utilizing squeezed states.

LTu5I.2 • 16:30 Invited
Harnessing the Time-frequency Structure of Ultrafast Quantum States, Benjamin Brecht[1], Vahid Ansari[1], Andreas Christ[1], Georg Harder[1], Hubertus Suche[1], Christine Silberhorn[1]; [1]*Integrated Quantum Optics, Univ. of Paderborn, Germany.* Time-frequency modes of ultrafast quantum states are promising candidates for high-dimensional quantum information applications. Here, we present waveguide devices that facilitate a complete control over TF modes, rendering them useful for actual implementations.

Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12

FiO

FTu5A • Quantum Electronics I—Continued

FTu5A.4 • 16:45
Dynamic control on light polarization through electromagnetically induced transparency in a rare-earth ion doped crystal, Zhixiang Li[1,2], Jingjun Xu[1,2], Guoquan Zhang[1,2]; [1]*School of Physics, Nankai Univ., China;* [2]*TEDA Applied Physics Inst., Nankai Univ., China*. We showed that the electromagnetically induced transparency in Pr^{3+}:Y_2SiO_5 crystals can induce significant polarization changes of light, which may be employed to compensate for the polarization change resulting from birefringence.

FTu5A.5 • 17:00
All-Fiberized Double-Cladding Yb-Doped Fiber Amplifier Operation near 980 nm, Jianqiu Cao[1], Yu Yu[1], Yingye An[1], Shaofeng Guo[1], Xiaojun Xu[1], Jinbao Chen[1], Xinming Lü[1]; [1]*National Univ of Defense Technology, China*. An all-fiberized continuous-wave double-cladding Yb-doped fiber amplifier operating near 980 nm is presented. More-than-6-W signal power is obtained with the slope efficiency of 32%.

FTu5A.6 • 17:15
Three-dimensional measurement of the Airy-Bessel wave packet propagation, Qian Cao[1], Chenchen Wan[1], Andy Chong[1,2]; [1]*Electro-Optics Program, Univ. of Dayton, USA;* [2]*Physics, Univ. of Dayton, USA*. We measured the three-dimensional (3D) intensity profile of the Airy-Bessel wave packet and its evolution under dispersion and diffraction. Its linear light bullet feature was verified in a 3D fashion.

FTu5B • Optical Fiber Sensors III—Continued

FTu5B.2 • 16:45
Detecting trapped atoms using an optical nanofiber, Tara Hennessy[1], Ciaran F. Phelan[1], Thomas Busch[1]; [1]*Okinawa Inst of Science & Technology, Japan*. We show that an optical nanofiber can be used to resolve spontaneous emission from a row of regularly separated ^{87}Rb atoms in an optical lattice with single site resolution.

FTu5B.3 • 17:00
Surface plasmon resonance (SPR) based fiber optic urea sensor using silver, ITO and enzyme entrapped gel layers, Satyendra K. Mishra[1], Banshi D. Gupta[1]; [1]*Physics Department, Indian Inst. of Technology Delhi, India*. Fabrication and characterization of a SPR based fiber optic urea sensor have been reported. The resonance wavelength of the probe fabricated using layers of ITO and enzyme decreases with the increase in the urea concentration.

FTu5C • Coherence and Polarization I—Continued

FTu5C.3 • 16:45
Optical memory based on coherent population oscillations, Marie-Aude Maynard[1], Fabien Bretenaker[1], Fabienne Goldfarb[1]; [1]*Laboratoire Aimé Cotton, CNRS, Université Paris Sud 11 - ENS Cachan, France*. We report the experimental observation of Coherent Population Oscillation (CPO) based light storage in metastable helium at room temperature. This light storage technique has been shown to be phase preserving.

FTu5C.4 • 17:00
Extra phase shift created by optically detuned light storage in metastable helium, Marie-Aude Maynard[1], Romain Bouchez[1], Etienne Brion[1], Tarek Labidi[1], Musawwadah Mukhtar[1], Santosh Kumar[2], Rupamanjari Ghosh[2,3], Fabien Bretenaker[1], Fabienne Goldfarb[1]; [1]*Laboratoire Aimé Cotton, CNRS, Université Paris Sud 11 - ENS Cachan, France;* [2]*School of Physical Sciences, Jawaharlal Nerhu Univ., India;* [3]*School of Natural Sciences, Shiv Nadar Univ., India*. We perform Electromagnetically Induced Transparency (EIT)-based storage in metastable helium at room temperature. An additional phase shift is shown to be imposed to the retrieved pulse when we detune the coupling and probe beams from the center of the Doppler profile.

FTu5C.5 • 17:15
Simultaneous Compression and Encryption of Polarimetric Images, M. Aldossari[1], Ayman Alfalou[1], C. Brosseau[1]; [1]*ISEN-Brest, France*. A series of experiments is performed to test a scheme of simultaneoues compression and encryption of polarimetric images. The ability to discriminate between objects embedded in scattering media makes this scheme suited to applications of underwater mine detection

FTu5D • Microresonators—Continued

FTu5D.4 • 16:45
Wavelength Conversion in Modulated Dual-Mode Resonators and its Equivalence to a Linear Filter Model, Mark T. Wade[1], Xiaoge Zeng[1], Milos Popovic[1]; [1]*Univ. of Colorado at Boulder, USA*. We present a resonant modulation scheme that enables efficient wavelength conversion. The system maps onto linear filter equations that provide straightforward analysis and optimized design. Efficiencies of silicon carrier-plasma modulator implementations are estimated.

FTu5D.5 • 17:00
Surface-Coupled Microsphere Resonators, Tom Galvin[1], Jose A. Rivera[1], Manas Gartia[1], Logan L. Liu[1], Gary J. Eden[1]; [1]*ECE, Univ. of Illinois, USA*. A novel micro-optical amplifier is evaluated experimentally and theoretically. Comprising a microsphere (onto which a gain medium is tethered) and a plasmonic surface, this micro-optical system is capable of amplifying Raman emission generated internally to the microsphere.

FTu5D.6 • 17:15
Broad-bandwidth pulse transmission through an ultrahigh-Q nanocavity with a chirped pulse, Zhelun Chen[1], Wataru Yoshiki[1], Takasumi Tanabe[1]; [1]*Science and Technology, Keio Univ., Japan*. We show that broad-bandwidth-chirped pulses can propagate through an ultrahigh-Q nanocavity by using optical nonlinearity. We found that the output of a certain wavelength was larger than the input because of adiabatic wavelength conversion.

FTu5E • Novel Image and Information Analysis Methods—Continued

FTu5E.3 • 16:45
Performance of DullRazor® on Digital Images Acquired at Multiple-Wavelengths, Jose Alberto Delgado Atencio[1], Margarita C. Rodríguez[1], Juan C. Valdiviezo[1], David Villegas[1], Alicia M. Godínez[1]; [1]*UPT, Mexico*. We investigated the performance of DullRazor® to remove hairs from a phantom mimicking a skin pigmented lesion. Results indicates that DullRazor® performed relatively well only when the phantom was illuminated at the green and red wavelengths.

FTu5E.4 • 17:00
Image Quality Metrics for Non-Traditional Imagery, Edward A. Watson[1,2]; [1]*Univ. of Dayton, USA;* [2]*Vista Applied Optics, USA*. We discuss some traditional image quality metrics and explore a different formulation to compare non-traditional imagery such as 3D point clouds (which offer contrast in range rather than contrast in irradiance) to a traditional 2D image.

Tucson Ballroom Salon A

FiO

FTu5F • General Optics in Biology and Medicine II—Continued

FTu5F.4 • 17:00
Understanding the Multispectral Forward Scatter Patterns by Diffraction Theory, Huisung Kim[1], Galen B. King[1], Arun K. Bhunia[2], Euiwon Bae[1]; [1]*Mechanical Engineering, Purdue Univ., USA;* [2]*Food Science, Purdue Univ., USA.* We present a comprehensive theoretical modeling of spectral light scattering phenomena from bacterial colonies. Individual colony is modeled as spatial light modulator, and effect of elevation, diameter, and refractive index of a colony were analyzed.

FTu5F.5 • 17:15
Nanoscaled Rare-Earth Doped Crystals Heater, Yurii V. Orlovskii[1,2], Alexander Vanetsev[1], Anastasia Ryabova[2], Konstantin Pukhov[2,3], Alexandr Popov[1,2], Elena Samsonova[1], Kerda Keevend[1], Igor Romanishkin[2], Ilmo Sildos[1], Victor Loschenov[2]; [1]*Inst. of Physics, Univ. of Tartu, Estonia;* [2]*A.M. Prokhorov General Physics Inst RAS, Russian Federation;* [3]*National Research Univ. "MPEI", Russian Federation.* We develop novel approach to hyperthermia for cancer treatment based on multiphonon relaxation of optical excitation in the Dy3+ doped nanocrystals after laser irradiation. It allows set fast and accurately preset temperature for local heating.

Tucson Ballroom Salon B

JOINT FiO/LS

JTu5G • Novel Intense Attosecond Sources II—Continued

JTu5G.3 • 17:00
Efficient generation of isolated attosecond soft x-ray pulses, Carlos Hernandez-Garcia[1,2], Tenio Popmintchev[1], Margaret M. Murnane[1], Henry C. Kapteyn[1], Luis Plaja[2], Agnieszka A. Jaron-Becker[1], Andreas Becker[1]; [1]*JILA, Univ. of Colorado, USA;* [2]*Grupo de Investigacion en Optica Extrema, Universidad de Salamanca, Spain.* We theoretically demonstrate the production of bright isolated attosecond pulses from mid-infrared-laser-driven high harmonic generation to photon energies well beyond the water window. Counterintuitively, the production of bright isolated attosecond pulses requires multi cycle driving pulses.

JTu5G.4 • 17:15
Ellipticity Dependence of High-order Harmonics Generation, Esben W. Larsen[1], Stefanos Carlström[1], Johan Mauritsson[1], Eleonora Lorek[1], Christoph Heyl[1], Anne L'Huillier[1], David Palecek[2], Donatas Zigmantas[2]; [1]*Department of Physics, Lund Universitet, Sweden;* [2]*Department of Chemical Physics, Lund Univ., Sweden.* We study how the two shortest quantum paths involved in high-order harmonic generation are affected by the polarization of the driving laser using a commercially available high repetition rate laser system.

Tucson Ballroom Salon C

LS

LTu5H • Chemical and Biological Sensing I—Continued

LTu5H.3 • 17:00 Invited
Sensing of Protein Reactions Using Pulsed Laser Based Transient Grating, Masahide Terazima[1]; [1]*Kyoto Univ., Japan.* For understanding biological functions, we have developed a time-resolved bio-sensing technique based on the pulsed laser induced transient grating method and succeeded in detecting conformational fluctuation and intermolecular interaction.

Tucson Ballroom Salon D

LS

LTu5I • Quantum Information II—Continued

LTu5I.3 • 17:00 Invited
Engineering Parametric Down-conversion in Multimode Nonlinear Waveguides, Konrad Banaszek[1], Michal Karpinski[2], Michal Jachura[1], Czeslaw Radzewicz[1], Jasleen Lugani[3], Divya Bharadwaj[3], Krishna Thyagarajan[3]; [1]*Univ. of Warsaw, Poland;* [2]*Univ. of Oxford, UK;* [3]*Indian Inst. of Technology Delhi, India.* We discuss intermodal dispersion as a versatile tool to control photon pairs produced in chi(2) waveguides, present experimental generation of spatially pure photons exhibiting high-visibility nonclassical interference, and describe schemes to produce spatial entanglement.

18:00–19:00 OSA Holography & Diffractive Optics Technical Group Networking Event, *Arizona Ballroom, Salon 10*

18:00–19:00 APS Annual Business Meeting, *Tucson Ballroom, Salon D*

18:00–19:00 OSA Annual Business Meeting, *Arizona Ballroom, Salon 8*

19:00–21:00 OSA Member Reception: The Scorchn' Sonoran, *Tucson Ballroom, Salons E & F*

19:00–21:00 Laser Science Banquet, *Signature Grill Restaurant, Outdoor Patio, JW Marriott Tucson Starr Pass Resort*

07:00–18:00 Registration, *Arizona Ballroom Foyer*

08:00–10:00
FW1A • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning I

Presider: Andrew Forbes; CSIR National Laser Centre, South Africa

FW1A.1 • 08:00 Invited

Controlling Light using Three-Dimensional Spatially Variant Self-Collimating Photonic Crystals, Stephen M. Kuebler[1,2], Jenefir Digaum[2], Javier Pazos[3], Jeffrey Chiles[2], Gabriel Padilla[1], Adrian Tatulian[1], Raymond C. Rumpf[3], Sasan Fathpour[2]; [1]*Chemistry Department and Physics Department, Univ. of Central Florida, USA;* [2]*CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA;* [3]*EM Lab, W. M. Keck Center for 3D Innovation, Univ. of Texas at El Paso, USA.* Tight control of an optical beam is demonstrated based on self-collimation within three-dimensional all-dielectric photonic crystals for which the orientation of the unit cell is progressively varied to direct power flow.

FW1A.2 • 08:30

Stable three-dimensional trapping of metallic nanoparticle at resonance with engineered vectorial optical field, Guanghao Rui[1], Qiwen Zhan[1]; [1]*Electro-Optics Program, Univ. of Dayton, USA.* A novel strategy is proposed to optically trap gold nanoparticles even under the resonant condition using engineered optical field. This optical tweezers supports stable three-dimensional trapping while avoiding trap destabilization due to optical overheating.

08:00–10:00
FW1B • Photonic Crystal Cavities and Waveguides

Presider: Mahmoud S. Rasras; Masdar Inst. of Science and Tech, United Arab Emirates

FW1B.1 • 08:00 Invited

Novel Effects in Photonic Crystal Cavities, Thomas F. Krauss[1]; [1]*Univ. of York, UK.* Photonic crystals never cease to amaze with their ability to control optical phenomena. For example, their ability to confine light and control the coupling to external radiation gives rise to strong enhancement of light emission; unusual boundary conditions give rise to interesting chaotic behaviour, and, as realised very recently, we can even use them to control thermal emission properties by controlling absorption.

FW1B.2 • 08:30 Invited

Silicon nanomembrane based Devices for Optical Sensing and On-chip Interconnects, Ray T. Chen[1,2]; [1]*Electrical and Computer Engineering, The Univ. of Texas, Austin, USA;* [2]*Omega Optics, USA.* Silicon nanomembrane based nanophotonic devices are presented. Further applications using defect engineered photonic crystal waveguide (PCW) based slow light devices provide us with an ultra-sensitive biosensing platform.

08:00–10:00
FW1C • Quantum Optical Measurement and Quantum Technologies I

Presider: Hugues de Riedmatten; ICFO -The Inst. of Photonic Sciences, Spain

FW1C.1 • 08:00 Invited

Quantum Motion and Microwave Fields, Tauno Palomaki[1]; [1]*JILA, Department of Physics, Univ. of Colorado, USA.* I will demonstrate coherent control of a mechanical oscillator with a precision at the quantum level. Mastery of the quantum state enables us to explore fundamental limits of measurement and consider applications in quantum information.

FW1C.2 • 08:30

Optical Detection of Radio Waves Through a Nanomechanical Transducer, Tolga Bagci[1], Anders Simonsen[1], Silvan Schmid[2], Louis G. Villanueva[2], Emil Zeuthen[1], Jürgen Appel[1], Jacob M. Taylor[3], Anders S. Sørensen[1], Koji Usami[1], Albert Schliesser[1], Eugene S. Polzik[1]; [1]*Niels Bohr Inst., Univ. of Copenhagen, Denmark;* [2]*Department of Micro- and Nanotechnology, Technical Univ. of Denmark, Denmark;* [3]*Joint Quantum Inst./NIST, USA.* Electronic signals are converted with high efficiency, and very low added noise, to the optical domain by coupling them to a nanomechanical membrane whose displacement is interferometrically monitored with quantum-limited sensitivity.

08:00–10:00
FW1D • Long Wavelength Mid-IR to THz Fiber Devices I

Presider: David Lancaster; Univ. of Adelaide, Australia

FW1D.1 • 08:00 Tutorial

Mid-Infrared Fiber Sources: Challenges and Opportunities, Stuart D. Jackson[1]; [1]*Engineering, Macquarie Univ., Australia.* I will provide a brief summary of the field of mid-infrared fiber lasers highlighting the important parameters and developments that have contributed to this field. I will then discuss the challenges, applications and opportunities for further research.

Stuart Jackson received the BSc and the BSc(Hons) degrees in 1989 and 1990 respectively from the University of Newcastle (Australia). In 1990, he joined the Centre for Lasers and Applications at Macquarie University to undertake research toward the PhD degree, which he received in 1996. In 1995, he joined the Laser Photonics Group at the University of Manchester and initiated the research there into high power fibre lasers. In 1999 he joined the Optical Fibre Technology Centre at the University of Sydney where he became a Senior Research Fellow and Technical Manager of silica fibre fabrication. In 2009 he moved the School of Physics at the University of Sydney as a Queen Elizabeth II Fellow funded by the Australia Research Council. In 2014 he moved to the Department of Engineering at Macquarie University to undertake a permanent position in teaching and research. His interests include diode pumped solid-state lasers, spectroscopy, nonlinear optics and integrated optics.

08:00–10:00
FW1E • Microscopy and OCT I

Presider: Brandon Redding; Yale Univ., USA

FW1E.1 • 08:00

Quantifying Cellular Response to Treatment and Dynamic Behaviors Using Quantitative Phase Microscopy (QPM), Katherine Creath[1,2], Goldie Goldstein[3]; [1]*Independent Consultant, USA;* [2]*The Univ. of Arizona, USA;* [3]*4D Technology Corp, USA.* QPM is utilized to quantify cellular response before, during and after treatment to discern reaction mechanisms, morphology changes and connect structure to function. Results highlight changes in optical thickness, optical volume and dry cell mass.

FW1E.2 • 08:15

Rapid diagnosis of whole prostate core-needle biopsies with video-rate structured illumination microscopy, Mei Wang[1], David Tulman[1], Tyler C. Schlichenmeyer[1], Hillary Kimbrell[2], J. Quincy Brown[1]; [1]*Biomedical Engineering, Tulane Univ., USA;* [2]*Pathology and Laboratory Medicine, Tulane Univ. School of Medicine, USA.* We report video-rate structured illumination microscopy (VR-SIM) as a practical method for high-resolution imaging of whole core-needle biopsies in seconds. Prostate cancer is rapidly and reliably identified in VR-SIM images, suggesting a use for in-procedure biopsy screening.

FW1E.3 • 08:30 Invited

Imaging Cancer-associated Motility and Remodeling by Temporal Statistics of OCT Signals, Amy L. Oldenburg[1,2]; [1]*Physics and Astronomy, Univ of North Carolina at Chapel Hill, USA;* [2]*Biomedical Research Imaging Center, Univ of North Carolina at Chapel Hill, USA.* Optical coherence tomography provides spatially-localized heterodyne dynamic light scattering, which is used to monitor ATP-driven motions of cells and Brownian motions of plasmonic probe particles in 3D breast cancer tissue models.

07:00–18:00 **Registration,** *Arizona Ballroom Foyer*

08:00–10:00
FW1F • Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard I

Presider: Pablo Artal; Universidad de Murcia, Spain

FW1F.1 • 08:00 Invited

Lasers in Retinal Imaging, Stephen A. Burns[1]; [1]*Indiana Univ., USA.* Lasers were used in measuring the optical quality of the eye as early as 1965, but it was about 1980 that they really began to impact retinal imaging. This talk describes the advancements in retinal imaging that have occurred over the last 35 years and the role lasers played in this development.

FW1F.2 • 08:30 Invited

The ANSI 2014 Standard for Safe Use of Lasers, Francois C. Delori[1]; [1]*Schepens Eye Research Inst., USA.* The revised ANSI 136.1 Standard incorporates comprehensive changes with the focus on usability. New experimental data on spot size dependence of thresholds and on damage mechanisms for ultra short pulses has resulted in general in less strigent safety levels.

08:00–10:00
LW1G • Resonators and Photonic Crystals II

Presider: Joshua Hendrickson; US Air Force Research Laboratory, USA

LW1G.1 • 08:00 Invited

Spontasneous Emission of Er atoms in Metallic Nanocavity, Yong-Hee Lee[1], Yong-Hee Lee[1]; [1]*Physics, KAIST, Republic of Korea.* Fast and bright spontaneous emission is observed from Er atoms placed in a gold nano-cavity. The record-high Purcell factor of >100 is directly measured.

LW1G.2 • 08:30 Invited

Quantum Nano-Photonic Devices Based on Rare-Earth Doped Crystals, Andrei Faraon[1], Tian Zhong[1], Evan Miyazono[1], Alex Hartz[1], Jonathan Kindem[1]; [1]*Applied Physics, California Inst. of Technology, USA.* Rare-earth ions in crystalline hosts are coupled to nano-resonators, thus enabling large Purcell factors and high optical depths in micron-long structures. These devices will enable dense on-chip optical quantum memories and new quantum bits.

08:00–10:00
LW1H • Attosecond Science II

Presider: Andy Kung; National Tsing Hua Univ., Taiwan

LW1H.1 • 08:00 Invited

Generation of Bright Isolated Attosecond Soft X-Ray Pulses Driven by Multi-Cycle Mid-Infrared Lasers, Ming-Chang Chen[1,2], Christopher Mancuso[1], Carlos Hernández-García[1,3], Franklin Dollar[1], Ben Galloway[1], Dimitar Popmintchev[1], Pei-Chi Huang[2], Barry Walker[4], Luis Plaja[3], Agnieszka A. Jaron-Becker[1], Andreas Becker[1], Margaret M. Murnane[1], Henry C. Kapteyn[1], Tenio Popmintchev[1]; [1]*JILA and Department of Physics, Univ. of Colorado Boulder, USA;* [2]*Inst. of Photonics Technologies, National Tsing Hua Univ., Taiwan;* [3]*Grupo de Investigación en Óptica Extrema, Universidad de Salamanca, Spain;* [4]*Department of Physics, Univ. of Delaware, USA.* By driving the high harmonic generation process with multi-cycle mid-infrared laser pulses, we demonstrate bright isolated, attosecond soft X-ray pulses for the first time.

LW1H.2 • 08:30 Invited

Waveforms for Optimal Enhancement of High-order Harmonics by Synthesizing Two- or three-color Laser Fields, Chii Dong Lin[1], Cheng Jin[1], Anh Thu Le[1]; [1]*Kansas State Univ., USA.* High-order harmonics reaching keV energies can be generated with optimized waveform by synthesizing a 2-micron mid-infrared laser with a small fraction of its third harmonic, resulting in a ten-fold increase of harmonic yields.

08:00–10:00
LW1I • Filamentation I

Presider: Jean-Claude Diels; Univ. of New Mexico, USA

LW1I.1 • 08:00 Invited

Title not Available, Andrius Baltuska[1]; [1]*Technische Universitait Wien, Austria.* Abstract not available.

LW1I.2 • 08:30 Invited

The Role of Filamentation in THz Wave Air Photonics, Xi-Cheng Zhang[1], Kang Liu[1]; [1]*The Inst. of Optics, Univ. of Rochester, USA.* Laser-induced filamentation with femtosecond optical excitation provides new method to generate and detect broadband THz waves. We report new results of using filamentation for THz wave air photonics, including remote THz wave sensing.

FiO

FW1A • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning I—Continued

FW1A.3 • 08:45
Simulation of Multiple-Optical-Axis Pattern-Integrated Interference Lithography (PIIL) Systems, Donald E. Sedivy[1], Thomas K. Gaylord[1]; [1]*ECE, Georgia Inst. of Technology, USA.* Exposure patterns for an optimized multiple-optical-axis PIIL system are simulated using a combination of ray tracing and Fourier analysis for several lens tilt configurations. Reasonable fidelity is shown to be possible for tilts up to 40 deg.

FW1A.4 • 09:00
Three-Dimensional Periodic Structures via Pattern-Integrated Interference Lithography, Matthieu C. Leibovici[1], Thomas K. Gaylord[1]; [1]*Electrical and Computer Engineering, Georgia Inst. of Technology, USA.* Simulation results predicting the single-exposure fabrication of custom-modified 3D periodic microstructures by pattern-integrated interference lithography (PIIL) are presented. These results indicate PIIL is a viable method of making versatile 3D microstructures rapidly.

FW1A.5 • 09:15
Photothermal in-situ synthesis of localized tungsten oxide nanobeam structures, Jaeho Shim[1], Jong-Bum You[1], Jeong Oen Lee[1], Kyungmook Kwon[1], Jun-Bo Yoon[1], Kyoungsik Yu[1]; [1]*Department of Electrical Engineering, Korea Advanced Inst of Science & Tech, Republic of Korea.* We demonstrate tungsten oxide semiconductor nanostructures fabricated by photothermal oxidation processes on the suspended metal nano-layer. The electrical conductivities of the nanobeam structures are measured against the temperature to validate their metal/semiconductor material properties.

FW1B • Photonic Crystal Cavities and Waveguides—Continued

FW1B.3 • 09:00
Withdrawn.

FW1B.4 • 09:15
Microphotonic Channel Add-Drop Filter Based on Dual Photonic Crystal Cavity System in Push-Pull Mode, Christopher V. Poulton[1], Xiaoge Zeng[1], Mark T. Wade[1], Milos Popovic[1]; [1]*Univ. of Colorado at Boulder, USA.* We demonstrate an add-drop filter based on a dual photonic crystal microcavity system that emulates a traveling-wave resonator. Realized on a 45nm SOI CMOS chip, the device shows 16dB through-port extinction and 1dB drop loss.

FW1C • Quantum Optical Measurement and Quantum Technologies I—Continued

FW1C.3 • 08:45
Generation of Photon Pairs in Green Fluorescent Protein, Siyuan Shi[1], Abu Thomas[1], Neil V Corzo[1], Prem Kumar[1], Yu-Ping Huang[1], Kim Fook Lee[1]; [1]*Center for Photonic Communication and Computing, EECS Department, Northwestern Univ., USA.* We demonstrate generation of correlated photon pairs in naturally occurring Green Fluorescent Protein through the process of nondegenerate four-wave mixing. We obtain high purity photon pairs with a maximum coincidence to accidental ratio of ~70.

FW1C.4 • 09:00
Ultrabroadband spontaneous parametric fluorescence in 800 nm region toward ultra-high-resolution quantum optical coherence tomography, Masayuki Okano[1,2], Hwan H. Lim[3], Ryo Okamoto[1,2], Akira Tanaka[1,2], Yuichi Nagamatsu[1,2], Norihiko Nishizawa[4], Sunao Kurimura[3], Shigeki Takeuchi[5,1]; [1]*Research Inst. for Electronic Science, Hokkaido Univ., Japan;* [2]*The Inst. of Scientific and Industrial Research, Osaka Univ., Japan;* [3]*National Inst. for Materials Science, Japan;* [4]*Graduate School of Engineering, Nagoya Univ., Japan;* [5]*Graduate School of Engineering, Kyoto Univ., Japan.* Quantum optical coherence tomography can realize high-resolution imaging with dispersion tolerance by virtue of quantum entanglement. We generate ultrabroadband spontaneous parametric fluorescence from chirped quasi-phase matching devices to achieve the ultrahigh-resolution imaging.

FW1C.5 • 09:15
Hybrid optomechanical cooling via atomic three-level schemes, Francesco Bariani[1], Pierre Meystre[1], Swati Singh[2], Lukas Buchmann[3], Mukund Vengalattore[4]; [1]*College of Optical Sciences, Univ. of Arizona, USA;* [2]*Physics Department, Harvard Univ., USA;* [3]*Department of Physics, Univ. of California, USA;* [4]*Laboratory of Atomic and Solid State Physics, Cornell Univ., USA.* We investigate hybrid optomechanical schemes involving cold atoms to improve cooling in the Doppler regime. We focus on two specific examples of tunable three-level configurations: Electromagnetically Induced Transparency and Recoil Induced Resonances.

FW1D • Long Wavelength Mid-IR to THz Fiber Devices I—Continued

FW1D.2 • 08:45
Experimental and Numerical Investigations on 2.8 μm Q-switched Pulse Amplification, Gongwen Zhu[1], Xiushan Zhu[1], Robert Norwood[1], Nasser Peyghambarian[1]; [1]*College of Optical Sciences, Univresity of Arizona, USA.* An Er^{3+}-doped ZBLAN fiber amplifier for Q-switched pulses at 2.79 μm is reported. Over 24 μJ pulse energy at an average output power of 1.0 W was achieved at a pump power of 9.4 W.

FW1D.3 • 09:00
Hybrid Chalcogenide Nanowire for Mid-IR Single-Optical Cycle Pulse Generation, Amine Ben Salem[1], Rim Cherif[1], Mourad Zghal[1]; [1]*Univ. of Carthage, Engineering School of Communication of Tunis (Sup'Com), GreS'Com Laboratory, Tunisia.* We design an As2S3 nanowire embedded-core in silica photonic crystal fiber. The hybrid structure shows to be very promising for mid-IR pulse compression in the monocycle regime with broadband low-energy supercontinuum generation at 1550 nm.

FW1D.4 • 09:15
Highly Nonlinear Triangular Core Photonic Crystal Fiber with All Normal Dispersion for Supercontinuum Generation, Ravindra K. Sinha[1], Ajeet Kumar[1], Than Singh Saini[1]; [1]*Delhi Technological Univ., India.* New design of triangular-core PCF in As2Se3 glass with all-normal dispersion has been proposed for supercontinuum generation. Structure possesses nonlinear coefficient as high as 5400 W^(-1) Km^(-1) with -2 ps/nm.Km dispersion at 4400 nm wavelength.

FW1E • Microscopy and OCT I—Continued

FW1E.4 • 09:00
Oxygen Distribution in Cortical Microvasculature, Sava Sakadzic[1], Emiri T. Mandeville[1], Louis Gagnon[1], Joseph Musacchia[1], Mohammad Yaseen[1], Eng H. Lo[1], Anna Devor[2], David A. Boas[1]; [1]*Harvard Medical School, Massachusetts General Hospital, USA;* [2]*Univ. of California, San Diego, USA.* We applied multimodal microscopic imaging of the cortical intravascular partial pressure of O2 and blood flow to elucidate the roles of arterioles and capillaries in securing tissue oxygenation during metabolic and blood flow perturbations.

FW1E.5 • 09:15
Application of Task-based Assessment in Optical Coherence Tomography in the Context of Tear Film Imaging, Jinxin Huang[1], Qun Yuan[2,5], Eric Clarkson[3], Matthew Kuppinski[4], Jannick P. Rolland[5]; [1]*Department of Physics and Astronomy, Univ. of Rochester, USA;* [2]*School of Electronic and Optical Engineering, Nanjing Univ. of Science and Technology, China;* [3]*Department of Radiology, Univ. of Arizona, USA;* [4]*College of Optical Sciences, Univ. of Arizona, USA;* [5]*The Inst. of Optics, Univ. of Rochester, USA.* In the context of tear film imaging, we developed a task-based assessment framework that enables a customized OCT system to yield unbiased estimates of thickness down to 20 nm with nanometer-class precision.

FiO

LS

FW1F • Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard I—Continued

FW1F.3 • 09:00 Invited

Laser Technologies Enhancing OCT Performance, Wolfgang Drexler[1]; [1]*Medizinische Universitait Wien, Austria.* OCT is one of the fastest clinically and economically accepted optical imaging techniques. The most important light sources technologies that have significantly improved axial resolution, penetration depth and imaging speed in OCT will be reviewed.

LW1G • Resonators and Photonic Crystals II—Continued

LW1G.3 • 09:00 Invited

Topological States of Photons in Nanostructures, Alexander N. Poddubny[1,2]; [1]*Ioffe Inst., Russian Federation;* [2]*ITMO Univ., Russian Federation.* We present our recent theoretical and experimental results on the topological edge states of plasmons, exciton-polaritons and photons in various nanostructures, including zigzag chains of nanodisks and nanospheres, coupled quantum wells, waveguides and resonators.

LW1H • Attosecond Science II—Continued

LW1H.3 • 09:00 Invited

A 200 TW Driving Laser for Generating Microjoule Level Isolated Attosecond Pulses, Zenghu Chang[1]; [1]*Univ. of Central Florida, CREOL, USA.* A carrier-envelope phase stabilized 200 TW, 15 fs Ti:Sapphire laser is being developed for generating isolated attosecond pulses with microjoule energy. Preliminary carrier-envelope phase effects have been demonstrated in Double Optical Gating experiments.

LW1I • Filamentation I—Continued

LW1I.3 • 09:00 Invited

Fully Microscopic Studies of Strong-Field Atom Ionization, Stephan W. Koch[2,1], Kolja Schuh[1], Joerg Hader[1], Jerome V. Moloney[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA;* [2]*Physics Department, Philipps Universitaet Marburg, Germany.* The interaction of a highly off-resonant light pulse with an atomic gas is modeled fully microscopically. The resulting equations are solved numerically for an atomic model system excited by a strong light pulse.

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Arizona Ballroom Salon 8	Arizona Ballroom Salon 9	Arizona Ballroom Salon 10	Arizona Ballroom Salon 11	Arizona Ballroom Salon 12
FiO				
FW1A • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning I—Continued	**FW1B • Photonic Crystal Cavities and Waveguides—Continued**	**FW1C • Quantum Optical Measurement and Quantum Technologies I—Continued**	**FW1D • Long Wavelength Mid-IR to THz Fiber Devices I—Continued**	**FW1E • Microscopy and OCT I—Continued**
FW1A.6 • 09:30  **Simulation of Photonic-Crystal Devices Fabricated by Pattern-Integrated Interference Lithography,** Matthieu C. Leibovici[1], Thomas K. Gaylord[1]; [1]*Electrical and Computer Engineering, Georgia Inst. of Technology, USA.* We simulated the fabrication by pattern-integrated interference lithography (PIIL) of three photonic-crystal devices and calculated their transmission spectra. The performance of the PIIL-produced devices is comparable to that of their idealized counterparts.	**FW1B.5 • 09:30**  **Post-Process Tuning of Slow Light Photonic Crystal Waveguides,** Sebastian A. Schulz[1], Kashif M. Awan[2], Dennis X. Liu[1,3], Ksenia Dolgaleva[2], Jeremy Upham[1], Robert W. Boyd[1,4]; [1]*Department of Physics, Univ. of Ottawa, Canada;* [2]*School of Electrical Engineering and Computer Science, Univ. of Ottawa, Canada;* [3]*Department of Engineering, Univ. of Waterloo, Canada;* [4]*Inst. of Optics, Univ. of Rochester, USA.* We present a wet chemical method for tuning the slow light operating wavelength of silicon photonic crystal waveguides. This procedure compensates for the effects of slab thickness - and systematic hole radii - variations.	**FW1C.6 • 09:30** **Observing angular deviations in light beam reflection via weak measurements,** Michele Merano[1], Gaurav Jayaswal[1], Giampaolo Mistura[1]; [1]*Fisica e Astronomia, Universita degli Studi di Padova, Italy.* We report the first observation of the angular Goos-Hänchen shift for a Gaussian light beam via weak value amplification. Weak measurements faithfully amplify the effect at any angle of incidence, even at Brewster.	**FW1D.5 • 09:30** Invited **Nonlinear Properties of Silicon Optical Fibers from Telecoms to the Mid-infrared,** Anna C. Peacock[1], Li Shen[1], Priyanth Mehta[1], Noel Healy[1]; [1]*Univ. of Southampton, UK.* The nonlinear transmission properties of hydrogenated amorphous silicon core fibers are characterized for short pulse propagation spanning the telecoms band to the edge of the mid-infrared regime.	**FW1E.6 • 09:30** **Withdrawn.**
FW1A.7 • 09:45  **Fabrication of waveguides in doped organic/Silica hybrid materials using femtosecond laser pulses,** Adriano J. Otuka[1], Paulo Ferreira[1], Diego S. Manoel[2], Dimas R. Vollet[2], Dario A. Donatti[2], Fabio S. De Vicente[2], Cleber R. Mendonça[1]; [1]*Instituto de Física de São Carlos, Universidade de São Paulo, Brazil;* [2]*Departamento de Física, Universidade Estadual Paulista, Brazil.* Fabrication of waveguides using femtosecond laser micromachining technique in Rhodamine B-doped organic/Silica hybrid materials is demonstrated. Optical properties and microscopic images were measured; and the produced waveguides present 2.3 dB/mm total loss.	**FW1B.6 • 09:45**  **Nonlinear Processes in One-Dimensional Photonic Crystal with Graphene-based Defect,** Maria Antonietta Vincenti[1], Domenico de Ceglia[1], Marco Grande[2], Antonella D'Orazio[2], Michael Scalora[3]; [1]*US Army AMRDEC, National Research Council, USA;* [2]*Dipartimento di Ingegneria Elettrica e dell'Informazione (DEI), Politecnico di Bari, Italy;* [3]*Charles M. Bowden Research Laboratory, AMRDEC, US Army RDECOM, USA.* We investigate nonlinear properties of one-dimensional photonic crystal with a graphene-based defect, and show that the field enhancement provided by the photonic crystal cavity enhances third harmonic generation and lowers the threshold of nonlinear processes.	**FW1C.7 • 09:45** **Observation of the Imbert-Fedorov effect via weak value amplification,** Michele Merano[1], Giampaolo Mistura[1], Gaurav Jayaswal[1]; [1]*Dipartimento di Fisica e Astronomia, Università degli Studi di Padova, Italy.* We report the first experimental observation of the Imbert-Fedorov shift via weak value amplification.		**FW1E.7 • 09:45** **Illumination coding for fast Fourier Ptychography with large field-of-view and high-resolution,** Lei Tian[1], Laura Waller[1]; [1]*Univ. of California Berkeley, USA.* Fourier Ptychography recovers high-resolution phase and amplitude from low-resolution images taken at varying illumination angles. Here, we describe multiplexing methods for reduction of both acquisition time and data size requirements.

08:30–12:30 OSA Members and Families: Arizona-Sonora Desert Museum Tour, *Bus will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 08:30.*

10:00–10:30 Coffee Break and Unopposed Exhibit Time, *Arizona Ballroom, Salons 1-7*

10:00–14:00 Exhibit Open, *Arizona Ballroom, Salons 1-7*

FiO

FW1F • Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard I—Continued

FW1F.4 • 09:30 Invited

Application of Second Harmonic Generation Imaging for Visualization of the Characteristics of Corneal Stromal Collagen in Normal and Diseased Eyes, Naoyuki Morishige[1]; *[1]Ophthalmology, Yamaguchi Univ., Japan.* Second harmonic generation has been applied to non-invasively visualize collagen lamellae of the excised human corneal tissue. This imaging technique revealed the three-dimensional characteristics of collagen lamellae in the normal and diseased corneas.

LS

LW1G • Resonators and Photonic Crystals II—Continued

LW1G.4 • 09:30

Effect of Metallic Antenna Shape on the Near-Field Coupling to a Semiconductor Quantum Well, Michael R. Gehl[1], Sander Zandbergen[1], Ricky D. Gibson[1], Muriel Béchu[2], Nima N. Esfahani[3,4], Joshua Hendrickson[3], Jasmine Sears[1], Patrick Keiffer[1], Martin Wegener[2], Galina Khitrova[1]; *[1]College of Optical Sciences, Univ. of Arizona, USA; [2]Institut für Angewandte Physik, Institut für Nanotechnologie, Karlsruhe Inst. of Technology, Germany; [3]Air Force Research Laboratory, Wright Patterson Air Force Base, USA; [4]Solid State Scientific Corporation, USA.* Arrays of metallic antennae with wire, square and split-ring shapes are fabricated on a near-surface quantum well. The hybrid system is investigated using photoluminescence, transmission and transient pump-probe experiments.

LW1G.5 • 09:45

In Situ Growth of Self-assembled Indium Islands in Close Proximity to Semiconductor Quantum Emitters, Ricky D. Gibson[1], Michael Gehl[1], Sander Zandbergen[1], Jasmine Sears[1], Nima N. Esfahani[2,3], Patrick Keiffer[1], Joshua Hendrickson[3], Martin Wegener[4], Galina Khitrova[1]; *[1]College of Optical Sciences, Univ. of Arizona, USA; [2]Sensors Directorate, Air Force Research Laboratory, USA; [3]Solid State Scientific Corporation, USA; [4]Institut für Angewandte Physik, Institut für Nanotechnologie, Karlsruhe Inst. of Technology, Germany.* Self-assembled indium islands on III-V quantum dot (QD) samples with a 7nm cap show a 4x enhancement in the peak intensity of the PL offering a bottom-up platform for studying the resonant coupling between plasmonic structures and semiconductor quantum emitters.

LW1H • Attosecond Science II—Continued

LW1H.4 • 09:30 Invited

Tabletop Nanometer Extreme Ultraviolet Imaging in an Extended Reflection Mode, Daniel Adams[1], Bosheng Zhang[1], Matthew Seaberg[1], Dennis Gardner[1], Elisabeth Shanblatt[1], Margaret M. Murnane[1], Henry C. Kapteyn[1]; *[1]NIST/JILA/CU, USA.* We demonstrate the most general, highest fidelity reflection mode coherent diffractive imaging to date. Using a high harmonic tabletop source with ptychography- and keyhole-coherent diffraction techniques, images are reconstructed with < 1 nm axial resolution.

LW1I • Filamentation I—Continued

LW1I.4 • 09:30

Terahertz Generation in Two-color Photoionization and Its Microscopic Mechanism, Yong Sing You[1], Ki-Yong Kim[1], Dongwen Zhang[2]; *[1]Inst. for Research in Electronics and Applied Physics, Univ. of Maryland, USA; [2]Department of Physics, National Univ. of Defense Technology, China.* We verify the microscopic mechanism of terahertz emission in two-color laser-produced plasmas by simultaneously measuring laser pulse phases, plasma currents, and terahertz radiation.

LW1I.5 • 09:45

Multiple High-Intensity THz Generation by Consecutive Two-Color Filaments in Air, Traian Dascalu[1], Razvan Ungureanu[1], Gabriel Cojocaru[1], Oana Grigore[1], Romeo Banici[1], Mihai Dinca[1]; *[1]Natl Inst Lasers Plasma & Radiation Phys, Romania.* Multiple high-intensity THz pulses with controlled delay and energy ratio are generated in air by two-color filamentation technique. Two THz transients with energy up to 1 µJ and delay controlled in the 1ps-100ps range are reported.

08:30–12:30 OSA Members and Families: Arizona-Sonora Desert Museum Tour, *Bus will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 08:30.*

10:00–10:30 Coffee Break and Unopposed Exhibit Time, *Arizona Ballroom, Salons 1-7*

10:00–14:00 Exhibit Open, *Arizona Ballroom, Salons 1-7*

FiO

10:30–11:30
FW2A • Imaging

Presider: Rongguang Liang; Univ. of Arizona, USA

FW2A.1 • 10:30

Super-resolution optical disks beyond 10 Terabytes, Yaoyu Cao[1], Xiangping Li[1], Min Gu[1]; *[1]Centre for Micro-photonic, Faculty of Science, Engineering and Technology, Swinburne Univ. of Technology, Australia.* A novel super-resolution optical two-beam technique compatible with a standard optical drive is applied in the recording and reading process to enable the 10 Terabytes optical disk development for ultra-high density optical data storage.

FW2A.2 • 10:45

Demonstration of an optimised focal field with long focal depth and high transmission obtained with the Extended Nijboer-Zernike theory, Lei Wei[1], Sander Konijnenberg[1], Nitish Kumar[1], Paul Urbach[1]; *[1]Optics Research Group, Delft Univ. of Technology, Netherlands.* We present an optimization algorithm based on the Extended Nijboer Zernike theory to design the pupil mask which gives an extended depth of focus with high lateral resolution.We also have demonstrated the outcomes of the algorithm experimentally.

FW2A.3 • 11:00

Reflection-based Diffraction Phase Microscopy using Broadband Illumination, Christopher A. Edwards[1], Basanta Bhaduri[1], Gabriel Popescu[1], Lynford Goddard[1]; *[1]Univ. of Illinois at Urbana-Champaign, USA.* We present a reflection-based broadband illumination quantitative phase imaging technique that provides halo-free images of opaque samples with sub-nanometer spatial and temporal noise.

10:30–12:00
FW2B • Materials for Integrated Photonic

Presider: Ray Chen; Univ. of Texas at Austin, USA

FW2B.1 • 10:30

Integrated nanophotonics based on nanowire plasmons and atomically-thin material, Kenneth M. Goodfellow[1], Ryan Beams[1], Chitraleema Chakraborty[2], Lukas Novotny[3], Anthony N. Vamivakas[1]; *[1]Inst. of Optics, Univ. of Rochester, USA; [2]Materials Science, Univ. of Rochester, USA; [3]Photonics Laboratory, ETH Zürich, Switzerland.* We demonstrate a nanophotonic integrated circuit element composed of a silver nanowire and single-layer molybdenum disulfide (MoS_2). We show that the nanowire can both excite MoS_2 photoluminescence via plasmons and collect decaying excitons as plasmons.

FW2B.2 • 10:45

Direct patterning of C-shape arrays on graphene oxide thin films using direct laser printing, Xiaorui Zheng[1], Zheng Cao[1], Baohua Jia[1], Ling Qiu[2], Dan Li[2], Min Gu[1]; *[1]Centre for Micro-Photonics and CUDOS, Swinburne Univ. of Technology, Australia; [2]Department of Materials Engineering, Monash Univ., Australia.* Planar C-shape arrays are fabricated on a high quality graphene oxide thin film using direct laser printing method. Minimum fabricated feature size is 500 nm, making the structures potentially useful for near infrared photonic devices.

FW2B.3 • 11:00

Optical Phase Control at the Nanometer Scale in Vanadium Dioxide, Alain Hache[1], Tran Vinh Son[1], Real Vallee[2], Cheikhou Ba[2], Gisia Beydaghyan[1]; *[1]Physics, Universite de Moncton, Canada; [2]COPL, Universite Laval, Canada.* Large refractive index changes during phase transition in vanadium dioxide are exploited to control the phase of a light at 1300 nm over distances of less than 100 nm without altering other properties of light.

10:30–12:00
FW2C • Quantum Optical Measurement and Quantum Technologies II

Presider: Alexander Sergienko, Boston Univ., USA

FW2C.1 • 10:30 Invited

Interfacing Optical Quantum Memories with Telecommunication Optical Fibres, Hugues de Riedmatten[1,2]; *[1]ICFO -The Inst. of Photonic Sciences, Spain; [2]ICREA, Spain.* We present experiments interfacing optical quantum memories based on rare-earth doped solids and cold atomic gases with telecom fibres, using a widely non degenerate quantum light source and an integrated optics quantum frequency conversion device.

FW2C.2 • 11:00

Observation of the temporal Talbot effect for entangled photons, Ogaga D. Odele[1], Joseph M. Lukens[1], Carsten Langrock[2], Martin M. Fejer[2], Daniel E. Leaird[1], Andrew M. Weiner[1]; *[1]Purdue Univ., USA; [2]Stanford Univ., USA.* We demonstrate the generation of two-photon correlation trains based on spectral filtering of broadband biphotons and for the first time verify the temporal Talbot effect for entangled photons.

10:30–11:45
FW2D • Long Wavelength Mid-IR to THz Fiber Devices II

Presider: Stuart Jackson; Macquarie Univ., Australia

FW2D.1 • 10:30 Invited

New Materials and Structures: Expanding the Properties of Optical Fibres, Daniel Lancaster[1], Tanya M. Monro[1]; *[1]Univ. of Adelaide, Australia.* The development of optical glasses and fibres with extended transmission and with novel emission characteristics will be described. Advances in optical fibre fabrication, new routes to introducing structure into the fibre cross-section, and a diverse range of new device architectures will be described.

FW2D.2 • 11:00

Comparison of Fluoroindate and Fluorozirconate Rare Earth Doped Glasses for Mid-IR Lasers, Richard S. Quimby[1], Mohammed Saad[2]; *[1]Worcester Polytechnic Inst., USA; [2]Thorlabs, USA.* Temperature dependent fluorescence lifetimes for Dy and Er doped fluoroindate and fluorozirconate glasses are measured and fit to multiphonon relaxation theory. The two glasses are more similar than expected, and Dy decays anomalously rapidly.

10:30–12:00
FW2E • Coherence and Polarization II

Presider: Amit Ashok; Univ. of Arizona, USA

FW2E.1 • 10:30 Tutorial

Passive and Active Polarization Imaging: Fundamentals, Phenomenology, and Systems, J. Scott Tyo[1]; *[1]Univ. of Arizona, USA.* This tutorial will review the fundamentals of sensing the vector nature of the optical field, explore phenomenology in applications ranging from microscopy to astronomy, and present state-of-the-art imaging polarimeters.

J. Scott Tyo is a professor in the College of Optical Sciences at the University of Arizona. He received the PhD degree form the University of Pennsylvania in 1997. He served from 1994-2001 in the US Air Force, and was in the ECE Department at the University of New Mexico from 2001-2006. Prof. Tyo directs the Advanced Sensing Lab at OSC, and his research interests span many areas of imaging and sensing including polarimetry, spectral imagery, and coherence at optical wavelengths. Prof. Tyo is a fellow of SPIE, OSA, and the IEEE.

FiO

10:30–11:00
FW2F • Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard II
Presider: Robert Zawadzki; Univ. of California Davis, USA

FW2F.1 • 10:30 Invited

The Limits of Human Vision, Josef Bille[1]; [1]*Ruprecht-Karls-Universitat Heidelberg, Germany.* Adaptive optics and femtosecond laser surgical systems have allowed the measurement and correction of the optical properties of the human eye, extending the knowledge of the limits of human vision.

10:30–11:45
FW2G • General Optics in Biology and Medicine III
Presider: Pietro Ferraro; Istituto Nazionale di Ottica (CNR), Italy

FW2G.1 • 10:30

Three-dimensional holographic tracking approach based on full-field complex wavefront matching, Pasquale Memmolo[1,2], Lisa Miccio[1], Francesco Merola[1], Paolo A. Netti[2], Pietro Ferraro[1]; [1]*CNR - Istituto Nazionale di Ottica, Italy;* [2]*Center for Advanced Biomaterials for HealthCare@CRIB, Istituto Italiano di tecnologia, Italy.* A new holographic tracking method capable to calculate, simultaneously and in a single step, all the spatial coordinates is presented. Experimental tests on trapped particles and living cells, flowing into a microfluidic channel, are accomplished.

FW2G.2 • 10:45

Low-Spatial Coherence Chaotic Cavity Laser for Speckle-Free Full-Field Imaging, Brandon Redding[1], Alexander Cerjan[1], Xue Huang[2], Douglas Stone[1], Minjoo Lee[2], Michael Choma[3,4], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA;* [2]*Electrical Engineering, Yale Univ., USA;* [3]*Diagnostic Radiology, Yale School of Medicine, USA;* [4]*Biomedical Engineering, Yale Univ., USA.* We demonstrate electrically-pumped semiconductor-based chaotic microcavity lasers. The cavity shape is designed to maximize the number of lasing modes, providing emission with low spatial coherence and high-power per mode for high-speed, speckle-free full-field imaging applications.

FW2G.3 • 11:00

Partially Coherent Deconvolution Tomography for Reconstructing Weakly Scattering Objects, Micah Jenkins[1], Thomas K. Gaylord[1]; [1]*Georgia Inst. of Technology, USA.* A novel algorithm is presented for reconstructing weakly scattering objects using partially coherent illumination. The method is validated using a photonic crystal fiber as a test object and will be useful for applications in biology.

11:00–12:00
FW3F • Low-cost Ophthalmic Instrumentation and Imaging
Presider: Ann Elsner; Indiana Univ., USA

FW3F.1 • 11:00 Invited

mobileVision: A Face-mounted, Voice-activated, Non-mydriatic "Lucky" Ophthalmoscope, Adam Samaniego[1], Vivek Boominathan[1], Ashutosh Sabharwal[1], Ashok Veeraraghavan[1]; [1]*ECE, Rice Univ., USA.* We present mobileVision, a portable, smartphone-based ophthalmoscopy system intended to reduce the barriers to ocular pathology screening in developing regions.

LS

10:30–12:00
LW2H • Quantum Information III
Presider: Julian Sweet, Air Force Research Laboratory, USA

LW2H.1 • 10:30 Invited

Quantitative Quantum Communication: Practical Realizations of Exponential Quantum Advantage, Juan Miguel Arrazola[1], Norbert Lutkenhaus[1]; [1]*Univ. of Waterloo, Canada.* Quantum Communication Complexity Theory discovered protocols showing significant advantage of quantum over classical communication using highly entangled states of qubits. We present a coding scheme that can realize the advantage using simple laser pulses.

LW2H.2 • 11:00 Invited

Experimental Realisation of a Measurement-based Noiseless Linear Amplifiers, Thomas Symul[1]; [1]*Australian National Univ., Australia.* I show that measurement based noiseless linear amplifier can extend the range of QKD, and then demonstrates it can be used to perform state amplification and cloning better than the best theoretically possible deterministic device.

10:30–12:00
LW2I • Solid-State Optical Physics
Presider: Ricky Gibson; Univ. of Arizona, USA

LW2I.1 • 10:30

Multiple-time-scale blinking and radiative efficiency of InAs/GaAs microcavity-quantum dot single photon sources, Marcelo I. Davanco[1,2], Carl S. Hellberg[3], Serkan Ates[1,2], Antonio Badolato[4], Kartik Srinivasan[1]; [1]*Center for Nanoscale Science and Technology, National Inst of Standards & Technology, USA;* [2]*Maryland Nanocenter, Univ. of Maryland, USA;* [3]*Center for Computational Materials Science, Code 6390, Naval Research Laboratory, USA;* [4]*Department of Physics and Astronomy, Univ. of Rochester, USA.* Photon correlations measured over 12 decades in time reveal multiple-time-scale blinking in InAs/GaAs microcavity-quantum dot single-photon sources and enable estimation of quantum dot radiative efficiency. Non-unity efficiencies suggest nanofabrication may produce traps responsible for blinking.

LW2I.2 • 10:45

Coherence Properties of a Single-Mode Polariton Laser, seonghoon kim[1], Bo Zhang[1], Zhaorong Wang[1], Christian Schneider[2], Sebastian Brodbeck[2], Sven Hofling[2], Martin Kamp[2], Hui Deng[1]; [1]*Univ. of Michigan, USA;* [2]*Univ. of Wuerzburg, Germany.* First and second-order coherence functions of a zero-dimensional microcavity are measured. In contrast to a two-dimensional system, intensity fluctuations of a polariton laser are significantly reduced.

LW2I.3 • 11:00

Withdrawn.

FW2A • Imaging—Continued

FW2A.4 • 11:15
Highly Sensitive and Linear Electron-injection Detectors at the Telecomm Wavelength, Vala Fathipour[1], Sung Jang[1], Robert Brown[1], Hooman Mohseni[1]; [1]*Northwestern Univ., USA*. We present results from electron-injection detectors showing un-gated detection of extremely low optical powers at telecomm-band. These devices show excellent linearity over 40 dB dynamic range and a noise equivalent sensitivity of 13 photons at 220K.

FW2A.5 • 11:30
Withdrawn.

FW2B • Materials for Integrated Photonic—Continued

FW2B.4 • 11:15
Withdrawn.

FW2B.5 • 11:30
Transparent and Nanostructred CdS Filsm for Integrated Systems in Facades, Ana L. Leal-Cruz[1], Alicia Vera-Marquina[1], Ignacio Zaldivar[3], Carlos I. Villa Velázquez Mendoza[2], Luis A. García[1], Benito R. Noeriga[1], Alejandro Garcia-Juarez[1], Dainet Berman Mendoza[1], Armando G. Rojas[1]; [1]*Departamento de Investigación en Fisica, Universidad de Sonora, Mexico;* [2]*Laboratorio de Micro y Nanomateriales, Universidad de Sonora, Mexico;* [3]*INAOE, Mexico*. The aim of this work is process and characterize transparent and semitransparent CdS nanostructured films via chemical bath deposition, with potential application in solar cells for integrated systems in facades.

FW2B.6 • 11:45
Optical properties of annealed CdS-nanostructured films for solar cells, Alicia Vera-Marquina[1], Ana Lilia Leal Cruz[1], Dainet Berman[1], Ignacio Zaldivar[2], Luis A. García[1], Alejandro García[1], Armando G. Rojas[1]; [1]*Investigación en Física, Universidad de Sonora, Mexico;* [2]*Electrónica, Instituto Nacional de Astrofísica, Optica y Electrónica, Mexico*. The effect of annealing process on optical properties of cadmium sulfide thin films is presented. Optical behavior of CdS thin films were evaluated by UV-Visible spectroscopy and band gap values were calculated by approximation using Tauc plot.

FW2C • Quantum Optical Measurement and Quantum Technologies II—Continued

FW2C.3 • 11:15
Nonlocal Wavefunction Collapse for a Single Particle Using Homodyne Measurement without Post-selection, Maria Fuwa[1], Shuntaro Takeda[1], Marcin Zwierz[2], Howard Wiseman[3], Akira Furusawa[1]; [1]*Applied Physics, The Univ. of Tokyo, Japan;* [2]*Physics, Univ. of Warsaw, Poland;* [3]*Physics, Griffith Univ., Australia*. We demonstrate the nonlocal wavefunction collapse for a single particle, the idea of which dates back to Einstein's first argument on his concerns about quantum theory, by performing EPR-steering using heralded single photons.

FW2C.4 • 11:30
Single-atom quantum switch for coherent light pulses, Andrew Parkins[1], Takao Aoki[2]; [1]*Univ. of Auckland, New Zealand;* [2]*Waseda Univ., Japan*. We propose a scheme for single-atom, quantum control of the direction of propagation of a multi-photon coherent optical pulse incident, via a tapered fiber, upon a microtoroidal whispering-gallery-mode resonator.

FW2C.5 • 11:45
Quantum State Manipulation of Single-Photon Wave Packets, Laura J. Wright[1], Michal Karpinski[1], Brian J. Smith[1]; [1]*Univ. of Oxford, UK*. We experimentally demonstrate deterministic modification of the spectral-temporal mode structure of quantum states of light. The method is based upon a unitary transformation implemented with electro-optic phase modulation and which preserves the non-classical nature of the single photon.

FW2D • Long Wavelength Mid-IR to THz Fiber Devices II—Continued

FW2D.3 • 11:15 Invited
Synthesis, Characterization and Applications of Mid-infrared Optical Fibers, Pierre Lucas[1]; [1]*Univ. of Arizona, USA*. Chalcogenide glasses constitute the only class of amorphous materials with full infrared transparency. The compositional landscape available to produce these glasses is large and offers a wide potential for optimizing the development of optical fibers.

FW2E • Coherence and Polarization II—Continued

FW2E.2 • 11:15 Invited
Bio-Inspired Spectral-Polarization Imaging Sensors for Medical Applications, Viktor Gruev[1,2]; [1]*Computer Engineering, Washington Univ. in St. Louis, USA;* [2]*Electrical Engineering, Washington Univ. in St Louis, USA*. Inspired by the vision system of several marine species, we have developed image sensor capable of recording all three fundamental properties of light by monolithically integrating metallic nanowires with vertically stacked photodetectors.

FW2E.3 • 11:45
Coherence engineering for microscopy, Laura Waller[1], Lei Tian[1]; [1]*Univ. of California Berkeley, USA*. We describe the connection between phase imaging methods that use illumination coherence patterning via coded illumination at the source plane. Our framework is in phase space, the wave-optical analogy to light field space-angle distributions.

12:00–13:30 Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*

12:00–13:30 JW3A • Joint Poster Session II, *Arizona Ballroom, Salons 1-7*

FiO

FW3F • Low-cost Ophthalmic Instrumentation and Imaging—Continued

FW3F.2 • 11:30 Invited

NETRA-G: Towards a Subjective Self-Refraction, Vitor Pamplona[1], Rahul Modi[1], Nadine Solaka[2], Hillary Gaiser[2], Ran He[2], Bruce Moore[2]; [1]*EyeNetra Inc, USA;* [2]*New England College of Optometry, USA.* We discuss NETRA-G's spherocylindrical self-refractions for teenagers. NETRA-G achieved accuracies of .48D on sphere and .30D on cylinder. Visual acuity was 20/20 or better in 70% of all cases and 20/25 or better for 90%.

FW2G • General Optics in Biology and Medicine III—Continued

FW2G.4 • 11:15

Multimodal Imaging of Breast Cancer Xenografts in a Mouse Mammary Window Chamber Model to Investigate Chemotherapy Response, Hui M. Leung[1,2], Rachel L. Schafer[3], Arthur F. Gmitro[1,2]; [1]*College of Optical Sciences, Univ. of Arizona, USA;* [2]*Department of Medical Imaging, Univ. of Arizona, USA;* [3]*Department of Biomedical Engineering, Univ. of Arizona, USA.* Multispectral imaging was used to follow blood oxygenation changes in breast cancer xenografts in mice treated with chemotherapy. The correlation between tissue perfusion, glycolytic metabolism and blood oxygenation was also investigated with nuclear and MR imaging techniques.

FW2G.5 • 11:30

Phase-sensitive Bloch surface wave sensing, Yuhang Wan[1], Liya Shu[1], Xuekun Zhu[1], Zheng Zheng[1]; [1]*School of Electronic and Information Engineering, Beihang Univ., China.* A detection scheme that leverages the sharp phase variation by the exitation of Bloch surface wave is demonstrated, which has good sensitivity and is ready to monitor fast signal changes due to its simple setup.

LS

LW2H • Quantum Information III—Continued

LW2H.3 • 11:30 Invited

Quantum Communication in Space, Rupert Ursin[1], Dominique Elser[2]; [1]*Austrian Academy of Sciences, Austria;* [2]*Max Planck Institute Science of Light, Germany.* I will present recent feasibility studies demonstrating quantum communication on ground, over a 140 km free-space link as well as studies proving the feasibility to perform such kind of experiments in space.

LW2I • Solid-State Optical Physics—Continued

LW2I.4 • 11:15

Excitonic Dark States in Single Atomic Layer of Transition Metal Dichalcogenide, Ziliang Ye[1], Ting Cao[1], Kevin O'Brien[1], Hanyu Zhu[1], Xiaobo Yin[1], Yuan Wang[1], Steven G. Louie[1], Xiang Zhang[1]; [1]*Univ. of California, USA.* We experimentally discover a series excitonic dark states in two-photon excitation spectra of single-layer WS2. The findings quantitatively agree with the calculated excitonic state and suggest a large exciton binding energy of 0.7 eV.

LW2I.5 • 11:30

Large Enhancement of Nonlinear Terahertz Absorption in Intrinsic GaAs by Plasmonic Nano-Antennas, Young-Gyun Jeong[1,2], Michael J. Paul[1], Seung-Hyun Kim[3,4], Ki-Ju Yee[3], Dai-Sik Kim[2], Yun-Shik Lee[1]; [1]*Physics, Oregon State Univ., USA;* [2]*Center for Subwavelength Optics and Department of Physics and Astronomy, Seoul National Univ., Republic of Korea;* [3]*Physics, Chungnam National Univ., Republic of Korea;* [4]*GRAST, Chungnam National Univ., Republic of Korea.* We demonstrate remarkably strong nonlinear THz effects in an intrinsic GaAs wafer patterned with a nanometer-width slot antenna array. The antenna near-field reaches 20 MV/cm due to the huge field enhancement in the plasmonic nano-structure.

LW2I.6 • 11:45

Self-Organized Emitters in a Single Broad Area Diode Laser by Wavelength-Selective Feedback, Nils Werner[1], Christof Zink[1], Andreas Jechow[1], Axel Heuer[1], Ralf Menzel[1]; [1]*Inst. of Physics and Astronomy, Photonics, Univ. of Potsdam, Germany.* Self-organized emitters are realized in a single broad area diode laser by utilizing a spectral beam combining external cavity. The wavelength-selective feedback yields to an array-like behavior with 38 independent emitters.

12:00–13:30 Unopposed Exhibit Only Time, *Arizona Ballroom, Salons 1-7*

12:00–13:30 JW3A • Joint Poster Session II, *Arizona Ballroom, Salons 1-7*

12:00–13:30
JW3A • Joint Poster Session II

JW3A.1
Spectroscopic Ellipsometry Investigation of Oxygen Impurities Influence on Cobalt, Olena Polianska[1], Vasyl S. Stashchuk[1]; [1]*Faculty of Physics, Chair of Optics, Taras Shevchenko National Univ. of Kyiv, Ukraine*. This work is devoted to investigations of Co - O compounds' optical properties by the Beatty spectroscopic ellipsometry method. The energy dependencies of optical characteristics were calculated using measured ellipsometry parameters and analysed.

JW3A.2
Angular and Azimuthal Ellipsometry of Indium Tin Oxide Films, Taras Hanulia[1], Leonid Poperenko[1], Olga Lopatynska[1], Vasyl Lendel[2]; [1]*Physics, Taras Shevchenko National Univ. of Kyiv, Ukraine;* [2]*The Faculty of Mechanics and Mathematics, Taras Shevchenko National Univ. of Kyiv, Ukraine*. We investigated the optical properties of indium tin oxide thin (ITO) films, produced by reactive magnetron sputtering. Ellipsometric parameters were determined by laser ellipsometer. The refractive index and thickness of ITO films were calculated.

JW3A.3
Feasibility Study of Localized Plasmon Based Raman Signal Enhancements Using Silver Nanoislands, hyerin song[1], Kyujung Kim[1]; [1]*Department of Cognitive Mechatronics Engineering, Pusan National Univ., Republic of Korea.* Varied-thick nanoislands fabricated by thermal annealing methods were used for Raman enhancements. For experiments, SERS of Au-NPs attached dsDNAs was measured on nanoislands. Consequently, we quantified the correlation factors between initial film thickness and SERS.

JW3A.4
Reflective Liquid Crystal Display Designed Optically for High Performance, Jin Seog Gwag[1], Gyu Jin Choi[1]; [1]*Department of Physics, Yeungnam Univ., Republic of Korea.* We propose a reflective liquid crystal designed optically with thicker cell gap which is preferred for high productibility. It consists of a half-wave retardation film, a quarter-wave film, and an LC cell.

JW3A.5
Color Schlieren Imaging with Monochromatic Sources, Jan L. Chaloupka[1]; [1]*Department of Physics and Astronomy, Univ. of Northern Colorado, USA.* Color, direction-indicating schlieren images are generated with a two-path system using monochromatic light. Two simultaneous views of physical processes are captured that can be combined into a single, synthesized color composite.

JW3A.6
Polarization Independent Tunable Band Pass Filter in Terahertz Regime, Han-Wei Zhang[1], Po-Sheng Fang[1], Hsuan-Yin Chen[1], Chuck Lee[1]; [1]*Photonics, National Sun Yat-sen Univ., Taiwan*. In this work, using choleseric liquid crystal, we demonstrate a polarization independent tunable THz band pass filter based on one-dimensional photonic crystal cavity.

JW3A.7
Freeform Diffractive Structure Writing through Maskless Lithography, Lee Johnson[1], Melissa Zaverton[1], Tyler Hashimoto[1], Tom Milster[1], Youngsik Kim[1], Alex Felli[1]; [1]*Optical Sciences, The Univ. of Arizona, USA.* Printing of diffractive structures on 3D surfaces has been demonstrated using focal adjustment during i-line maskless lithography. A diffractive pupil for asymmetric astrometric distortion correction was fabricated on spherical mirrors with diameters up to 50mm.

JW3A.8
Adaptive Optics Systems at the Large Binocular Telescope, Julian C. Christou[1], Simone Esposito[4], Sebastian Rabien[2], Tom Herbst[5], Phil Hinz[3], John Hill[1], Douglas Miller[1], Gustavo Rahmer[1], Guido Brusa[1], Juan C. Guerra[1], Mark R. Wagner[1], Christian Veillet[1]; [1]*Large Binocular Telescope Observatory, USA;* [2]*Max-Planck-Institut für extraterrestrische Physik, Germany;* [3]*Steward Observatory, Univ. of Arizona, USA;* [4]*Arcetri Astrophysical Observatory, Italy;* [5]*Max-Planck-Institut für Astronomie, Germany.* We describe the different Adaptive Optics systems on the Large Binocular Telescope making use of the adaptive secondary mirrors and different wavefront sensors. System performances will be discussed.

JW3A.9
Subsurface Damage Characterization with Nonlinear High Numerical Microscopy, Phat Lu[1], Tom Milster[1]; [1]*Coll. of Optical Sciences, Univ. of Arizona, USA.* Sub-surface damage characterization occurs in semiconductor device fabrication, like diamond turning and milling. Third harmonic generation (THG) microscopy can help to characterize subsurface damage, because nanometer sized asperities caused by defects amplify the THG signal.

JW3A.10
Coherence Imaging in LED Holographic Reconstruction, Jian-Wen Dong[1]; [1]*Physics and Engineering, Sun Yat-Sen Univ., China.* We will show you the new method on encoding CGH by introducing fast Fourier transform and affine transform, and also analyze the coherence of LED reconstructed light in order to improve the image quality.

JW3A.11
Resonant and Non-Resonant Operations in Double-Groove Gratings, Kota Ito[1], Takayuki Matsui[1], HIDEO IIZUKA[1]; [1]*Toyota Central R&D Labs, Japan*. We compare roles of propagating modes in resonant and non-resonant dielectric double-groove gratings that exhibit spatially asymmetric diffraction phenomena by accounting for the mode profiles and the coupling strength between the modes and diffraction orders.

JW3A.12
Label - free Fluorescence Lifetime Imaging of Microfluidic Device Based Three-dimensional Cardiac Tissue Metabolism, Rupsa Datta[1], Christopher Heylman[1], David Tran[1], Steven C. George[1], Enrico Gratton[1]; [1]*Univ. of California Irvine, USA.* In this work, we show mapping of metabolic activity and non-invasive monitoring of drug response of a microphysiological tissue system in a PDMS microfluidic device chamber by fluorescence lifetime imaging of NADH, an endogenous fluorophore

JW3A.13
Cholesterol Crystals with Gold Nanoparticles: Photothermally Induced Effects, Lilia C. Courrol[1], Ricardo E. Samad[2]; [1]*Universidade Federal de São Paulo (UNIFESP), Brazil;* [2]*IPEN/CNEN-SP, Brazil.* Gold nanoparticles embedded in cholesterol crystals promote localized heating under intense light illumination at the surface plasmon resonance absorption band, allowing material displacement from their original position, showing potential applications in cardiology.

JW3A.14
Proposal of a new imaging method with trapped gold nano particles and the properties of multi-photon emission, Akira Eguchi[1,3], Phat Lu[1], Tom Milster[1], Koen Visscher[2]; [1]*College of Optical Sciences, The Univ. of Arizona, USA;* [2]*Department of Physics, The Univ. of Arizona, USA;* [3]*Canon Inc, Japan*. We propose a new concept to obtain a super-resolution resolution image with optically trapped gold nano particles (GNPs) and multi-photon emission (MPE). The properties of MPE from GNPs are described.

JW3A.15
Development of Optical Microscopy with a 121.6 nm Source, Thiago Jota[1], Youngsik Kim[1], Dolaphine Kwok[1], Tom Milster[1], Dakota S. Luepke[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* A new microscope with a Hydrogen Lyman-α source at 121.6 nm is presented with respect to its initial development. Advances in the optical and mechanical design, tolerancing, and practical solutions are presented.

JW3A.16
Combination of structural and functional examination techniques of cellular cultures, Maria Muravyeva[1], Yuri Zakharov[1]; [1]*General physics, UNN of Lobachevsky, Russian Federation*. Upgrade of a laser scanning microscope was made for expansion of standard research methods. An opportunity of digital holograms recording in scanning operating mode of a microscope in parallel with Calcium imaging technique was achieved. Mathematical simulation was given.

JW3A.17
Resolution Enhancement in Two-photon Microscopy by Applying Structured Line Illumination, Chi-Deng Lin[1], Chia-Hua Yeh[1], Szu-Yu Chen[1]; [1]*National Central Univ., Taiwan*. To enhance the resolution of two-photon microscopy, structured illumination was applied with a line scanning geometry. Using the square proportionality between two-photon emission and excitation intensity, a ~3-fold resolution improvement was shown in the results.

JW3A.18
Numerical investigation of plasmonic near-field localization by simple nanoapertures for subwavelength imaging, Wonju Lee[1], Kyujung Kim[2], Donghyun Kim[1]; [1]*School of Electrical and Electronic Engineering, Yonsei Univ., Republic of Korea;* [2]*Department of Nanofusion Technology, Pusan National Univ., Republic of Korea.* Localization properties by various nanoapertures were explored in the near field for applications in super-resolved fluorescence imaging. The smallest and most symmetric field on the scale of 50-100 nm was obtained by square nanoapertures.

JW3A.19
Slow-light generation and waveform correction via Brillouin scattering in tellurite fiber, Kenshiro Nagasaka[1], Guanshi Qin[2], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Research Center for Advanced Photon Technology, Toyota Technological Inst., Japan;* [2]*State Key Laboratory on Integrated Optoelectronics, College of Electronic Science and Engineering, Jlin Univ., China.* Slow-light generation and waveform correction are theoretically investigated in tellurite fiber. Our results shows that a minimum pulse broadening factor of 0.93 with an acceptable pulse distortion for 80 ns incident Gaussian pulse is achieved by optimizing the doublet Brillouin gain lines.

JW3A.20
Application of Photonic crystal Fiber Sagnac loop in DWDM as a Flat top Comb-Filter, Santosh Kumar[1], Ajay Kumar, Sanjeev K. Raghuwanshi; [1]*Indian School of Mines, India.* The paper includes the theoretical demonstration of optical comb filter based on the Sagnac loop interferometer of Photonic Crystal Fiber. These types of devices can be advantageous for the Dense Wavelength division Multiplexing (DWDM) applications.

JW3A.21
An Elliptical Core Birefringence Tellurite Microstructured Optical Fiber, Dinghuan Deng[1], Daisuke Sega[1], Tonglei Cheng[1], Weiqing Gao[1], Xiaojie Xue[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Research Center for Advanced Photon Technology, Toyota Technological Inst., Japan.* An elliptical core birefringence tellurite microstructured optical fiber was demonstrated and experimentally characterized by a white light spectral interferometric technique over a wide spectral range.

JW3A • Joint Poster Session II—Continued

JW3A.22
Phase Fluctuation Extraction from Optical Frequency-Domain Reflectometry, Mudabbir Badar[1], Iwashita Katsushi[1]; [1]*Department of Electronics and Phonics Systems Engineering, Kochi Univ. of Technology, Japan*. We have given a novel method to extract phase noise from optical frequency domain reflectrometry (OFDR), which can be used to cancel the phase noise in OFDR or it can be used to measure laser parameters i.e. laser linewidth.

JW3A.23
A broadband linearization in microwave photonics link based on integrated parallel Mach-Zehnder modulator, Jian Li[1], Song Yu[1], Wanyi Gu[1]; [1]*State Key Laboratory of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, China*. A broadband linearized microwave photonics link is presented based on integrated parallel Mach-Zehnder modulator with single sideband modulation. IMD3 and second-order distortions are linearized simultaneously. Power fading problem is also effectively eliminated.

JW3A.24
Isolated Polarization Singularities in Optical Beams, Enrique J. Galvez[1], Brett L. Rojec[1], Kory Beach[1]; [1]*Physics and Astronomy, Colgate Univ., USA*. We demonstrate a method to produce optical beams with any type of C-point polarization singularity. We also propose a spherical representation that maps all types of C-points onto points on the surface of the sphere.

JW3A.25
Multiple Image Reconstruction in Arbitrary Position Using Double-Phase Retrieval And Modulation Schemes, Hsuan-Ting Chang[1], Che-Hsien Lin[1], Chien-Yue Chen[1]; [1]*National Yunlin Univ of Science and Tech, Taiwan*. We proposed an algorithm of reconstructing multiple images with the double phase-only-function architecture based on the double phase retrieval and modulation algorithms in the Fresnel transform domain. In addition, the low crosstalk among the reconstructed images is achieved.

JW3A.26
Silicon Nitride 1x8 Power Splitter for Mid-Infrared Applications, Jianwei Mu[1], Pao-Tai Lln[1], Lin Zhang[1], Xiaoman Duan[1], Anuradha M. Agarwal[1], Lionel C. Kimerling[1]; [1]*M.I.T, USA*. We present a silicon nitride 1x8 power splitter based on a multimode interference coupler for mid infrared wave applications. Simulation shows a 9.3 dB insertion loss over a broad wavelength range (70 nm)

JW3A.27
Nonlinear optical effects in hybrid a:Si-liquid crystal device, Beatriz A. Martínez Irivas[1], Maximino L. Arroyo[1], Marcela M. Mendez[1], Ruben Ramos-Garcia[1,2], David Iturbe[1,2]; [1]*BUAP, Mexico;* [2]*INAOE, Mexico*. Abstract. Nonlinear refractive index and nonlinear absorption of hybrid device are measured with the Z-scan. The space charge field produced in the a:Si reorients the L.C. Both responses can be obtained at mW power levels.

JW3A.28
Antimony Sulfoiodide as Novel Material for Photonic Crystals, Anna Starczewska[1], Marian Nowak[1], Piotr Szperlich[1], Iwona Bednarczyk[2], Krystian Mistewicz[1], Miroslawa Kepinska[1], Piotr Duka[1]; [1]*Inst. of Physics - Center for Science and Education, Silesian Univ. of Technology, Poland;* [2]*Department of Materials Science, Silesian Univ. of Technology, Poland*. Semiconducting ferroelectrics promise construction of crystals with tuned photonic band gap. Such structures were synthesized by self-assembling SiO2 spheres, followed by melt infiltration with antimony sulfoiodide and the removal of SiO2 spheres by chemical etching.

JW3A.29
Plasmonic Photocatalyst for Photodegradation with Spinning Optical Disk Reactor, Wen Ting Hsieh[1], Yu Lim Chen[1], I Da Jiang[1], Li Chung Kuo[1], Min Lun Tseng[2], Hao Ming Chen[1,3], Chih Kai Chen[3], Hung Ji Huang[4], Ru-Shi Liu[3], Din Ping Tsai[1,5]; [1]*Department of Physics, National Taiwan Univ., Taiwan;* [2]*Graduate Inst. of Applied Physics, National Taiwan Univ., Taiwan;* [3]*Department of Chemistry, National Taiwan Univ., Taiwan;* [4]*Instrument Technology Research Center, National Applied Research Laboratories, Taiwan;* [5]*Research Center for Applied Sciences, Academia Sinica, Taiwan*. An efficient and novel photocatalytic reactor for environmental treatment was fabricated with zinc oxide nanorods growing on optical disk substrate as the photocatalyst. Plasmonic photocatalysis was also demonstrated to enhance the photodegradation efficiency.

JW3A.30
Electronic spectra and lateral photocurrent in Si/Ge heterostructures with quantum dots, Yurii Hyrka[1], Serhiy Kondratenko[1]; [1]*Chair of optics, OSA Student chapter, Ukraine*. The work generalizes the results of studies of morphological, optical and electrical properties of SiGe/Si nanoheterostructures. It is shown that the photoconductivity of nanoheterostructures SiGe/Si in the infrared range.

JW3A.31
Compact Two-Dimensional Multipass GaAs Optical Cavity with a Long Path Length, Takehiro Fukushima[1], Susumu Shinohara[2], Satoshi Sunada[3], Takahisa Harayama[4], Kenichi Arai[2], Kazuyuki Yoshimura[2], Koichiro Sakaguchi[1], Yasunori Tokuda[1]; [1]*Department of Information and Communication Engineering, Okayama Prefectural Univ., Japan;* [2]*NTT Communication Science Laboratories, NTT Corporation, Japan;* [3]*Faculty of Mechanical Engineering, Kanazawa Univ., Japan;* [4]*Department of Applied Physics, Waseda Univ., Japan*. We fabricated and tested a compact multipass GaAs optical cavity with a round-trip path length of approximately 3.7 mm. The optical light injected into the cavity was found to propagate along a stable ray trajectory.

JW3A.32
Refractive index sensor based on slow light in photonic crystal on SOI platform, Preeti Rani[1], Yogita Kalra[1], Ravindra K. Sinha[1]; [1]*Delhi Technological Univ., India*. We report the slow light enhanced photonic crystal sensor to measure sucrose concentration in (PAm)-hydrogel sucrose solution. The proposed structure arrangement on SOI platform can also behave as a refractive index sensor.

JW3A.33
All-optical switching of Pendellösung effect in 1D porous silicon photonic crystal, Vladimir B. Novikov[1], Sergey E. Svyakhovskiy[1], Boris I. Mantsyzov[1], Anton I. Maydykovskiy[1], Tatiana V. Murzina[1]; [1]*Quantum electronics, M. V. Lomonosov Moscow State Univ., Russian Federation*. Optical switching of the Pendellözung effect in a porous silicon 1D photonic crystal at Bragg diffraction in Laue geometry is observed experimentally under an external optical illumination or direct thermal heating.

JW3A.34
Metal-dielectric Structure Anti-Reflective Coating in the Mid-Wave Infrared, Joshua Hendrickson[1], Nima Nader[2], Boyang Zhang[3], Hou-tong Chen[4], Junpeng Guo[3]; [1]*Sensors Directorate, US Air Force Research Laboratory, USA;* [2]*Solid State Scientific Corporation, USA;* [3]*Department of Electrical and Computer Engineering, Univ. of Alabama in Huntsville, USA;* [4]*Center for Integrated Nanotechnologies, Los Alamos National Laboratory, USA*. A subwavelength metal-dielectric structure for anti-reflection in the mid-wave infrared regime has been designed and experimentally verified. Applied to high index germanium substrates, less than 5% power reflection is achieved over a wide angular range.

JW3A.35
An Integrated-Design Approach to Shorter Wavelength Quantum Cascade Lasers, Gregory Triplett[1]; [1]*Univ. of Missouri-Columbia, USA*. In this work, we explore a novel approach that incorporates lasing and nonlinear conversion within the same QCL waveguided region using orientation-patterned substrates. The synthesis of these integrated devices and initial results are presented.

JW3A.36
Phase response of guided mode resonances, Michael J. Theisen[1], Thomas G. Brown[1]; [1]*The Inst. of Optics, USA*. We analyze, and measure, the phase response of guided mode resonant structures. We consider designs based on grating coupled leaky modes in a silicon on insulator platform. Modes near cutoff show strong amplitude and phase anomalies.

JW3A.37
Optical performance with multi-zone multifocal designs with natural and corrected ocular aberrations, Maria Vinas[1], Carlos Dorronsoro[1], Susana Marcos[1]; [1]*Visual Optics & Biophotonics Lab, Instituto De Optica (CSIC), Spain*. We evaluate though-focus optical quality and depth of focus with presbyopic multizone corrections of radial/ and angular zones. The effect of the natural aberrations and its correction on their performance was also explored.

JW3A.38
Intraocular Retinal Prostheses: Monocular Depth Perception in the Low Resolution Limit, Noelle R. Stiles[1], Ben McIntosh[2], Armand R. Tanguay[3], Mark S. Humayun[4]; [1]*Computation and Neural Systems, California Inst. of Technology, USA;* [2]*Electrical Engineering-Electrophysics, Univ. of Southern California, USA;* [3]*Electrical Engineering-Electrophysics, Chemical Engineering and Material Science, Biomedical Engineering, Opthalmology, Physics and Astronomy, and Neuroscience Graduate Program, Univ. of Southern California, USA;* [4]*Opthalmology, Cell and Neurobiology, and Biomedical Engineering, Univ. of Southern California, USA*. Depth perception via monocular cues was studied with a reach and grasp task in a retinal prosthesis simulator at low resolution. Results indicate that depth perception may be possible with retinal prostheses implanted only monocularly.

JW3A.39
Treatment of Biodiesel Contaminants Through Solar Photo-Fenton Oxidation Using a Stand-Alone Photovoltaic System, Miriam F. Oliveira[1], Whelton B. Santos[1], Fernando F. Vieira[1], Geralda C. Lima[1], Carlos P. Lima[1], Tâmara P. de Oliveira[1]; [1]*Departamento de Física / Engenharia, Universidade Estadual da Paraíba, Brazil*. Biodiesel effluents were treated via photo-Fenton oxidation absorbing sunlight through a catalytic reactor connected to a stand-alone photovoltaic system, decreasing of almost 34% the biodiesel contaminants while storing energy to aid the whole process.

JW3A.40
3-D Analysis of Pinhole Size Optimization for a Confocal Signal-based Wavefront Sensor, Md. Atikur R. Jewel[1], Vyas Akondi[1], Brian Vohnsen[1]; [1]*Univ. College Dublin, Ireland*. The performance of a confocal signal-based wavefront sensor is determined by the chosen pinhole. Here, a numerical 3-D analysis has been performed to find the most appropriate pinhole for the wavefront sensing.

13:30–15:30
FW4A • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning II

Presider: John Koshel; College of Optical Sciences/Univ Arizona, USA

FW4A.1 • 13:30 Invited

Integrated Impedance-matched Photonic Dirac-cone Metamaterials, Yang Li[1]; [1]*Harvard Univ., USA.* We experimentally demonstrate zero index of an in-plane Dirac-cone metamaterial at 1550 nm. This design can serve as an on-chip platform to explore the exotic physics of Dirac-cone metamaterials and its applications in integrated photonics.

FW4A.2 • 14:00

Withdrawn.

13:30–15:30
FW4B • Integrated Photonics

Presider: Dieter Knoll; IHP GmbH, Germany

FW4B.1 • 13:30 Invited

Agile Silicon Photonic Systems for Sensing and Telecommunications, Axel Scherer[1]; [1]*California Inst. of Technology, USA.* This talk will discuss agile silicon photonic systems for sensing and telecommunications.

FW4B.2 • 14:00 Invited

Silicon Nitride Optomechanical Crystals, Kartik Srinivasan[1], Marcelo I. Davanco[1], Karen Grutter[1]; [1]*National Inst of Standards & Technology, USA.* We present silicon nitride optomechanical crystals where few GHz frequency phonons and 980 nm wavelength photons coherently interact. Fabrication improvements, cryogenic testing, and optimized geometries for multimode applications like quantum frequency conversion will be discussed.

13:30–15:30
FW4C • Quantum Optical Measurement and Quantum Technologies III

Presider: Fabio Sciarrino; Universita degli Studi di Roma La Sapienza, Italy

FW4C.1 • 13:30 Invited

Entanglement and Simplified Quantum Information Operations, Raj Patel[1], Sacha Kocsis[1], Joseph Ho[1], Adam Bennet[1], Franck Ferreyrol[1,3], Michael W. Hall[1], Tim Ralph[2], Geoffrey Pryde[1]; [1]*Griffith Univ., Australia;* [2]*The Univ. of Queensland, Australia;* [3]*Institut d'Optique, France.* We report a linear optical Fredkin gate using an entanglement resource and an expanded Hilbert space. Additionally we demonstrate verification of weak entanglement which does not require trust in the measurement devices or their operators.

FW4C.2 • 14:00

Demonstration of Dynamic Squeezing Gate for Continuous-Variable Quantum Information Processing, Hisashi Ogawa[1], Kazunori Miyata[1], Hidehiro Yonezawa[2], Petr Marek[3], Radim Filip[3], Akira Furusawa[1]; [1]*Applied Physics, The Univ. of Tokyo, Japan;* [2]*Engineering and Information Technology, The Univ. of South Wales, Australia;* [3]*Optics, Palacký Univ., Czech Republic.* We report demonstration of a dynamically controllable squeezing gate for a dynamically changing input state. This gate can follow changes of MHz order and can be used as a feedforward in teleportation-based non-Gaussian quantum gate.

13:30–15:15
FW4D • Novel Fiber And Communications Devices

Presider: TMisha Brodsky; AT&T Labs, USA

FW4D.1 • 13:30

The Optical Capacitor : A Cavity with an extended broad-band mode using chirped fiber-Bragg gratings, Sébastien Loranger[1], Mathieu Gagné[1], Raman Kashyap[1,2]; [1]*Engineering Physics, Polytechnique Montreal, Canada;* [2]*Electrical Engineering, Polytechnique Montreal, Canada.* We present a novel cavity using chirped fiber Bragg gratings in which an oscillating mode's wavelength dependency is eliminated making. Unlike a Fabry-Perot resonator, this cavity has no frequency constraints within the operating bandwidth.

FW4D.2 • 13:45

Wireless transmission systems using a microwave carrier of 5 GHz generated with a DFB laser biased in the low laser threshold current region, Alejandro Garcia-Juarez[1], Ignacio Zaldivar[2], María del Rocío Gómez Colín[1], Luis A. García[1], Ana Lilia Leal Cruz[1], Alicia Vera-Marquina[1], Armando G. Rojas[1], Roberto Gómez Fuentes[1], Dainet Berman Mendoza[1]; [1]*Departamento de Investigación en Física, Universidad de Sonora, Mexico;* [2]*Departamento de Electrónica, Instituto Nacional De Astrofísica Óptica y Electrónica, Mexico.* A wireless transmission system using a couple of CPW-fed G-shaped monopole antennas is reported in this paper. The microwave carrier is generated with a DFB laser biased in the low laser threshold current region.

FW4D.3 • 14:00

Electrical Power Setting for Optical Single Side-band Millimeter-wave Generation, Maryam Niknamfar[1], Mehdi Shadaram[1]; [1]*Electrical and Computer Engineering, Univ. of Texas at San Antonio, USA.* A scheme is suggested to generate single side-band millimeter-wave signal. Mathematical analysis is considered for electrical power adjustment. Two Mach-Zehnders are used to up-convert the radio frequency to the 60 GHz range.

13:30–15:30
FW4E • Symposium on Laser Particle Acceleration and Novel Acceleration Methods I

Presider: Laszlo Veisz; Max-Planck-Institut fur Quantenoptik, Germany

FW4E.1 • 13:30 Invited

Laser Accelerator on a Chip (>300MeV/m): A Path to TeV Energy Scale Physics and Table Top Coherent X-rays, Robert L. Byer[1]; [1]*Stanford Univ., USA.* We report on the first observation and progress of high-gradient acceleration of electrons in lithographically fabricated dielectric micro-structures. Accelerators on a chip enable attosecond physics from the XUV to the X-ray region in the near term and open the possibility of TeV energy scale physics in the future.

FW4E.2 • 14:00 Invited

Development of a High Repetition Rate Laser-plasma Accelerator for Application to Ultrafast Electron Diffraction, Jerome Faure[1], Benoit Beaurepaire[1], Agustin Lifschitz[1], Zhaohan He[2], Alexander Thomas[2], Karl Krushelnick[2]; [1]*LOA, France;* [2]*Univ. of Michigan, USA.* We are developing a laser-wakefield accelerator operating at kHz repetition rate and producing electron bunches suitable for electron diffraction. We will show first experimental results and plans for increasing energy to the 5 MeV level.

FiO

13:30–15:00
FW4F • Ocular Aberrations and Wavefront Sensing
Presider: Melanie Campbell; Univ. of Waterloo, Canada

FW4F.1 • 13:30 Invited
Evolution of Ocular Wavefront Sensing, Jim Schwiegerling[1]; [1]*Univ. of Arizona, USA.* Techniques for measuring ocular aberrations have evolved over the past few decades. These techniques and their capabilities and limitations are explored.

FW4F.2 • 14:00 Invited
Wavefront Aberrations of the Eye During the Development of Refractive Error, Nancy J. Coletta[1], Susana Marcos[2], David Troilo[3]; [1]*Vision Science, New England College of Optometry, USA;* [2]*Instituto de Optica, CSIC, Spain;* [3]*College of Optometry, SUNY, USA.* Higher-order aberrations of marmoset eyes were measured during visual experience with lenses or occluders. Treated eyes had increased asymmetric aberrations, implying that alignment of the eye's optical surfaces requires normal visual experience during development.

13:30–15:30
FW4G • Microscopy and OCT II
Presider: Sava Sakadzic; Harvard Medical School, USA

FW4G.1 • 13:30
Wide-field axial plane optical microscopy, Tongcang Li[2,3]; Sadao Ota[2,3]; Jeongmin Kim[1,3]; Zi Jing Wong[1,3]; Yuan Wang[2,3]; Xiaobo Yin[4]; Xiang Zhang[2,3]; [1]*Department of Mechanical Engineering, Univ. of California, USA;* [2]*NSF Nanoscale Science and Engineering Center, Univ. of California, USA;* [3]*Materials Sciences Division, Lawrence Berkeley National Laboratory, USA;* [4]*Department of Mechanical Engineering, Univ. of Colorado, USA.* We present axial plane optical microscopy (APOM) that enables wide-field imaging of samples along an axial plane perpendicular to the focal plane of the microscope's objective lens.

FW4G.2 • 13:45
Superresolution Two-photon Image with Quasi-comb Structured Illumination, Chia-Hua Yeh[1], Szu-Yu Chen[1], Cheng-En Tan[1]; [1]*National Central Univ., Taiwan.* To improve the lateral resolution of two-photon microscopy (TPM), quasi-comb intensity modulation is applied to point-scanning two-photon microscopy to perform structured illumination. The theoretical models were established and a 1.85-fold resolution improvement was successfully demonstrated.

FW4G.3 • 14:00
High-Sensitivity Quantitative Phase Microscopy Using Spectral Encoding, Ruibo Shang[1], Shichao Chen[1], Yizheng Zhu[1]; [1]*Virginia Tech, USA.* A quantitative phase microscope is demonstrated using spectrally-encoded interferometric phase modulation. The technique offers speckle-free, high sensitivity (~0.14nm) optical pathlength measurement at high acquisition speed. It is well suited for precise quantification of dynamic processes.

LS

13:30–15:30
LW4H • Resonators and Photonic Crystals III
Presider: Alexander Poddubny; Ioffe Inst., Russian Federation

LW4H.1 • 13:30 Invited
Nanocavity and Nanobeam Waveguide Optomechanics, Paul E. Barclay[1]; [1]*Physics and Astronomy, Univ. of Calgary, Canada.* Recent demonstrations of optical nanocaviities optimized for torque sensing, and diamond based nanobeams designed for coupling to diamond nitrogen vacancy centers will be presented. Their application to sensing and quantum optics applications will also be reviewed.

LW4H.2 • 14:00 Invited
Coupling Spins in Quantum Dots to Photonic Crystal Cavities, Sam Carter[1], Timothy M. Sweeney[2], Patrick M. Vora[2], Mijin Kim[3], Chul Soo Kim[1], Lily Yang[2], Peter G. Brereton[4], Dmitry Solenov[2], Sophia E. Economou[1], Thomas L. Reinecke[1], Allan S. Bracker[1], Dan Gammon[1]; [1]*Naval Research Laboratory, USA;* [2]*NRC Research Associate at the Naval Research Laboratory, USA;* [3]*Sotera Defense Solutions, Inc., USA;* [4]*US Naval Academy, USA.* We have incorporated charge-controlled quantum dots and pairs of coupled dots into photonic crystal cavities and made use of the spin degree of freedom. Optical measurements demonstrate potential as a spin-photon interface and photon source.

13:30–15:15
LW4I • Filamentation II
Presider: Andre Mysyrowicz; LOA, France

LW4I.1 • 13:30 Invited
Air Waveguides Generated by Femtosecond Filaments, Jared K. Wahlstrand[1], Nihal Jhajj[1], Eric Rosenthal[1], Reuven Birnbaum[1], Howard M. Milchberg[1]; [1]*Univ. of Maryland at College Park, USA.* Femtosecond filaments deposit energy in gases, producing a significant hydrodynamic response. We harness this effect to generate an optical waveguide in air with a millisecond lifetime and use it to guide a delayed laser pulse.

LW4I.2 • 14:00 Invited
Rogue Events in the Atmospheric Turbulence of Multifilaments, Gunter Steinmeyer[1], S. Birkholz[1], C. Brée[2], A. Demircan[3]; [1]*Max Born Inst., Germany;* [2]*Weierstrab-Institut fur Angewandte Analysis und Stochastik, Mohrenstr, Germany;* [3]*Institut für Quantenoptik, Leibniz-Universitat Hannover, Germany.* The appearance of short-lived flashes in the transverse plane of multifilaments is discussed. These flashes follow a heavy-tail fluence distribution and are intimately related to atmospheric turbulence in a gas cell.

FW4A • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning II—Continued

FW4A.3 • 14:15
Rotational symmetry and nanoparticle oligomers as a platform for Fano resonances and chirality, Ben Hopkins[1], Alexander N. Poddubny[2,3], Andrey E. Miroshnichenko[1], Yuri S. Kivshar[1,3]; *[1]Nonlinear Physics Centre, Australian National Univ., Australia; [2]Ioffe Physical-Technical Inst. of the Russian Academy of Sciences, Russian Federation; [3]National Research Univ. for Information Technology, Mechanics and Optics, Russian Federation.* The regime of strong coupling is often avoided when designing nanoparticle scattering systems. Here we show that discrete rotational symmetry enables simple mode analysis of such systems, allowing design of chiral interference and Fano resonances..

FW4A.4 • 14:30
Long Lifetime Optical Recording in Gold-nanorod-dispersed Organically Modified Ceramic Nanocomposites, Qiming Zhang[1], Zhilin Xia[2,3], Xiangping Li[1], Yi-Bing Cheng[2], Min Gu[1]; *[1]Swinburne Univ. of Technology, Australia; [2]Department of Materials Engineering, Monash Univ., Australia; [3]School of Materials Science and Engineering, Wuhan Univ. of Technology, China.* Gold nanorods have been incorporated into organically modified ceramic nanocomposites for long lifetime optical recording. An enhancement in the thermal stability of gold nanorods and hence the lifetime of recorded information have been demonstrated.

FW4A.5 • 14:45
Withdrawn.

FW4B • Integrated Photonics—Continued

FW4B.3 • 14:30
Operation bandwidth of forward stimulated Brillouin scattering in silicon Brillouin active membrane waveguides, Heedeuk Shin[1], Jonathan Cox[2], Robert Jarecki[2], Andrew Starbuck[2], Wenjun Qiu[3], Zheng Wang[4], Peter Rakich[1]; *[1]Applied Physics, Yale Univ., USA; [2]Sandia National Laboratories, USA; [3]Physics, MIT, USA; [4]Electrical and computer engineering, Univ. of Texas at Austin, USA.* We studied the operation bandwidth of forward SBS with the optical waveguide width in Brillouin-active-membrane waveguides. Narrow waveguide width yields Brillouin features over wide frequency range, but waveguides with broad width induce less nonlinear absorption.

FW4B.4 • 14:45
Tapered air-core Bragg waveguides for spectrally resolved fluorescence detection on a chip, Aaron D. Melnyk[1], Torrey Thiessen[1], Brian Drobot[1], Trevor Allen[1], Ray DeCorby[1]; *[1]Univ. of Alberta, Canada.* We describe a microspectrometer based on a tapered channel Bragg waveguide, and show that it is well-suited to spectrally resolved fluorescence detection in optofluidic micro-systems. Experimental results for small-volume emitters (fluorescent beads) are reported.

FW4C • Quantum Optical Measurement and Quantum Technologies III—Continued

FW4C.3 • 14:15
Characterization of Hong-Ou-Mandel Bunched States by Quantum Homodyne Tomography, Yosuke Hashimoto[1], Makino Kenzo[1], Jun-ichi Yoshikawa[1], Hideaki Ohdan[1], Peter van Loock[2], Akira Furusawa[1]; *[1]Department of Applied Physics, School of Engineering, The Univ. of Tokyo, Japan; [2]Inst. of Physics, Johanes Gutenberg-Universität Mainz, Germany.* We experimentally demonstrate quantum homodyne tomography of Hong-Ou-Mandel bunched states, which are created by dynamically adjusting emission timings of two heralded single photons using coupled cavities.

FW4C.4 • 14:30
Tomographic measurement of a (105 x105)-dimensional entangled state, Eliot Bolduc[1], Genevieve Gariepy[1], Jonathan Leach[1]; *[1]Physics, Inst. of Physics and Quantum Sciences, UK.* We report on a novel method for the efficient characterization of high-dimensional pure quantum states and show the results of its application on a spatially entangled state generated through SPDC.

FW4C.5 • 14:45
Coherence Area Profiling in Multi-Spatial-Mode Squeezed States, Benjamin Lawrie[1], Raphael Pooser[1]; *[1]Quantum Information Science Group, Oak Ridge National Laboratory, USA.* Sub-shot-noise microcantilever displacement sensitivity achieved with multi-spatial-mode squeezed light requires unprecedented spatial control of the quantum-correlated modes. We demonstrate a simple approach to map these modes, enabling sub-shot noise microcantilever displacement measurements.

FW4D • Novel Fiber And Communications Devices—Continued

FW4D.4 • 14:15
All-fiber Tunable Multifunctional Device Based On Selectively Liquid-Crystal-Infiltrated Photonic Crystal Fiber, Yamile Cardona Maya[1], Pedro Torres[1]; *[1]Universidad Nacional de Colombia, Colombia.* In this work we present an all-fiber tunable multifunctional device based on the phenomenon of resonant tunneling in photonic crystal fibers selectively infiltrated with liquid crystal (LCPCF).

FW4D.5 • 14:30
8x, 12x, and 23x Spectral Compression by All-Fiber, Classic, and Similaritonic Techniques, Hrach Toneyan[1], Aram Zeytunyan[1], Levon Mouradian[1], Vasili Tsakanov[1,2], Frederic Louradour[3], Alain Barthelemy[3], Ruben Zadoyan[4]; *[1]Ultrafast Optics Laboratory, Faculty of Physics, Yerevan State Univ., Armenia; [2]CANDLE Synchrotron Research Inst., Armenia; [3]Departement Photonique, XLIM Institut de Recherche, France; [4]Technology & Applications Center, Newport Corporation, USA.* We implement femtosecond pulse spectral compression through all-fiber and classic techniques by self-phase modulation, and similaritonic technique by sum-frequency generation, and experimentally demonstrate 8x, 12x, and 23x ratios for the process, respectively.

FW4D.6 • 14:45
Soliton stability in multimode fibers, Shaival Buch[1], Yuzhe Xiao[1], Govind Agrawal[1]; *[1]Univ. of Rochester, USA.* We study numerically stability of optical solitons in few-mode fibers. While a single fundamental soliton propagating in any fiber mode is stable, simultaneous propagation of multiple solitons becomes unstable under certain conditions.

FW4E • Symposium on Laser Particle Acceleration and Novel Acceleration Methods I—Continued

FW4E.3 • 14:30 Invited
Multi-GeV Laser-plasma Electron Accelerators, Michael C. Downer[1]; *[1]Univ. of Texas at Austin, USA.* Laser-plasma acceleration is now entering an era of petawatt lasers, tenuous plasmas and multi-GeV electron energies. I will review initial results in this regime, and discuss plasma diagnostics needed to understand, optimize and scale them.

FiO

FW4F • Ocular Aberrations and Wavefront Sensing—Continued

FW4F.3 • 14:30 Invited

Night myopia revisited with Adaptive Optics, Pablo Artal[1]; [1]*Lab. Optica, Universidad de Murcia, Spain.* The causes and magnitude of night myopia, the tendency to near-sighted in low light, were not well understood. We have used adaptive optics instruments to study eye's optics and vision under low luminance both monocular and binocularly.

FW4G • Microscopy and OCT II—Continued

FW4G.4 • 14:15

Coherent anti-Stokes Raman scattering microscopy with low depletion powers by cylindrical-polarized beams, Wei Li[1], Zheng Gong[1], Ya Liu[1], Yu Sun[1], Jiansheng Liu[1], Zheng Zheng[1]; [1]*School of Electronic and Information Engineering, Beihang Univ., China.* A super-resolution, cylindrical-polarized-beam-excited coherent anti-Stokes Raman scattering (CP-CARS) microscopy has been proposed to achieve higher lateral resolutions (17 nm) with lower required depletion power (2.8×10^7 W/cm^2) than the scheme using linearly polarized depletion beams.

FW4G.5 • 14:30

Full-field Interferometric Confocal Microscopy using a VCSEL Array, Brandon Redding[1], Yaron Bromberg[1], Michael Choma[2,3], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA;* [2]*Diagnostic Radiology, Yale School of Medicine, USA;* [3]*Biomedical Engineering, Yale Univ., USA.* We present an interferometric confocal microscope using a low-spatial-coherence VCSEL array. Spatial coherence gating provides continuous virtual pinholes allowing an entire en face plane to be imaged in a snapshot at camera limited frame rate.

FW4G.6 • 14:45

Q-STORM: Quantitative Super-resolution Microscopy from Localization of Reversibly Switchable Single-Molecules, Robert Nieuwenhuizen[1], Mark Bates[2], Bernd Rieger[1], Sjoerd Stallinga[1]; [1]*Department of Imaging Physics, Delft Univ. of Technology, Netherlands;* [2]*Department of NanoBiophotonics, Max Planck Inst. for Biophysical Chemistry, Germany.* We make localization microscopy with reversibly switchable fluorophores a quantitative imaging technique by measuring the average number of activation events per marker from the buildup of spatial image correlations during image acquisition.

LS

LW4H • Resonators and Photonic Crystals III—Continued

LW4H.3 • 14:30 Invited

A Nanophotonic Quantum Phase Switch with a Single Atom, Jeff Thompson[1]; [1]*Harvard Univ., USA.* We discuss a new platform for cavity QED consisting of a single Rubidium atom trapped near a nanoscale optical resonator. The combination of good atomic coherence and strong atom-photon interactions enables a variety of applications.

LW4I • Filamentation II—Continued

LW4I.3 • 14:30 Invited

Laser Filament-induced Ice Multiplication under Cirrus Cloud Conditions, Jean Pierre Wolf[1], Jerome Kasparian[1], Mary Matthews[1], Thomas Leisner[2], Ludger Woeste[3]; [1]*Universite de Geneve, Switzerland;* [2]*Karlsruhe Inst. of Technology, Germany;* [3]*Freie Universitaet Berlin, Germany.* Laser filaments interacting with cirrus like ice crystals produce a large number of small secondary ice particles by re-condensation of the released water vapor. This new phenomenon drastically modifies its radiative forcing.

FW4A • Three-Dimensional Optical Structure Design, Fabrication and Nanopatterning II—Continued

FW4A.6 • 15:00

Throughput Enhancement in Femtosecond Laser Ablation of Silicon by N-type Doping, Qiang Cao[1], Juqiang Fang[1]; [1]*Beijing Inst. of Technology, China*. Experiments show femtosecond laser ablation enhancement of silicon through N-type doping. We found that the material removal is affected by doping concentrations rather than doping types, due to initial free electron density.

FW4A.7 • 15:15

Perfluoropolyether-Based Hydrophobic AFM Tips Fabricated by Two-Photon Polymerization, Francesca Bragheri[1], Tommaso Zandrini[2], Carmela De Marco[3], Raffaella Suriano[3], Stefano Turri[3], Roberto Osellame[1,2]; [1]*Istituto di Fotonica e Nanotecnologie, Consiglio Nazionale delle Ricerche, Italy;* [2]*Dipartimento di Fisica, Politecnico di Milano, Italy;* [3]*Dipartimento di Chimica, Materiali e Ingegneria Chimica "Giulio Natta", Politecnico di Milano, Italy.* Two-photon polymerization technology is used to fabricate atomic force microscopy tips with tailorable geometry and chemical properties. In particular hydrophobic and chemically resistant tips for optimized wet imaging are manufactured in a perfluoropolyether-based resist.

FW4B • Integrated Photonics—Continued

FW4B.5 • 15:00

Electrically Tunable Optical Delay Line in a Polymer Bragg Grating, Oscar D. Herrera[1], Kyung-Jo Kim[1], Roland Himmelhuber[1], Robert Norwood[1], Nasser Peyghambarian[1]; [1]*Univ. of Arizona, USA.* A hybrid electro-optic polymer waveguide Bragg grating was designed and fabricated. Slow light propagation can be achieved by tuning the carrier wavelength around the reflection bandwidth. 30ps delays at <10V can be expected in transmission.

FW4B.6 • 15:15

Measurement of Cavity Length in Cavity-Resonator-Integrated Guided-Mode Resonance Filter, Junichi Inoue[1], Tomohiro Kondo[1], Kenji Kintaka[2], Kenzo Nishio[1], Yasuhiro Awatsuji[1], Shogo Ura[1]; [1]*Kyoto Inst. of Technology, Japan;* [2]*National Inst. of Advanced Industrial Science and Technology, Japan.* A cavity-resonator-integrated guided-mode resonance filter is a kind of narrowband filters, which uses a resonance effect of a waveguide cavity. The cavity length was measured experimentally for estimating the response time of the filter.

FW4C • Quantum Optical Measurement and Quantum Technologies III—Continued

FW4C.6 • 15:00

Consideration on the Nature of Wavefunction Collapse in Entangled Ghost Imaging, John F. Reintjes[1], Mark Bashkansky[2]; [1]*Sotera Defense Solutions, Inc., USA;* [2]*Optical Sciences Division, Naval Research Laboratory, USA.* We examine the restrictions that are placed on the form of the collapsed wavefunction in the configuration of entangled ghost imaging in order to maintain agreement with non-collapse models.

FW4C.7 • 15:15

Super-resolving single-photon number-path-entangled state and its generation, Michelle Lollie[1,2], Wei Feng[3], Kebei Jiang[1], M. Suhail Zubairy[3,4], Jonathan P. Dowling[1,3]; [1]*Physics and Astronomy, Hearne Inst. for Theoretical Physics, Louisiana State Univ., USA;* [2]*Physics and Optical Engineering, Rose-Hulman Inst. of Technology, USA;* [3]*Beijing Computational Science Research Center, China;* [4]*Physics and Astronomy, Inst. for Quantum Science and Engineering, Texas A&M Univ., USA.* A field in a single-photon state can carry multifold phase information. Two protocols are shown that generate this desired state with different probabilities dependent on the detector being used with applications to quantum lithography.

FW4D • Novel Fiber And Communications Devices—Continued

FW4D.7 • 15:00

A Novel Power Play in the Supercontinuum Generation Induced by Modulational Instability in Saturable Nonlinear Media, Nithyanandan K[1]; [1]*Pondicherry Univ., India.* The supercontinuum generation is observed to behave in a unique in saturable nonlinearity, such that the broadband is observed at shortest distance for pumping at saturation power, in comparison to all other pump power configurations.

FW4E • Symposium on Laser Particle Acceleration and Novel Acceleration Methods I—Continued

FW4E.4 • 15:00 Invited

Multi-GeV Laser Plasma Accelerators Using Plasma Waveguides and Integration of Multiple Acceleration Modules, Jeroen van Tilborg[1], A. J. Gonsalves[1], H. S. Mao[1], K. Nakamura[1], C. Benedetti[1], C. B. Schroeder[1], C. S. Toth[1], J. Daniels[1], D. E. Mittelberger[1], S. Steinke[1], N. H. Matlis[1], B. Shaw[1], S. S. Bulanov[1], J. L. Vay[1], Cameron G. Geddes[1], E. Esarey[1], W. P. Leemans[1]; [1]*Lawrence Berkeley National Laboratory, USA.* Laser Plasma Accelerators offer high gradients important to compact machines. We present results towards high energies via staged acceleration integrating two independent modules, and multi-GeV e-beams from the BELLA 1Hz petawatt-class laser.

15:30–16:00 Coffee Break, *Tucson and Arizona Ballroom Foyer*

FiO

FW4G • Microscopy and OCT II—Continued

FW4G.7 • 15:00
Super-resolved axial imaging based on extraordinary light transmission using linear nanoaperture arrays, Wonju Lee[1], Jong-ryul Choi[2], Kyujung Kim[3], Youngjin Oh[1], Donghyun Kim[1]; [1]*School of Electrical and Electronic Engineering, Yonsei Univ., Republic of Korea;* [2]*Medical Device Development Center, Daegu-Gyeongbuk Medical Innovation Foundation, Republic of Korea;* [3]*Department of Nanofusion Technology, Pusan National Univ., Republic of Korea.* We explored super-resolved axial imaging by extraordinary transmission using linear nanoaperture arrays, which was based on differential penetration depth of light. Axial distribution of ganglioside in cells was measured with a resolution of 20 nm.

FW4G.8 • 15:15
Design of a Compact Optical Sensor for Heat Flux Measurement in Biological Tissue, Victor Argueta[1], Celia Sanchez Perez[2]; [1]*Physics, Alma College, USA;* [2]*Optical and Electronic Sensing Lab, UNAM-CCADET, Mexico.* The composition and structure of biological tissue affects its thermal properties. This work presents the optical characteristics and performance for an optical sensor used to measure heat flux by beam deflection in biological tissue.

LS

LW4H • Resonators and Photonic Crystals III—Continued

LW4H.4 • 15:00 Invited
Breaking the Mirror Symmetry of Spontaneous Emission Via Spin-orbit Interaction of Light, Arno Rauschenbeutel[1]; [1]*Vienna Center for Quantum Science and Technology, Vienna Univ. of Technology, Austria.* Light with strong intensity gradients at the wavelength scale exhibits a significant polarization component along its direction of propagation. The interaction of quantum emitters with such light fields leads to new and surprising effects.

LW4I • Filamentation II—Continued

LW4I.4 • 15:00
Remote Collection of Optical Signals using Air Waveguides, Eric Rosenthal[1]; [1]*Univ. of Maryland at College Park, USA.* Remote collection of weak distant signals significantly limits LIBS and LIDAR schemes. We demonstrate use of an air waveguide acting as a remote collection lens for increasing the signal-to-noise in such measurements.

15:30–16:00 Coffee Break, *Tucson and Arizona Ballroom Foyer*

16:00–18:00
FW5A • General Optical Design, Fabrication, Testing, and Instrumentation I

Presider: Jannick Rolland; Univ. of Rochester, USA

FW5A.1 • 16:00 Invited

Design of Optical Imaging Systems Using Freeform Surfaces, James H. Burge[1]; [1]*Univ. of Arizona, USA.* Conventional design of imaging systems applies rules for low order aberration correction followed by numerical optimization. A different approach is shown that develops freeform surfaces directly to satisfy fundamental relations that underlie image formation.

FW5A.2 • 16:30

Scanning White Light Interferometry for Optical Scanner Calibration using GEM-foil based Traceable Standard, Aneliya Karadzhinova[1], Anton Nolvi[2], Timo Hilden[1,2], Rauno Lauhakangas[1], Edward Haeggström[2], Eija Tuominen[1], Ivan Kassamakov[1,2]; [1]*Detector Laboratory, Helsinki Inst. of Physics, Finland;* [2]*Department of Physics, Univ. of Helsinki, Finland.* Gas Electron Multiplier (GEM) detectors record particle trajectories in colliders. GEM characterization is important during manufacturing and final testing. We established a traceable method to calibrate our Optical Scanning System employed for quality control of GEM foils.

16:00–18:00
FW5B • Hybrid Integrated Photonics

Presider: Wataru Nakagawa; Montana State Univ., USA

FW5B.1 • 16:00 Invited

Nanomembrane Integrated Silicon Photonics and Flexible Optoelectronics, Weidong Zhou[1], Zhenqiang (Jack) Ma[2]; [1]*Electrical Engineering, Univ. of Texas at Arlington, USA;* [2]*Electrical and Computer Engineering, Univ. of Wisconsin, USA.* We review surface-normal Fano resonance photonic crystal crystalline nanomembrane photonic devices for integrated silicon photonics, including membrane lasers on Si, critically coupling, and high Q filters. Nanomembrane enabled flexbile RF electronics/optoelectronics will also be introduced.

FW5B.2 • 16:30 Invited

High Performance Photonic BiCMOS - A Novel Technology for the Large Bandwidth Era, Dieter Knoll[1], Lars Zimmermann[1], Stefan Lischke[1]; [1]*IHP, Germany.* A novel photonic BiCMOS process is described which allows for dense co-integration of 200GHz bipolar transistors and CMOS devices with waveguides, couplers, modulators and high-speed Ge photodiodes. First Proof of Concept demonstrators are presented.

16:00–18:00
FW5C • Quantum Electronics II

Presider: Raj Patel; Griffith Univ., Australia

FW5C.1 • 16:00

Measurements on the reality of the wavefunction, Martin Ringbauer[2,3], Benjamin Duffus[2,3], Cyril Branciard[1,4], Eric Cavalcanti[5], Andrew White[2,3], Alessandro Fedrizzi[2,3]; [1]*Univ. of Queensland, Australia;* [2]*Centre for Engineered Quantum Systems, Australia;* [3]*Centre for Quantum Computer and Communication Technology, Australia;* [4]*Institut Néel, France;* [5]*Univ. of Sydney, Australia.* Using a high precision single photon experiment, we rule out maximally Ψ-epistemic models by more than 250 standard deviations.

FW5C.2 • 16:15

Laser Based, Single Trapped Ion Optical Atomic Clock with 1 × 10^-17 Uncertainty Evaluated using the Time-Dilation Effect, Alan Madej[1,2], Pierre Dubé[1], Maria Tibbo[1,2], John E. Bernard[1]; [1]*National Research Council Canada, Canada;* [2]*Physics, Univ. of Ottawa, Canada.* An atomic frequency reference using a single trapped ion has been evaluated to 1.2×10^-17 uncertainty by exploiting the experimentally observed cancellation of micromotion induced Stark and time dilation shifts on the 88^Sr^+ 445-THz S-D transition.

FW5C.3 • 16:30

Relation Between Interband Dipole and Momentum Matrix Elements in Semiconductors, Baijie Gu[1], N. Kwong[1], Rolf Binder[1]; [1]*Univ. of Arizona, USA.* The relation between dipole and momentum matrix elements in crystals, treated with periodic boundary conditions, is revisited. A correction term to standard expressions is found to be large for bulk GaAs, small for THz transitions.

16:00–18:15
FW5D • Enabling Technologies for Astrophotonics

Presider: Morten Ibsen; Univ. of Southampton, UK

FW5D.1 • 16:00 Invited

Diffraction-limited Photonic Micro-Spectrographs for Astronomy, Sergio G. Leon-Saval[1]; [1]*Univ. of Sydney, Australia.* Compact spectrographs at high/medium resolution are challenging due to their multimoded nature. Multimode photonics techniques such as photonic lanterns enable compact photonic diffraction-limited spectroscopy in astronomy for the first time, while maintaining collection efficiency.

FW5D.2 • 16:30 Tutorial

A Green Astro-comb for Earth-like Exoplanet Searches, Chih-Hao Li[1], Alexander G. Glenday[1], Guoqing Chang[2,3], Li-Jin Chen[4], Gabor Furesz[1], Nicholas Langellier[5], Alexander Zibrov[5], Franz Kärtner[2,3], David F. Phillips[1], Dimitar Sasselov[1,5], Andrew Szentgyorgyi[1], Ronald L. Walsworth[1,5]; [1]*Harvard-Smithsonian Center for Astrophysics, USA;* [2]*MIT, USA;* [3]*Univ. of Hamburg, Germany;* [4]*Idesta Quantum Electronics LLC, USA;* [5]*Harvard Univ., USA.* Our astro-comb, providing >7000 lines spaced by 16 GHz from 500-620 nm, has been deployed at TNG telescope as a wavelength calibrator for HARPS-N spectrograph. It provides sub-10 cm/s calibration accuracy required for exo-Earth searches.

(continued on page 88)

16:00–18:00
FW5E • Symposium on Laser Particle Acceleration and Novel Acceleration Methods II

Presider: Laszlo Veisz; Max-Planck-Institut fur Quantenoptik, Germany

FW5E.1 • 16:00 Invited

Optimized Photonic Structures for GV/M Laser Acceleration of Electrons, James Rosenzweig[1]; [1]*Univ. of California Los Angeles, USA.* We review the electromagnetic design, fabrication and beam dynamics of GV/m dielectric laser accelerators. Challenges encountered at ultra-high field and micron scale are discussed, as are application of these devices to novel light sources.

FW5E.2 • 16:30 Invited

Electron Acceleration Experiments by Using a Density-tapered Capillary Plasma Source, Hyyong Suk[1], Inhyuk Nam[1], Minseok Kim[1], Seungwoo Lee[1], Taehee Lee[1]; [1]*Dept. of Physics and Photon Science, GIST, Republic of Korea.* We have developed a density-tapered capillary plasma source for high energy electron generation by using the laser wakefield acceleration, where the dephasing problem will be suppressed and higher acceleration energies are expected. In this presentation, the research results are introduced.

FiO

16:00–18:00
FW5F • Retinal Imaging and Analysis
Presider: Wolfgang Drexler; Medizinische Universität Wien, Austria

FW5F.1 • 16:00 Invited

Progress on Cellular Resolution Retinal Imaging: Setting the Stage for Translation Between Clinical and Basic Science, Robert J. Zawadzki[1]; [1]*Univ. of California Davis, USA.* I will review our progress on developing clinical and animal (mice) cellular resolution in vivo retinal imaging modalities. Example applications of these technologies to in vivo studies of microscopic retinal morphology will be presented.

FW5F.2 • 16:30 Invited

The Use of Masks and Split-detection in Adaptive Optics Scanning Light Ophthalmoscopy, Yusufu N. Sulai[1]; [1]*Univ. of Rochester, USA.* Confocal adaptive optics scanning light ophthalmoscopes have historically provided high contrast images of the retina at the cellular level. Here, we demonstrate non-confocal detection in imaging retinal structures previously unresolved by confocal imaging.

16:00–18:00
FW5G • Frequency Combs in Novel Spectral Ranges
Presider: Ian Coddington; National Inst of Standards & Technology, USA

FW5G.1 • 16:00 Tutorial

Intracavity High Harmonic Generation: Frequency Combs From IR to the XUV, R. Jason Jones[1]; [1]*Univ. of Arizona, USA.* We review the technological development of these sources, their fundamental limitations, and their potential impact on science and technology.

Jason R. Jones is an Associate Professor at the College of Optical Sciences at the University of Arizona. He received his Ph.D. from the University of New Mexico in 2001. He was a National Research Council Postdoctoral Award recipient and senior research associate at JILA (University of Colorado and NIST, Boulder) until July 2006, when he left to join the College of Optical Sciences as an Assistant Professor. His research interests include optical physics, precision spectroscopy and frequency metrology, and ultrafast optics. He has over 80 combined journal and conference publications and two patents. He is the recipient of a National Science Foundation CAREER award (2007), the DARPA Young Faculty Award (2009), as well as a Kavli Fellow of the National Academy of Sciences (Frontiers of Science 2010). He is a member of the American Physical Society and The Optical Society.

LS

16:00–18:15
LW5H • Attosecond Science III
Presider: Zenghu Chang; Univ. of Central Florida, CREOL, USA

LW5H.1 • 16:00 Invited

Attosecond Probing of Atomic & Molecular Structure, Louis F. DiMauro[1]; [1]*Ohio State Univ., USA.* The talk examines the implication of strong-field scaling in the classical limit as it pertains to the production of energetic particles, generation of attosecond pulses and ultrafast molecular imaging. The results are interpreted using a semi-classical model.

LW5H.2 • 16:30 Invited

Probing and Controlling Electron Dynamics in Atoms and Molecules with Attosecond Electron Wave Packets, Xinhua Xie[1]; [1]*Photonics Inst., Vienna Univ. of Technology, Austria.* We experimentally and theoretically investigated the applications of attosecond electron wave packets on probing ultrafast electron dynamics of atoms and controlling electron recollision induced double ionization of atoms and fragmentation of hydrocarbon molecules.

16:00–17:30
LW5I • Chemical and Biological Sensing II
Presider: King-Chuen Lin; National Taiwan Univ., Taiwan

LW5I.1 • 16:00 Invited

Single-Beam Stimulated Raman Scattering for sub-Microgram Standoff Detection of Explosives, Marcos Dantus[1]; [1]*Department of Chemistry, Michigan State Univ., USA.* A 12fs laser pulse is used to both excite vibrational modes and amplify Raman scattering. Selectivity is accomplished by temporal shaping. Imaging of microcrystals on different substrates from several meters becomes possible.

LW5I.2 • 16:30 Invited

Chemical Imaging of Single Nanoparticles by Photothermal Microscopy, Eun-Sohl Koh[1], Bogdan Dragnea[1]; [1]*Chemistry, Indiana Univ., USA.* Photothermal imaging detects absorbing nanoparticles with superior dynamic range which makes it an attractive alternative to single particle fluorescence microscopy. Here we focus on its application to the measurement of adsorption and desorption of macromolecules at a nanoparticle surface.

FW5A • General Optical Design, Fabrication, Testing, and Instrumentation I—Continued

FW5A.3 • 16:45
Method and apparatus for detecting the surface shape of reflective freeform optics, Florian Schurig[1], Mohamed Bichra[1], Stefan Sinzinger[1]; [1]*Fachgebiet Technische Optik, IMN MacroNano, Technische Universität Ilmenau, Germany.* We present a new method for optical shape measurement of refractive surfaces. The presented concept is based on triangulation and able to measure the surface of complex freeform optics with high inclinations.

FW5A.4 • 17:00
Phase Contrast Alignment for All Polymer Optical Interconnect Devices, TAO GE[1], Jilin Yang[1], Yuzuru Takashima[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* We tested feasibility of alignment process by using weak phase structure as fiducial marks imaged by a phase contrast microscope in reflection mode. The process enables fabrication of all-polymer flexible optical interconnects cables.

FW5A.5 • 17:15
Snapshot full Stokes vector measurement based on spectral interferometry, Daesuk Kim[1], Yoonho Seo[1], Yonghee Yoon[1], Jaejong Lee[2]; [1]*Chonbuk National Univ., Republic of Korea;* [2]*Korea Inst. of Machinery & Materials, Republic of Korea.* This paper describes a snapshot full Stokes vector measurement method based on spectral interferometry. The proposed method enables us to obtain an accurate spectral Stokes vector in msec without using a vibration-free optical table.

FW5B • Hybrid Integrated Photonics—Continued

FW5B.3 • 17:00
A printed nanobeam laser on a SiO2/Si substrate for low-threshold continuous-wave operation, indra karnadi[1], Jaehyeon Son[2], Ju Young Kim[2], Hoon Jang[1], Seungwoo Lee[2], Ki Soo Kim[3], Bumki Min[2], Yong-Hee Lee[1]; [1]*Physics, KAIST, Republic of Korea;* [2]*Mechanical Engineering, KAIST, Republic of Korea;* [3]*Convergence and Components& Materials Research Laboratory, ETRI, Republic of Korea.* A small-footprint nanobeam photonic crystal laser made of InGaAsP material is directly integrated on a SiO2/Si substrate via transfer-printing process. The transferred nanobeam structure shows single mode lasing near 1550 nm with continuous-wave (CW) operation at room-temperature.

FW5B.4 • 17:15
Electric Field Detection Using an Electro-optic Polymer Refilled Silicon Slot Photonic Crystal Waveguide, Xingyu Zhang[1], Amir Hosseini[2], Harish Subbaraman[2], Shiyi Wang[3], Qiwen Zhan[3], Jingdong Luo[4], Alex Jen[4], Ray T. Chen[1]; [1]*Univ. of Texas at Austin, USA;* [2]*Omega Optics, Inc., USA;* [3]*Univ. of Dayton, USA;* [4]*Univ. of Washington, USA.* We demonstrate an integrated photonic electric field sensor based on an electro-optic polymer refilled silicon slot photonic-crystal waveguide modulator driven by a bowtie-antenna. The minimum detectable electric field is measured to be 2.5V/m at 8.4GHz.

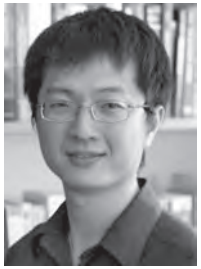
FW5C • Quantum Electronics II—Continued

FW5C.4 • 16:45
Pump-polarization Dependent Polaritonic Skyrmion and Vortex-ring in Spinor Exciton-polariton Condensates, Ting-Wei Chen[1], Wen-Feng Hsieh[2], Szu-Cheng Cheng[1]; [1]*Department of Optoelectric Physics, Chinese Culture Univ., Taiwan;* [2]*Department of Photonics and Inst. of Electro-Optical Engineering, National Chiao Tung Univ., Taiwan.* The numerical spin states of the spinor polariton condensates are calculated with a polarization-tunable pumping beam. The findings suggest the generation and nondestructive manipulation of polaritonic skyrmion and half-vortex rings in experimentally feasible configurations.

FW5C.5 • 17:00
Highly Transmitting Channels for Light in Absorbing Scattering Media, Seng Fatt Liew[1], Sebastien Popoff[1], Allard Mosk[2], Willem L. Vos[2], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA;* [2]*Complex Photonic Systems (COPS), MESA+ Inst. for Nanotechnology, Univ. of Twente, Netherlands.* We study numerically the effects of optical absorption on highly transmitting channels in random media. Our results show that they are robust against weak absorption, but change to ballistic-like transport in case of strong absorption.

FW5C.6 • 17:15
Interacting Dark Resonance Physics with MetaMolecules, Pankaj K. Jha[1], Michael Mrejen[1], Jeongmin Kim[1], Chihhui Wu[1], Xiaobo Yin[1], Yuan Wang[1], Xiang Zhang[1,2]; [1]*NSF Nano-scale Science and Engineering Center (NSEC), 3112 Etcheverry Hall,, Univ. of California, Berkeley, USA;* [2]*Materials Science Division, Lawrence Berkeley National Laboratory, USA.* We investigate interacting dark resonance type physics with plasmonic metamolecule consisting of a multi-layered radiative atom coupled to cascaded subradiant atoms. In addition to sub-natural spectral response, these metamolecules also exhibits efficient intramolecular excitation transfer.

FW5D • Enabling Technologies for Astrophotonics—Continued



Chih-Hao Li is a staff scientist at Harvard-Smithsonian Center for Astrophysics (CfA), Cambridge, Massachusetts. He received his Ph.D. from Department of Physics at U.C. Berkeley, where he worked on precision laser spectroscopy for the fundamental symmetry tests. Since 2007, he has been leading the development of a new laser system, coined "astro-comb", at CfA for exoplanet searches, in collaboration with several research groups at Harvard and MIT.

FW5D.3 • 17:15 Invited
Photonic Bandgap Fiber Laser for Sodium Guide Star Applications, Akira Shirakawa[1]; [1]*Univ. of Electro-Communications, Japan.* This talk will discuss photonic bandgap fiber lasers for sodium guide star applications.

FW5E • Symposium on Laser Particle Acceleration and Novel Acceleration Methods II—Continued

FW5E.3 • 17:00 Invited
Dielectric Laser Acceleration -- From the Proof-of-concept Experiment with Non-relativistic Electrons to Future Applications, Peter Hommelhoff[1]; [1]*Friedrich-Alexander-Universitait Erlangen, Germany.* Dielectric laser acceleration will allow reaching acceleration gradients exceeding 1 GeV/m. We review our proof-of-concept experiment with non-relativistic electrons that showed gradients of 25MeV/m, on par with today's RF-accelerators, and will discuss future applications.

FiO

FW5F • Retinal Imaging and Analysis—Continued

FW5F.3 • 17:00 Invited

Polarimetric Imaging of the Human Retina for the Quantification of Neural and Blood Vessel Status, Ann E. Elsner[1], Joel A. Papay[1], Stephen A. Burns[1], Jason G. Green[1], Donald T. Miller[1], Barry Cense[1,2], Dean A. VanNasadale[1], Matthew Muller[1,3]; *[1]Indiana Univ., USA; [2]Univ. of Utsonimiya, Japan; [3]Aeon Imagign, LLC, USA.* A Several key structures and molecules in the human retina are known to exhibit birefringence, and therefore can be probed with polarimetric imaging. By using scanned illumination, the contrast is increased, revealing otherwise undetectable pathology.

FW5G • Frequency Combs in Novel Spectral Ranges—Continued

FW5G.2 • 16:45 Invited

Mid-Infrared Frequency Combs for Direct Molecular Spectroscopy, Albert Schliesser[1], Nathalie Picqué[2,3], Theodor Hänsch[2,4]; *[1]Niels Bohr Inst., Copenhagen Univ., Denmark; [2]Max Planck Institut für Quantenoptik, Germany; [3]Institut des Science Moleculaires d'Orsay, France; [4]Ludwig-Maximilians-Universität, Germany.* New frequency comb sources based on femtosecond lasers, difference frequency generation, optical parametric oscillations and the Kerr effect in microresonators bring novel, powerful spectroscopic techniques to the mid-infrared spectral region crucial for direct molecular spectroscopy.

FW5G.3 • 17:15 Invited

Broadband Comb-resolved Spectroscopy in the Midinfrared, Kevin F. Lee[1]; *[1]IMRA America, Inc., USA.* We measure frequency comb line resolved spectra at wavelengths of 3.1 to 5.5 micrometers with a Fourier transform spectrometer. Comb line positions can be scanned to within the 240 kHz comb line accuracy.

LS

LW5H • Attosecond Science III—Continued

LW5H.3 • 17:00 Invited

Sub-10 fs DUV Laser Pulses and Their Application to Ultrafast Molecular Spectroscopy and Dynamics, Takayoshi Kobayashi[1]; *[1]Univ. of Electro-Communications, Japan.* We have developed sub-10fs DUV-pulse laser and applied them to study of the mechanism of ultrafast relaxations in DNA bases. Ultrashort decay from S2 to S1 observed is interpreted in terms of the conical intersections.

LW5I • Chemical and Biological Sensing II—Continued

LW5I.3 • 17:00 Invited

Time Resolved Frequency Comb Spectroscopy for Studying Gas Phase Free Radical Kinetics, Adam J. Fleisher[2,3], Bryce Bjork[2], Thinh Q. Bui[1], Kevin C. Cossel[2], Mitchio Okumura[1], Jun Ye[2]; *[1]Arthur Amos Noyes Laboratory of Chemical Physics, California Inst. of Technology, USA; [2]JILA, National Inst. of Standards and Technology and Univ. of Colorado, USA; [3]Material Measurement Laboratory, National Inst. of Standards and Technology and Univ. of Colorado, USA.* We report the development of a novel technique, mid-Infrared Time Resolved Frequency Comb Spectroscopy (TRFCS) for the high sensitivity, broad-band, detection of trace free radicals and reactive intermediates in gas phase, and the study of their reaction kinetics in real-time.

FW5A • General Optical Design, Fabrication, Testing, and Instrumentation I—Continued

FW5A.6 • 17:30 Invited

Evolution of a Linear Systems Formulation of Surface Scatter Theory, James E. Harvey[1]; *[1]Photon Engineering LLC, USA.* The intuitive Generalized Harvey-Shack (GHS) surface scatter theory has evolved into a practical modeling tool to calculate BRDFs from optical surface metrology data for situations that violate the smooth surface approximation implicit in the Rayleigh-Rice theory and/or the paraxial limitation of the Beckmann-Kirchhoff theory.

FW5B • Hybrid Integrated Photonics—Continued

FW5B.5 • 17:30

Hybrid Electro-Optic Polymer/TiO2 Multilayer Slot Waveguide Modulators for Lower Half Wave Voltage and Electrode Length Product, Yasufumi Enami[1], Youssef Jouane[1], Dan Zhang[1], Yu-Chi Chang[1], Jingdong Luo[2], Alex Jen[2]; *[1]School of System Engieenring, Kochi Univ. of Technology, Japan; [2]Department of Materials Science and Engineering, Univ. of Washington, USA.* We demonstrate a hybrid electro-optic (EO)/TiO2 multilayer slot waveguide modulator. Half wave voltage (Vpi) is 2.0 V for electrode length (Le) of 1 cm (Vpi Le = 2.0 V cm) at a wavelength of 1550 nm, using low-index guest-host EO polymer SEO125 (in-device r33 = 78 pm/V).

FW5B.6 • 17:45

Prediction of Optical Gain in PMMA/SiO2:Er3+/Yb3+ Nanocomposite, Sajad Ghatrehsamani[1], Graham Town[1]; *[1]Macquarie, Australia.* We present a numerical study on erbium-ytterbium doped silica nanoparticles in poly-methyl-methacrylate (PMMA), including the effect of scattering at pump and signal wavelengths, and show that gain is possible in the nanocomposite material.

FW5C • Quantum Electronics II—Continued

FW5C.7 • 17:30

Complete Evaluation of Optical Nonlinearities by the Z-Scan within ARINS, Ricardo R. Correia[1]; *[1]Univ Federal do Rio Grande do Sul, Brazil.* We present a nonlinear interferometric approach placing a Z-scan setup within a Sagnac interferometer and show that it is self-sufficient for the separation and evaluation of nonlinearities based on the Gaussian beam analysis.

FW5C.8 • 17:45

Modeling "Turbulent" Intensity Dynamics in Multimode Stimulated Brillouin Scattering, Cameron R. Armstrong[1], Yu-Cheng Chen[1], John A. David[2], John R. Thompson[1]; *[1]Physics and Astronomy, Virginia Military Inst., USA; [2]Applied Mathematics, Virginia Military Inst., USA.* We present a simple numerical model that is used in conjunction with a systematic algorithm for parameter optimization to understand the three-dimensional stochastic intensity dynamics of stimulated Brillouin scattering in a multimode optical fiber.

FW5D • Enabling Technologies for Astrophotonics—Continued

FW5D.4 • 17:45 Invited

Dispersion Engineering in Silicon Nitride, Martin Roth[1], Daniel Bodenmüller[1], Jose M. Chavez Boggio[1], Rene Eisermann[1], Tino Fremberg[1], Michael Böhm[2], Lars Zimmermann[3], Roger Haynes[1]; *[1]innoFSPEC, Astrophysikalisches Institut Potsdam (AIP), Germany; [2]Physikalische Chemie, Universität Potsdam, Germany; [3]IHP, Germany.* As part of ongoing efforts towards development of integrated optoelectronic platforms on a single chip, specifically integrated photonic spectrographs for Astronomy, we report numerical and experimental results from dispersion engineering in integrated silicon nitride waveguides.

FW5E • Symposium on Laser Particle Acceleration and Novel Acceleration Methods II—Continued

FW5E.4 • 17:30

Self-Accelerating Dirac Electrons in Free-Space, Ido Kaminer[1,2], Jonathan Nemirovsky[1], Mikael Rechtsman[1], Rivka Bekenstein[1], Mordechai Segev[1]; *[1]Physics, Technion Israel Inst. of Technology, Israel; [2]Physics, MIT, USA.* A recent experiment confirmed the 35-year-old prediction of Airy-shaped electron beams that accelerate in the absence of any potential. Yet many of their intriguing properties remain unclear, namely: can they reach relativistic speeds?

FW5E.5 • 17:45

Quasi-phase-matched direct laser electron acceleration of variable-length electron bunches in plasma waveguides, Ming-wei Lin[1], Igor Jovanovic[1], Yao-Li Liu[2], Shih-Hung Chen[2]; *[1]Mechanical and Nuclear Engineering, Pennsylvania State Univ., USA; [2]Department of Physics, National Central Univ., Taiwan.* Effect of the electron bunch length on direct laser acceleration of electrons by radially polarized laser pulses in density-modulated plasma waveguides is investigated using a 3-D particle-in-cell model.

Join the conversation on Twitter.
Use hashtag **#FiO14**.

17:00–20:00 OSA Science Educators' Day, *Tucson Ballroom, Salon E*

18:00–22:00 University of Arizona, Celebrating 50 Years of Optical Science at Old Tucson, *Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass at 18:00.*

18:30–19:30 OSA Applications of Visual Science Technical Group Networking Event, *Arizona Ballroom, Salon A*

FiO

FW5F • Retinal Imaging and Analysis—Continued

FW5F.4 • 17:30
Polarization properties of amyloid beta in an animal model of Alzheimer's disease, Melanie C. Campbell[1,2], Wing Chung Theodore Chow[1], Laura Emptage[1], Christopher Cookson[1], Bill Milgram[3,4], Howard Dobson[3,5]; *[1]Univ. of Waterloo, Canada; [2]Guelph Waterloo Physics Inst., Canada; [3]Cangog Technologies, Canada; [4]Univ. of Toronto, Canada; [5]Univ. of Guelph, Canada.* Polarimetry was performed on presumed amyloid beta deposits (thioflavin S positive) in retinas of an animal model of Alzheimer's disease. They showed Mueller matrix properties and polarization contrast similar to deposits in diseased human retinas.

FW5F.5 • 17:45
Modeling Photoreceptor Mosaic Imaging as Backscattering of Light from Multilayered Discs, Brian Vohnsen[1]; *[1]Univ. College Dublin, Ireland.* Imaging of backscattering from bi- and multilayered structures representative of the photoreceptor mosaic is simulated for both flood illumination and beam scanning. Results suggest that scattering may better match in-vivo photoreceptor imaging than exclusive waveguiding.

FW5G • Frequency Combs in Novel Spectral Ranges—Continued

FW5G.4 • 17:45
A Method to Achieve Targeted Repetition Rates for All-Fiber Mode-Locked Lasers, Lindsay Sonderhouse[1], Esther Baumann[1], Laura C. Sinclair[1], Ian R. Coddington[1], Nathan R. Newbury[1]; *[1]NIST, USA.* We demonstrate a method to achieve any targeted repetition rate for all-fiber frequency combs through coherent optical frequency-domain reflectometry. This method has applications in microwave generation, dual-comb systems, and future comb-based fieldable electro-optic systems.

17:00–20:00 OSA Science Educators' Day, *Tucson Ballroom, Salon E*

18:00–22:00 University of Arizona, Celebrating 50 Years of Optical Science at Old Tucson, *Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass at 18:00.*

18:30–19:30 OSA Applications of Visual Science Technical Group Networking Event, *Arizona Ballroom, Salon A*

LS

LW5H • Attosecond Science III—Continued

LW5H.4 • 17:30
Attosecond Quantum Beat Spectroscopy, Niranjan Shivaram[1,3], Henry Timmers[1], Xiao-Min Tong[2], Arvinder Sandhu[1]; *[1]Physics, Univ. of Arizona, USA; [2]Center for Computational Sciences, Univ. of Tsukuba, Japan; [3]Chemical Sciences Division, Lawrence Berkeley National Laboratory, USA.* We investigate electron wavepacket dynamics in Helium using an attosecond pulse train to prepare a superposition of states. The wavepacket is probed by a femtosecond infrared pulse on a 900 femtosecond timescale with attosecond resolution.

LW5H.5 • 17:45
Studying Ultrafast Magnetization Dynamics with Ultrafast Extreme Ultraviolet Light, Emrah Turgut[1], Patrik Grychtol[1], Chan La-o-vorakiat[1], Dmitriy Zusin[1], Henry C. Kapteyn[1], Margaret M. Murnane[1], Justin Shaw[2], Hans Nembach[2], Thomas Silva[2], Ronny Knut[2,1], Ofer Kfir[3], Oren Cohen[3], Avner Fleicher[3], Dennis Rudolf[4], Roman Adam[4], Claus Schneider[4], Stefan Mathias[5], Martin Aeschlimann[5]; *[1]Physics/JILA, Univ. of Colorado, USA; [2]Electromagnetics Division, NIST, USA; [3]Technion Univ., Israel; [4]Research Centre Jülich, Germany; [5]Univ. of Kaiserslautern, Germany.* By using laser-based high harmonic EUV sources, we make several advances in uncovering new understanding of correlated charge and spin dynamics on few femtosecond timescales, and in developing new element-specific capabilities for probing magnetic materials.

LW5H.6 • 18:00
Coherent Attosecond Extreme Ultraviolet Vortices from High-Order Harmonic Generation, Carlos Hernandez-Garcia[1,2], Antonio Picon[3], Julio San Roman[2], Luis Plaja[2]; *[1]JILA, Univ. of Colorado, USA; [2]Grupo de Investigacion en Optica Extrema, Universidad de Salamanca, Spain; [3]Argonne National Laboratory, USA.* We present a theoretical study of high-order harmonic generation and propagation driven by an infrared field carrying orbital angular momentum (OAM). We show that extreme-ultraviolet high-OAM vortices with helical attosecond pulse structure are generated.

07:30–18:00 Registration, *Arizona Ballroom Foyer*

08:00–10:00 FTh1A • General Optical Sciences III

Presider: Byoungho Lee; Seoul National Univ., South Korea

FTh1A.1 • 08:00
Difference frequency generation at 9μm wavelength using a compact all-fiber laser source based on Thulium and Erbium fiber amplifiers, Dmitriy Churin[1], Khanh Q. Kieu[1], Nasser Peyghambarian[1]; [1]*Univ. of Arizona, USA.* We demonstrate a mid-infrared frequency comb spanning from 7.5 to 11.6μm using difference frequency generation in a $AgGaS_2$ crystal with a compact all-fiber source based on Tm and Er-amplifiers.

FTh1A.2 • 08:15
Dual-comb intracavity high harmonic generation, David R. Carlson[1], Tsung-Han Wu[1], R. Jason Jones[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* A high power fiber-based dual-comb system generates a train of coherent pulse pairs in the VUV with continuously tunable delay based on HHG in a single femtosecond enhancement cavity. An intracavity cross-correlation diagnostic is demonstrated.

FTh1A.3 • 08:30
Electron Diffraction from a Cold Atom Electron Source, Rory W. Speirs[1], Daniel J. Thompson[1], Dene Murphy[1], Ben M. Sparkes[1], Rob E. Scholten[1]; [1]*School of Physics, Univ. of Melbourne, Australia.* We present single-shot nanosecond and picosecond electron diffraction measurements from gold and graphene using ultracold electrons generated by photoionisation of laser cooled atoms.

08:00–10:00 FTh1B • Enabling Technologies for High Speed Optical Communications I

Presider: Kazi Abedin; OFS Laboratories, USA

FTh1B.1 • 08:00 Invited
Manufacturable Ultra-Low Loss Pure-Silica-Core Fiber for Trans-Oceanic Telecommunication, Masaaki Hirano[1]; [1]*Sumitomo Electric Industries Ltd, Japan.* Applying pure-silica-core technology, loss of 0.15dB/km has become reality using manufacturable processes. The Aeff of fibers are appropriately enlarged from viewpoint of analytically developed fiber figure-of-merit, for enabling 100G and beyond trance-oceanic transmission.

FTh1B.2 • 08:30
32 x 32 Port Microsecond Reconfigurable All-Optical Cross Connect, Pierre-Alexandre Blanche[1], Brittany Lynn[1], Alex Miles[1], John Wissinger[1], Robert Norwood[1], Nasser Peyghambarian[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA.* We are presenting a new implementation of a 32 x 32 port optical cross connect using diffraction from a Texas Instruments Digital Micromirror Device (DMD) as the core switching mechanism.

08:00–10:00 FTh1C • Optics and Photonics of Disordered Systems I

Presider: Alexander Sergienko; Boston Univ., USA

FTh1C.1 • 08:00 Invited
Resonant and Non-resonant Electromagnetic Fields at the Nanoscale with Active Photonic-plasmonic nanostructures, Luca Dal Negro[1]; [1]*Electrical and Computer Engineering, Boston Univ., USA.* In this talk, I will present our results on the design and engineering of optical nanostructures and metamaterials for on-chip applications to light sources and nonlinear optical components based on the widespread silicon platform.

FTh1C.2 • 08:30
Focusing Inside Random Media, Xiaojun Cheng[1,2], Azriel Z. Genack[1,2]; [1]*Department of Physics, Queens College of the City Univ. of New York, USA;* [2]*Graduate Center, City Univ. of New York, USA.* We find that the variation inside a random sample with depth of the contrast in focusing equals the eigenchannel participation number for the field matrix inside a random sample.

08:00–10:00 FTh1D • Metamaterials

Presider: Demetrios Christodoulides; Univ. of Central Florida, USA

FTh1D.1 • 08:00 Tutorial
Dealing with Losses in Plasmonics and Metamaterials, Jacob Khurgin[1]; [1]*Johns Hopkins Univ., USA.* The reasons for high loss that impedes practical applications of Plasmonics and metamaterials will be reviewed and possible means of mitigation of this loss will be considered.

Jacob B. Khurgin has been a Professor of Electrical and Computer Engineering at Johns Hopkins University from 1988. Prior to that he was a Senior Member of Research Staff at Philips NV where he worked with various degrees of success on display components,visible lasers pumped by electron beam, and coffeemakers. Prof. Khurgin's main area of expertise is in optical and electronic solid state devices. In his 26 years at JHU Prof. Khurgin had made not so small contributions in the fields of nonlinear optics, semiconductor optoelectronic devices, quantum-cascade lasers, optical communications, THz technology, slow light, plasmonics, opto-mechanics, lase refrigeration, microwave photonics, and fundamental condensed matter physics. Prof Khurgin had authored over 280 technical papers, 500 Conference presentations, 5 book chapters, and 15 patents. He is a Fellow of APS and OSA,. Prof. Khurgin holds PhD from Polytechnic University of New York.

08:00–10:00 FTh1E • Lab-on-a-chip and Optofluidics

Presider: Pietro Ferraro; Istituto Nazionale di Ottica (CNR), Italy

FTh1E.1 • 08:00
Numerical and Analytical Investigation of a SPR Structure as Biosensor, Peyman Jahanshahi[1], Elian Dermosesian[1], Faisal Rafiq Mahamd Adikan[1], Soo Young[1]; [1]*Department of Electrical Engineering, Univ. of Malaya, Malaysia.* Surface plasmon resonance (SPR) technique has recently been utilized for medical diagnosis. Analytical and numerical analysis of a proposed SPR biosensor being with the bound analyte-ligand are presented in this study.

FTh1E.2 • 08:15
Laser Speckle Study of Pulsatile Flow in Presence of Induced Motion Artifact, Mahsa Nemati[1], Nandini Bhattacharya[1], Paul Urbach[1]; [1]*Imaging Physics, Delft Univ. of Technology, Netherlands.* Portable devices play an important role in continuous health monitoring. We have performed an experimental study for detection of fluid pulsation based on multi-exposure speckle images, in presence of motion induced artifacts.

FTh1E.3 • 08:30
Mid-Infrared Opto-nanofluidic Slot-Waveguide for Label-free On-Chip Chemical Sensing, Pao T. Lin[1,3], Sen Kwok[2], Hao-Yu Lin[2], Vivek Singh[1], Lionel C. Kimerling[1], George Whitesides[2], Dawn T. H. Tan[3], Anuradha M. Agarwal[1]; [1]*MIT, USA;* [2]*Harvard Univ., USA;* [3]*Singapore Univ. of Technology and Design, Singapore.* A mid-infrared sensor for label-free on-chip chemical detection was developed using an engineered nanofluidic channel consisting of a Si-liquid-Si slot-structure. A sensitivity with 75 times improvement was achieved compared to conventional evanescent-wave sensing.

07:30–18:00 Registration, *Arizona Ballroom Foyer*

08:00–10:15
FTh1F • Symposium on Radiation Reaction in Ultra-High Intensity Lasers I

Presider: Richard Hammond; US Army Research Lab, USA

FTh1F.1 • 08:00 Tutorial

Nonlinear Radiation Effects with Filaments - Inside and Outside, Martin Richardson[1], Magali Durand, Matthieu Baudelet, Nacholas Barbieri, Michael Chini, Khan Lim; [1]*Laser Plasma Laboratory, Townes Laser Inst., College of Optics and Photonics, Univ. of Central Florida, CREOL, USA;* [2]*Dept. of Electrical Engineering, The Univ. at Buffalo, State Univ. of New York, USA;* [3]*Micro-Photonics Laboratory - Center for Optical Material Science, Clemson Univ., USA.* Renewed interest in the properties and applications of air filaments produced by high intensity ultrafast lasers is being driven by new capabilities and fresh insight to the complex non-linear phenomena occurring in filaments.

Martin Richardson graduated from Imperial College, London, in Physics (1964) and gained his Ph.D in Photon Physics from London University in 1967. In 1980 he joined the University of Rochester where he worked for nine years as group leader for laser fusion experiments. In 1990 he and William Silfvast established the Laser Plasma Laboratory at CREOL at UCF, developing research programs in ultrafast laser development, laser-plasma studies, EUV/X-ray lithography and microscopy and laser materials processing. Professor Richardson has held visiting scientific positions at the Max Born Institute in Berlin, the Institute for Laser Engineering (ILE) Osaka University, the Max Planck Institute for Quantum Optics in Garching, and other institutions in Australia, Canada, France, Qatar and the former Soviet Union. He has published over 400 scientific articles in professional scientific journals. He holds ~ 20 patents, with several pending and has chaired many international conferences including IQEC, ICHSP, and several SPIE meetings. He is a former Associate Editor of JQE, a recipient of the Schardin Medal, and a Fellow of OSA.

08:00–10:00
FTh1G • General Optical Design, Fabrication, Testing, and Instrumentation II

Presider: John Koshel; College of Optical Sciences/Univ Arizona, USA

FTh1G.1 • 08:00 Invited

Freeform Optics Enables High-performance Augmented Reality Displays, Hong Hua[1]; [1]*Univ. of Arizona, USA.* Freeform optical technology has becoming more affordable both technically and economically. In this paper, I will present a few examples to demonstrate potentials of freeform optics in designing lightweight and high performance augmented reality displays.

FTh1G.2 • 08:30

First-order Radial Nanolayered Polymer GRIN Achromat, Joseph N. Mait[1], Predrag Milojkovic[1], Guy Beadie[2], Richard A. Flynn[2]; [1]*US Army Research Laboratory, USA;* [2]*US Naval Research Laboratory, USA.* We consider the design of a first-order radial GRIN achromat assuming it is fabricated using nanolayers of a two-polymer blend.

08:00–10:00
LTh1H • Resonators and Photonic Crystals IV

Presider: Michael Gehl; Univ. of Arizona, USA

LTh1H.1 • 08:00 Invited

Coherent Control of Light-Matter Interactions Using a Quantum Dot in a Cavity, Edo Waks[1]; [1]*Univ. of Maryland at College Park, USA.* We utilize a quantum dot coupled to a photonic crystal cavity to implement a qubit-in-a-cavity system that operates in the strong coupling regime. We show that this device can apply quantum logic on a photon.

LTh1H.2 • 08:30 Invited

Quantum Emitters in Optical Nanocavities: Physics and Applications, Jelena Vuckovic[1], Thomas Babinec[1], Kevin Fischer[1], Yousif kelaita[1], Konstantinos Lagoudakis[1], Arka Majumdar[1], Kai Mueller[1], Marina Radulaski[1], Armand Rundquist[1], Tomas Sarmiento[1]; [1]*E.L. Ginzton Laboratory, Stanford Univ., USA.* Strong light-matter interaction between InAs/GaAs quantum dots and optical nanoresonators (photonic crystals or nanometallic) is studied, with applications ranging from quantum technologies to optical switches. Alternative platforms such as impurities in SiC are considered.

08:00–09:45
LTh1I • Quantum States of Matter and Light

Presider: Kali Wilson; Univ. of Arizona, USA

LTh1I.1 • 08:00

Photonic Crystal Waveguides for Neutral-atom Bunching and Acceleration, Igor V. Melnikov[1,2], Joseph W. Haus[3]; [1]*Electronic Materials, National Research Univ. of Electronic Technology, Russian Federation;* [2]*Electrical and Computer Engineering, Univ. of Illinois, USA;* [3]*LADAR and Optical Communications Inst., Univ. of Dayton, USA.* We present a comprehensive study of photonic-crystal waveguides suitable for experiments in atomic physics with optically accelearted neutral atoms.

LTh1I.2 • 08:15

A THz-bandwidth molecular memory for light, Philip J. Bustard[1], Duncan G. England[1], Rune Lausten[1], Benjamin J. Sussman[1]; [1]*National Research Council Canada, Canada.* We demonstrate a memory for light based on storing photons in the vibrations of hydrogen molecules. The THz-bandwidth memory is used to store 100-fs pulses for durations up to ~1ns, enabling ~10^4 operational time bins.

LTh1I.3 • 08:30

Significance of Heralding in Spontaneous Parametric Down-Conversion, Mark Bashkansky[1], Igor Vurgaftman[1], John F. Reintjes[2]; [1]*Optical Sciences Division, Naval Research Laboratory, USA;* [2]*Sotera Defense Solutions, Inc., USA.* We demonstrate both theoretically and experimentally that heralding in spontaneous parametric down-conversion using non-photon-number-resolving detectors can only be used to characterize the signal-idler correlations rather than the nature of the signal-photon state alone.

FTh1A • General Optical Sciences III—Continued

FTh1A.4 • 08:45
High-Fidelity, Weak-Light Polarization Gate Using Room-Temperature Atomic Vapor, Lu Deng[1]; [1]*National Inst of Standards & Technology, USA*. Using a polarization-selective-Kerr-phase-shift technique we demonstrate a fast, high-fidelity polarization gate using a room-temperature atomic medium with a record low control light intensity, opening possible applications in advanced telecommunications and information processing.

FTh1A.5 • 09:00
Light-Wave Mixing and Scattering with Quantum Gases, Lu Deng[1], Chengjie Zhu[1], Edward W. Hagley[1]; [1]*National Inst of Standards & Technology, USA*. We show that optical processes originating from elementary excitations with dominant collective atomic recoil motion in a quantum gas can profoundly change many nonlinear optical processes routinely observed in a normal gas.

FTh1A.6 • 09:15
Abruptly Autofocusing Airy Pulses, Chenchen Wan[1], Qian Cao[1], Andy Chong[1,2]; [1]*Electro-Optics Program, Univ. of Dayton, USA;* [2]*Physics, Univ. of Dayton, USA*. We generated two counter-accelerating Airy pulses with a spatial light modulator pulse shaper and observed the autofocusing of such pulses in a dispersive medium. The same technique can be used to realize 3D autofocusing waves.

FTh1B • Enabling Technologies for High Speed Optical Communications I—Continued

FTh1B.3 • 08:45
Selective up-conversion of two orthogonal signal modes using shaped pump pulses, Paritosh Manurkar[1], Neil V Corzo[1], Prem Kumar[1], Gregory S. Kanter[1], Yu-Ping Huang[1]; [1]*Northwestern Univ., USA*. We demonstrate selective up-conversion of two orthogonal signal modes occupying the same time bin using temporally shaped pump pulses. Measured selectivities (8.4 and 4.2 dB) agree with simulation results that take device parameters into account.

FTh1B.4 • 09:00
Efficient Wavelength Conversion with Less Distortion Using Cross Phase Modulation Induced by Precisely Synthesized Saw-Tooth Pulse, Ken Kashiwagi[1]; [1]*Tokyo Univ of Agriculture and Technology, Japan*. We realized an efficient and low power penalty wavelength conversion using a saw-tooth pulse precisely generated by an optical pulse synthesizer. The power penalty for 10-Gbps OOK signal was 0.2 dB at 10^{-9} BER.

FTh1B.5 • 09:15
Adaptive Photonic Beamforming for Physical Layer Security of Mobile Signals in Optical Fronthaul Networks, John Chang[1,2], Neda Cvijetic[2], Ting Wang[2], Paul Prucnal[1]; [1]*Princeton Univ., USA;* [2]*NEC Laboratories America Inc, USA*. We experimentally demonstrate adaptive photonic beamforming for physical layer security of mobile signals over optical fronthaul networks. 33dB signal suppression to eavesdroppers located 0.1m away from intended users is achieved after 8km SSMF transmission.

FTh1C • Optics and Photonics of Disordered Systems I—Continued

FTh1C.3 • 08:45
Discrete Speckle: Localization and Coherence in Anderson-Disordered Lattices, Hasan E. Kondakci[1], Ayman F. Abouraddy[1], Bahaa E. Saleh[1]; [1]*Univ. of Central Florida, CREOL, USA*. We show that extended coherent light traveling through photonic lattices with disorder exhibits reduction of the coherence width as disorder increases, and emergence of speckle with grain dimensions proportional to the Anderson localization length.

FTh1C.4 • 09:00
Classical Cryptography in Multimode Fibers Using Optical Reciprocity, Yaron Bromberg[1], Brandon Redding[1], Sebastien Popoff[1], Nissim Ofek[1], Hui Cao[1]; [1]*Yale Univ., USA*. We demonstrate a method for secure optical communication in multimode fibers with classical light. Using strong mode mixing in the fiber, and optical reciprocity, a common random key is distributed between two remote parties.

FTh1C.5 • 09:15
Sparsity-based Recovery of Quantum States From Partial Measurements in a Single Setup, Dikla Oren[1], Maor Mutzafi[1], Yonina C. Eldar[2], Mordechai Segev[1]; [1]*Physics, Technion Israel Inst. of Technology, Israel;* [2]*Electrical Engineering, Technion Israel Inst. of Technology, Israel*. We show that prior knowledge that a state of several photons can be represented in compact form in an unknown basis enables the recovery of the quantum state from partial measurements in a single setup.

FTh1D • Metamaterials—Continued

FTh1D.2 • 08:45
Nonlinear-Optical Studies of Magnetic Dipole Metamaterials, Irina Kolmychek[1], Evgeniy A. Mamonov[1], Anton Y. Bykov[1], Tatiana V. Murzina[1], Sergey Kruk[2], Dragomir N. Neshev[2], Martin Weismann[3], Nicolae C. Panoiu[3], Yuri S. Kivshar[2]; [1]*Physics, Moscow State Univ., Russian Federation;* [2]*Nonlinear Physics Centre, Australian National Univ., Australia;* [3]*Electronic and Electrical Engineering, Univ. College London, UK*. Second harmonic generation in planar arrays of metal-dielectric-metal nanodiscs in the spectral vicinity of magnetic dipole plasmon resonance is experimentally studied. Observed features allow to reveal the mechanism of nonlinear-optical response.

FTh1D.3 • 09:00
Designing Nanolayered Metamaterials with Hyperbolic Dispersion, Brandon Himmel[1], Christopher Curtis[1], Lyuba Kuznetsova[1]; [1]*San Diego State Univ., USA*. The impact on nanolayered metamaterials with hyperbolic dispersion due to nonlocal effects is investigated. Calculations for Al:ZnO/ZnO and Al/SiO2 metamaterials show strong spectral dependence of dielectric permittivity in visible/near-IR as the number of layers decreases.

FTh1D.4 • 09:15
Plasmonic Metamaterials Controlling the Momentum of Light, Vincent Ginis[1], Philippe Tassin[2], Costas M. Soukoulis[3], Irina Veretennicoff[1]; [1]*Applied Physics Research Group, Vrije Universiteit Brussel, Belgium;* [2]*Department of Applied Physics, Chalmers Univ., Sweden;* [3]*Department of Physics and Astronomy, Iowa State Univ., USA*. We show how plasmonic metamaterials can enhance optical forces between two optical waveguides by several orders of magnitude. The result is based on the observation that plasmonic thin films reduce the optical distance between objects.

FTh1E • Lab-on-a-chip and Optofluidics—Continued

FTh1E.4 • 08:45
Holographic microscopy in different turbid layer conditions, Vittorio Bianco[1], Melania Paturzo[1], Andrea Finizio[1], Francesco Merola[1], Lisa Miccio[1], Pasquale Memmolo[1,2], Oriella Gennari[1], Paolo A. Netti[2], Pietro Ferraro[1]; [1]*INO-CNR, Italy;* [2]*Center for Advanced Biomaterials for Health Care @CRIB, Istituto Italiano di Tecnologia (IIT), Italy.* Digital Holography is a reliable technique to overcome the problem of imaging through turbid fluids and scattering layers in microfluidic channels. Amplitude imaging and quantitative phase-contrast cell microscopy through a turbid blood flow is shown.

FTh1E.5 • 09:00 Invited
3D Full Morphometric Assessment by Holographic Imaging at Lab-on-Chip Scale for Biomedical Applications, Pietro Ferraro[1]; [1]*Istituto Nazionale di Ottica, CNR, Italy.* Digital holographic microscopy is a well-established technique to study biological samples in bio-microfluidics. We demonstrate a holographic imaging tool for 3D morphometric characterization of cells, that can be integrated in Lab on Chip devices.

FiO

FTh1F • Symposium on Radiation Reaction in Ultra-High Intensity Lasers I—Continued

FTh1F.2 • 08:45 Invited

Solid-Density Experiments for Laser-Based Thomson Scattering: Approaching the Radiation Dominated Regime, John A. Nees[1], Alexander Thomas[1], Bixue Hou[1], Anatoly Maksimchuk[1], Victor Yanovsky[1], Karl Krushelnick[1]; [1]*Univ. of Michigan, USA.* Solid density materials can support acceleration of electrons to the point where they 'see' existing laser field strengths as being in the radiation-dominated regime. We will discuss tools related to Thomson scattering in this regime.

FTh1F.3 • 09:15 Invited

High Repetition Rate kJ-class Nanosecond to Femtosecond Lasers, Todd Ditmire[2,1]; [1]*Univ. of Texas at Austin, USA;* [2]*National Energetics, USA.* Using novel liquid cooled slab laser amplifier technology we have developed lasers capable of amplifying nanosecond pulses to energy of ~1 kJ at repetition rate up to 0.1 Hz. The design of these amplifiers will be described along with plans to scale this technology to femtosecond, 10 PW lasers.

FTh1G • General Optical Design, Fabrication, Testing, and Instrumentation II—Continued

FTh1G.3 • 08:45

Optical Design of an Auxiliary Wide Field Line Scan Adaptive Optics SLO, Ting Luo[1], Stephen A. Burns[1]; [1]*Indiana Univ. Bloomington, USA.* We present the optical design for a wide field line scan adaptive optics SLO which provides a 6 degree, 1780x2040 pixel imaging field on human retina and operates in parallel with a fully confocal 2 degree adaptive optics SLO.

FTh1G.4 • 09:00

Optomechanical Design with Wide Field of View Fiber-Coupled Image Systems, Adam R. Johnson[1], Jeremy Pessin[1], Igor Stamenov[2], Ashkan Arianpour[2], Joseph E. Ford[2], Ronald A. Stack[1]; [1]*Distant Focus Corporation, USA;* [2]*Electrical and Computer Engineering, Univ. of California San Diego, USA.* Fiber-coupled imaging provides new opportunities for optomechanical system design and layout, and also new challenges when achieving high pixel counts and wide fields of view using multiple sensors in monocentric imaging systems with integrated focus.

FTh1G.5 • 09:15

Tunable beam displacer, Luis Jose Salazar Serrano[1,2], Alejandra Valencia[2], Juan P. Torres[1,3]; [1]*ICFO -The Inst. of Photonic Sciences, Spain;* [2]*Quantum Optics Laboratory, Universidad de los Andes, Colombia;* [3]*Dept. of Signal Theory and Communications, Universitat Politecnica de Catalunya, Spain.* We report the implementation of a device that spatially separates, a polarized beam, into two parallel beams with orthogonal polarizations and whose separation can be continuously tuned up to a few centimeters.

LS

LTh1H • Resonators and Photonic Crystals IV—Continued

LTh1H.3 • 09:00 Invited

Nonlinear Quantum Optics and Precision Measurements in Mesoscopic High-Q Optical Cavities, Zhenda Xie[1], Shu-Wei Huang[1], James F. McMillan[1], Sajan Shrestha[1], Jinghui Yang[1], Chee Wei Wong[1]; [1]*Columbia Univ., USA.* Through advances in nanoscale device physics and precision engineering, here we contribute two frequency comb architectures of impact: firstly, the achievement of ultrashort coherent pulses on-chip and, secondly, quantum correlations in energy-time mode-locked two-photon states.

LTh1I • Quantum States of Matter and Light—Continued

LTh1I.4 • 08:45

Space-Variant Polarization States of Photons, Enrique J. Galvez[1], Xinru Cheng[1]; [1]*Physics and Astronomy, Colgate Univ., USA.* We prepare heralded single photons in qubit-qutrit polarization-spatial nonseparable states and diagnose them in the transverse position basis via imaging polarimetry. Polarization patterns of projected transverse positions reveal C-point polarization singularities.

LTh1I.5 • 09:00

Quantum Process Estimation with an Unknown Detector, Michal Karpinski[1], Merlin Cooper[1], Brian J. Smith[1]; [1]*Department of Physics, Univ. of Oxford, UK.* We present an operational approach to quantum process estimation, where the detector response is characterized directly by a set of probe states. Numerical simulations are presented for both discrete and continuous-variable quantum optical processes, which demonstrate the utility of this technique.

LTh1I.6 • 09:15

Creating spin cat states in Bose-Einstein condensates, hon wai lau[1], Zachary Dutton[2], Tian Wang[1], Christoph Simon[1]; [1]*Inst. for Quantum Science and Technology, Univ. of Calgary, Canada;* [2]*Quantum Information Processing Group, Raytheon BBN Technologies, USA.* We propose a method to create spin cat states in a two-component Bose-Einstein Condensates. We show that cat size with hundreds of atoms is possible due to the low atom loss, even with experimental imperfection.

FTh1A • General Optical Sciences III—Continued

FTh1A.7 • 09:30
Super-resolution imaging based on ground state depletion on nanodiamonds, Jelle Storteboom[1]; [1]*Centre for Micro-Photonics, Swinburne Univ. of Technology, Australia*. We report on the super-resolution imaging of single nitrogen vacancy centres based on the ground state depletion method. A resolution of 57.1 nm by 41.2 nm is achieved which holds the potential for ultra-high density optical data storage.

FTh1A.8 • 09:45
Attenuation compensating Airy beams generated by using a digital micro-mirror device, Miguel A. Preciado[1], Kishan Dholakia[1], Michael Mazilu[1]; [1]*School of Physics and Astronomy, Univ. of St Andrews, UK*. We present a novel form of the attenuation-compensated propagation-invariant Airy beam. We generate finite-energy versions of these beams using a digital micro-mirror device, with similar properties over a finite distance of propagation.

FTh1B • Enabling Technologies for High Speed Optical Communications I—Continued

FTh1B.6 • 09:30 Invited
High Spectral Efficiency Submarine Transmission Systems, Dmitri Foursa[1]; [1]*TE SubCom, USA*. Achieving high capacity in long haul systems requires high spectral efficiency modulation formats, large transmission bandwidth. In this presentation we will review recent transoceanic length transmission demonstrations with an emphasis on increasing capacity.

FTh1C • Optics and Photonics of Disordered Systems I—Continued

FTh1C.6 • 09:30
Controlling Diffusion of Light inside a Disordered Photonic Waveguide, Raktim Sarma[1], Timofey Golubev[2], Alexey Yamilov[2], Hui Cao[1]; [1]*Yale Univ., USA;* [2]*Missouri Univ. of Science & Technology, USA*. We control diffusion of light inside a disordered waveguide by modifying the waveguide geometry. Our results demonstrate that the localization effects inside a disordered system can be enhanced via geometry without increasing the structural disorder.

FTh1C.7 • 09:45
Probing Long Range Intensity Correlations inside Disordered Photonic Waveguides, Raktim Sarma[1], Alexey Yamilov[2], Pauf Neupane[2], Boris Shapiro[3], Hui Cao[1]; [1]*Yale Univ., USA;* [2]*Physics, Missouri Univ. of Science & Technology, USA;* [3]*Technion-Israel Inst. of Technology, Israel*. We report direct measurements of long-range spatial intensity correlations and fluctuations inside quasi-two-dimensional random structures. Long-range correlations are enhanced by reducing the waveguide width to strengthen localization effects inside the random media.

FTh1D • Metamaterials—Continued

FTh1D.5 • 09:30
Great light absorption enhancement in a Graphene metamaterial photodetector, Qin Chen[1], Shichao Song[1]; [1]*Suzhou Inst. of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, China*. A photodetector with graphene embedded in a metamaterial perfect absorber (MPA) is proposed. 17 times light absorption enhancement is obtained compared to a graphene monolayer. Cascaded MPAs integrated with graphene are investigated as multiband photodetectors.

FTh1D.6 • 09:45
Veselago Lens by Photonic Hyper-Crystals, Zun Huang[1,2], Evgenii E. Narimanov[1,2]; [1]*ECE, Purdue Univ., USA;* [2]*Birck Nanotechnology Center, USA*. Based on the concept of photonic hyper-crystal -- an artificial optical medium combining the properties of hyperbolic materials and photonic crystals, we develop a Veselago lens with nearly constant negative refractive index and substantially reduced image aberrations.

FTh1E • Lab-on-a-chip and Optofluidics—Continued

FTh1E.6 • 09:30
Experimental Verification of Multispectral Forward Scatter Phenotyping from Bacterial Colonies, Huisung Kim[1], Iyll-Joon Doh[1], Galen B. King[1], Arun K. Bhunia[2], Euiwon Bae[1]; [1]*Mechanical Engineering, Purdue Univ., USA;* [2]*Food Science, Purdue Univ., USA*. We present an experimental verification of multispectral forward scattering from individual bacteria colonies. A new instrument was designed to provide broader spectral data from bacterial colonies. Experiments with Staphylococcus colonies show excellent agreement with theories.

FTh1E.7 • 09:45
Real-Time Dynamics of Single Protein-Small Molecule Interactions with Label-Free, Free-Solution Double-Nanohole Optical Trapping, Ahmed Al Balushi[1], Reuven Gordon[1]; [1]*Univ. of Victoria, Canada*. We use a double-nanohole optical trap to observe single molecule biotin binding on the dynamics of streptavidin and monovalent streptavidin and to distinguish single binding events from multiple bindings.

10:00–10:30 Coffee Break, *Tucson and Arizona Ballroom Foyers*

10:30–12:00 FTh2 • FiO Postdeadline Paper Sessions, *Arizona Ballroom, Salons 8-9/Arizona Ballroom, Salons 11-12/Tucson Ballroom, Salons A-B*

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

13:00–17:00 University of Arizona, College of Optical Sciences and Steward Observatory Mirror Lab Tour,
Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 13:00.

FiO

FTh1F • Symposium on Radiation Reaction in Ultra-High Intensity Lasers I—Continued

FTh1F.4 • 09:45 Invited

Radiation Reaction and Ultra-high Intensity Lasers, Frederic V. Hartemann[1]; Sheldon Wu[1]; [1]*Lawrence Livermore National Laboratory, USA.* Radiation reaction describes the classical self-interaction of charged particles with their radiation field. The theory will be reviewed, as well as interesting possibilities to test the theory in the near future with ultrahigh intensity lasers.

FTh1G • General Optical Design, Fabrication, Testing, and Instrumentation II—Continued

FTh1G.6 • 09:30

Optimizing broadband attosecond Cr/Sc water window multilayer mirrors, Alexander Guggenmos[1,2], Stefan Radünz[1,2], Roman Rauhut[1,2], Sriram Venkatesan[3], Angela Wochnik[3], Christina Scheu[3], Eric Gullikson[4], Stefan Fischer[1,5], Bert Nickel[1,5], Ferenc Krausz[1,2], Ulf Kleineberg[1,2]; [1]*Ludwig-Maximilians-Universität München, Fakultät für Physik, Germany;* [2]*Max-Planck-Institut für Quantenoptik, Germany;* [3]*Ludwig-Maximilians-Universität München, Department Chemie, Germany;* [4]*Center for X-Ray Optics, Lawrence Berkeley National Lab, USA;* [5]*Center for NanoScience, Ludwig-Maximilians-Universität München, Germany.* Low-loss multilayer optics are of uttermost importance for various experiments. Here, we report about the realization of atomically smooth interfaces of broadband attosecond Cr/Sc multilayer mirrors by an optimized ion-beam deposition and assisted interface polishing.

FTh1G.7 • 09:45

Focusing of an ultrashort pulse through a multimode fiber using Digital Phase Conjugation, Edgar Morales[1], Salma Farahi[1,2], Ioannis Papadopoulos[2], Demetri Psaltis[2], Christophe Moser[1]; [1]*Laboratory of Applied Photonics Devices, School of Engineering, EPFL, Switzerland;* [2]*Laboratory of Optics, School of Engineering, EPFL, Switzerland.* We demonstrate a technique to generate an ultrashort focused pulse through a multimode fiber using digital phase conjugation. We compensate for spatial and temporal distortions due to modal dispersion by exciting modes of similar propagation constants which are spatially controlled to form a focus.

LS

LTh1H • Resonators and Photonic Crystals IV—Continued

LTh1H.4 • 09:30

Optomechanics with a sub-wavelength grating inside a Fabry-Perot cavity, Haitan Xu[1,2], Utku Kemiktarak[1,2], Corey Stambaugh[1], Jacob M. Taylor[1,2], John Lawall[1]; [1]*National Inst of Standards & Technology, USA;* [2]*Joint Quantum Inst., USA.* We place a silicon nitride membrane incorporating a subwavelength grating in the middle of an optical cavity. The high reflectivity of the grating couples the two sub-cavities with a normal mode splitting of 55 MHz.

LTh1H.5 • 09:45

A High-Q and Small-Mode-Volume Cavity in Microfibers, Junlong Kou[1], Hyuck Choo[1]; [1]*Caltech, USA.* We propose a novel approach to confine light in a silica microfiber (MF) cavity using a lattice-constant-varying nanohole array.

LTh1I • Quantum States of Matter and Light—Continued

LTh1I.7 • 09:30

Atom Chip-Based Microwave and RF Potentials for Ultracold Atoms, Charles Fancher[1], Austin Ziltz[1], Andrew J. Pyle[1], Megan K. Ivory[1], Seth A. Aubin[1]; [1]*College of William & Mary, USA.* We present progress towards using atom chip-based RF and microwaves to trap and spatially manipulate ultracold rubidium and potassium. We also investigate the use of RF evaporation in such traps.

10:00–10:30 Coffee Break, *Tucson and Arizona Ballroom Foyers*

10:30–12:00 FTh2 • FiO Postdeadline Paper Sessions, *Arizona Ballroom, Salons 8-9/Arizona Ballroom, Salons 11-12/Tucson Ballroom, Salons A-B*

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

13:00–17:00 University of Arizona, College of Optical Sciences and Steward Observatory Mirror Lab Tour,
Busses will depart from the Starr Circle Entrance at the JW Marriott Tucson Starr Pass Resort at 13:00.

13:30–15:30
FTh3A • Coherent Combination of Laser Beams
Presider: Igor Jovanovic; Pennsylvania State Univ., USA

FTh3A.1 • 13:30 Tutorial
High-energy Waveform Synthesis, Franz Kärtner[1]; [1]*Deutsches Elektronen Synchrotron, Germany.* We will review recent approaches towards high-energy waveform synthesis. It overcomes limitations due to the finite amplifier bandwidth and promises sub-optical-cycle pulses ideal for isolated attosecond pulse generation.

Franz X. Kärtner received his Diploma and Ph.D. degree in Electrical Engineering from Technische Universität München. He heads the Ultrafast Optics and X-rays Division at the Center for Free-Electron Laser Science (CFEL) at DESY, Hamburg, and is Professor of Physics at University of Hamburg, and Adjunct Professor of Electrical Engineering at Massachusetts Institute of Technology (MIT). His research interests include few-cycle and ultralow jitter femtosecond lasers, and optical waveform synthesis and its use in attosecond photonics and X-ray free-electron lasers. He is a fellow of the OSA and IEEE.

13:30–15:30
FTh3B • Enabling Technologies for High Speed Optical Communications II
Presider: Roland Ryf; Alcatel-Lucent, USA

FTh3B.1 • 13:30 Invited
Cladding Pumped Erbium-doped Multicore Fiber Amplifiers for Space Division Multiplexing, Kazi S. Abedin[1], Thierry Taunay[1], John Fini[1], Lalit Bansal[1], V. R. Supradeepa[1], Man Yan[1], Benyuan Zhu[1], Eric Monberg[1], David DiGiovanni[1]; [1]*OFS Laboratories, USA.* We report on recent development of multicore fiber amplifiers for applications in space division multiplexed systems. Amplification and noise properties of cladding pumped multicore erbium doped fiber amplifiers employing end- and side-pumping, are presented.

FTh3B.2 • 14:00
Beyond 1 Pb/s Serial Optical Transport over SMFs based on Orthogonal-Division Multiplexing (ODM), Ivan B. Djordjevic[1]; [1]*ECE, Univ. of Arizona, USA.* An orthogonal-division multiplexing (ODM) scheme is proposed employing Slepian sequences as impulse responses, which are mutually orthogonal regardless of sequence order, while occupying fixed bandwidth. Proposed scheme enables beyond 1 Pb/s serial optical transport.

13:30–15:30
FTh3C • Optics and Photonics of Disordered Systems II
Presider: To be determined

FTh3C.1 • 13:30
Single and collective mode behaviour in random lasers, Cefe Lopez[1]; [1]*Consejo Superior de Investigaciones Cientificas, Spain.* Random lasers largely elude control because they are based on disordered structures without a usual cavity. A specially engineered pumping can however demonstrate that it is possible to excite single modes and make them interact as well as excite many and reveal their collective behaviour.

FTh3C.2 • 13:45
Modal makeup of transmission eigenchannels, Zhou Shi[1], Azriel Z. Genack[1,2]; [1]*Queens College, City Univ. of New York, USA;* [2]*Graduate Center, City Univ. of New York, USA.* The wide range of transmission eigenvalues and correlation frequencies of the transmission eigenchannels is explained in terms of the transmission matrices of the modes of the random medium.

FTh3C.3 • 14:00
Wave localization as position-dependent diffusion: analytical results, Pauf Neupane[1], Alexey G. Yamilov[1]; [1]*Missouri Univ of Science & Technology, USA.* We obtain an analytical expression for position-dependent diffusion coefficient which adequately describes wave transport through 1D random medium in localized regime.

13:30–15:30
FTh3D • Beam Shaping and Enhanced Optical Transmission Plasmonics
Presider: To be determined

FTh3D.1 • 13:30
The Role of Quasi-Cylindrical Waves and Surface Plasmon Polaritons in Beam Shaping with Resonant Nanogratings, Choon How Gan[1], Jonathan Pugh[2], Martin Cryan[2], John Rarity[2], Geoffrey Nash[1]; [1]*College of Engineering, Mathematics and Physical Sciences, Univ. of Exeter, UK;* [2]*Department of Electrical and Electronic Engineering, Univ. of Bristol, UK.* Quasi-cylindrical waves supported on the surface of a nanograting, like plasmons, can lead to resonant beam shaping. This opens new possibilities in the design and study of dielectric rather than metallic beam shaping nanogratings.

FTh3D.2 • 13:45
Surface resonance switching involved in the Enhanced Optical Transmission in 1D slit array and its applications, Lei Wei[1], Paul Urbach[1], Nandini Bhattacharya[1], Pieter de Bokx[2]; [1]*Optics Research Group, Delft Univ. of Technology, Netherlands;* [2]*Philips Innovation Services, Netherlands.* In this work, we investigated the Enhanced Optical Transmission(EOT) phenomena in 1D slit array, as a result of this EOT, the switching of surface resonances between layers becomes possible, by simply changing the incident angle. We will discuss the possible applications of the switching phenomena.

FTh3D.3 • 14:00
Enhanced Directional Transmission through a Subwavelength Plasmonic Slit by Optical Microcavities, Ali Haddadpour[1], Georgios Veronis[1]; [1]*Louisiana State Univ., USA.* We show that a compact structure consisting of multiple optical microcavities on both the entrance and exit side of a subwavelength plasmonic slit can lead to greatly enhanced directional transmission through the slit.

13:30–15:30
FTh3E • Plasmonics
Presider: Jacob Khurgin; Johns Hopkins Univ., USA

FTh3E.1 • 13:30 Invited
Recent Progress in Plasmonic and Metallic Cavity Semiconductor Nanolasers, Cun-Zheng Ning[1]; [1]*Arizona State Univ., USA.* We will present an overview of our efforts in developing the metallic cavity nanolasers, including the demonstration of the first nanolaser with a below-diffraction limit size and the first room temperature subwavelength size nanolasers.

FTh3E.2 • 14:00 Invited
Quantum Electrodynamics with Plasmonic Waveguides, Francisco J. Garcia-Vidal[1], Carlos Gonzalez-Ballestero[1], Esteban Moreno[1]; [1]*Universidad Autonoma de Madrid, Spain.* In this talk we will show how one-dimensional plasmonic waveguides could serve as a feasible platform to generate entanglement between two qubits.

FiO

13:30–15:45
FTh3F • Symposium on Radiation Reaction in Ultra-High Intensity Lasers II
Presider: Martin Richardson; Univ. of Central Florida, CREOL, USA

FTh3F.1 • 13:30 Tutorial
Review of the Ford-O'Connell results on radiation reaction in electrodynamics, Robert O'Connell[1]; [1]*Physis, Louisiana State Univ., USA*. We review of the Ford-O'Connell results on radiation reaction in electrodynamics and contrast them with the work of others. We conclude that the Ford-O'Connell results are the most complete and exact results.

13:30–15:30
FTh3G • General Optical Design, Fabrication, Testing, and Instrumentation III
Presider: John Koshel; College of Optical Sciences/Univ Arizona, USA

FW3G.1 • 13:30
Bio-inspired, All-optical Acoustic Sensing with Ultra-high Aspect-ratio, Microsphere-tipped PDMS Micropillars, Jungwook Paek[1], Jaeyoun Kim[1]; [1]*Electrical and Computer Engineering, Iowa State Univ., USA*. We present a new acoustic sensor with all-optical read-out based on ultra-high aspect ratio, microsphere-tipped PDMS micropillar fabricated by a new technique incorporating in situ thermal hardening into the direct-drawing technique.

FTh3G.2 • 13:45
Whole-field Thickness Measurement of a Leaf Cuticle by Digital holographic tomography (DHT), Raul R. Cordero[3], Fernando Labbe[1], Miguel Leon[2], Amalia Martinez[2], Juan Rayas[2,3]; [1]*Mechanics, Universidad Técnica Federico Santa María, Chile;* [2]*Centro de Investigaciones en Óptica, Mexico;* [3]*Universidad de Santiago de Chile, Chile*. DHF allowed us to retrieve whole field maps of the refraction index of cuticles isolated from the abaxial surface of leaves; these were in turn sampled from an apple tree (Malus domestica).

FTh3G.3 • 14:00
Beam Deflectometry for Measuring Two-Dimensional Refractive Index Profiles in Rectangular Gradient-Index (GRIN) Optical Materials, Di Lin[1], James R. Leger[1]; [1]*Electrical and Computer Engineering, Univ. of Minnesota, USA*. We present a numerical method for calculating two-dimensional index fields from measured boundary values of ray position and slope. Refractive index errors of <1% (RMS) of the total index range (n_max - n_min) are achieved using this approach.

LS

13:30–15:30
LTh3H • Filamentation III
Presider: Jerome Moloney; Univ. of Arizona, USA

LTh3H.1 • 13:30 Invited
Resonant Radiation from Collapsing Light Pulses and Spatiotemporal Light Bullets, Daniele Faccio[1,6], Thomas Roger[1], Mihail Petev[1], Matteo Clerici[1,2], Roberto Morandotti[2], Francois Legare[2], Donatas Majus[3], Gintaras Tamosauskas[3], Audrius Dubietis[3], Arnaud Couairon[4], Goëry Genty[5], Paris Panagiotopoulos[6], Miroslav Kolesik[6]; [1]*Heriot-Watt Univ., UK;* [2]*INRS-EMT, Canada;* [3]*Vilnius Univ., Lithuania;* [4]*CNRS, Ecole Polytechnique, France;* [5]*Tampere Univ., Finland;* [6]*Univ. of Arizona, USA*. Resonant excitation of dispersive waves from spatiotemporal light bullets exhibits unique features such as rogue statistics. Resonant radiation may also be stimulated on a co-propagating THz pulse, bridging a 6 octave spectral gap.

LTh3H.2 • 14:00 Invited
Stimulated Emission from Filaments in Air, Yi Liu[1], Andre Mysyrowicz[1]; [1]*LOA, ENSTA, France*. We report on our recent results concerning stimulated emission from filament plasmas in air. Both forward and backward amplified spontaneous emission is observed. Optical gain arises from population inversion in neutral or ionized nitrogen molecules.

13:30–15:30
LTh3I • Chemical and Biological Sensing III
Presider: King-Chuen Lin; National Taiwan Univ., Taiwan

LTh3I.1 • 13:30 Invited
Optical Cavity-based Detection of Magnetic Field Effects in Condensed Phases, Stuart MacKenzie[1]; [1]*Chemistry, Univ. of Oxford, UK*. We report the development of a range of novel optical cavity-based techniques for the sensitive detection of magnetic field effects in biological reactions proceeding via spin-correlated radical pairs.

LTh3I.2 • 14:00 Invited
Evanescent Wave Cavity Ring-down Spectroscopy in Application to Chemical and Biological Sensing, King-Chuen Lin[1]; [1]*National Taiwan Univ., Taiwan*. Evanescent wave cavity ring-down absorption spectroscopy is applied to investigate thermodynamics, kinetics, orientation of the substrates on the surface, probe critical hemimicelle concentration of surfactants, and examine interaction and binding kinetics of DNA strands.

FTh3A • Coherent Combination of Laser Beams—Continued

FTh3A.2 • 14:15 Invited

Coherent Synthesis of Pulsed Waveforms and Energies Using Fiber-Array Combining and Pulse Stacking Techniques, Almantas Galvanauskas[1]; [1]*EECS, Univ. of Michigan, USA.* Coherent signal synthesis using spatial and spectral combining of multiple laser beams and time-domain pulse stacking enables overcoming fiber amplifier pulse duration and energy limitations and could lead to kHz repetition rate TW-peak power systems.

FTh3A.3 • 14:45 Invited

Tracing and Controlling Attosecond Dynamics in Condensed Matter, Eleftherios Goulielmakis[1]; [1]*Max-Planck-Institut fur Quantenoptik, Germany.* I will show that optical attosecond pulses enable control of electron dynamics in solids, as well as tracing and manipulation of ultrafast, multielectron phenomena in their bulk.

FTh3B • Enabling Technologies for High Speed Optical Communications II—Continued

FTh3B.3 • 14:15

Hybrid optical fiber architecture combining orbital angular momentum of photons and spatial domain multiplexing with wavelength division multiplexing for higher data rates, Syed H. Murshid[1], Saud Alanzi[1], Rayan Enaya[1], Abhijit Chakravarty[2], Gurinder Parhar[2], Gregory Lovell[1], Bilas Chowdhury[1]; [1]*Electrical and Computer Engineering, Florida Inst. of Technology, USA;* [2]*R&D, Emcore Corporation, USA.* A hybrid optical fiber communications MIMO architecture employing orbital angular momentum of photons, spatial domain multiplexing, and wavelength division multiplexing is presented for higher data capacity systems, owing to two added degrees of photon freedom.

FTh3B.4 • 14:30

Demonstration of a 280 G-bit/s Communications Link Utilizing Plane Wave Multiplexing, Martin P. Lavery[1,2], Hao Huang[2], Yongxiong Ren[2], Guodong Xie[2], Alan Willner[2]; [1]*Engineering, Univ. of Glasgow, UK;* [2]*Univ. of Southern California, USA.* We demonstrate a 280 Gbit/s free space communications link utilizing tilted plane wave multiplexing. We measure the system channel crosstalk less then -30 dB and a bit-error-rate is above the FEC limit.

FTh3B.5 • 14:45

Characterization of OAM states affected by turbulence for high-speed short-range links, Jaime A. Anguita[1], Horacio P. Rodriguez[1], Matias A. Vial[1]; [1]*College of Engineering and Applied Sciences, Universidad de los Andes, Chile.* An experimental system is devised to generate, propagate, and detect OAM states over a free-space horizontal 400-m range. We characterize the effects of turbulence on the detection of orbital states and present statistical models for scintillation and crosstalk.

FTh3C • Optics and Photonics of Disordered Systems II—Continued

FTh3C.4 • 14:15

Critical States Embedded in the Continuum, Milan Koirala[1], Alexey G. Yamilov[1], Ali Basiri[2], Yaron Bromberg[3], Hui Cao[3], Tsampikos Kottos[2]; [1]*Physics, Missouri Univ of Science & Technology, USA;* [2]*Physics, Wesleyan Univ., USA;* [3]*Applied Physics, Yale Univ., USA.* We introduce a class of critical states which are embedded in the continuum (CSC) of one-dimensional optical waveguide array with one non-Hermitian defect.

FTh3C.5 • 14:30

Quantum transport of photons in disordered non-Hermitian photonic lattices, Lei Xu[1,2], Yiling Dou[1,2], Fang Bo[1,2], Jingjun Xu[1,2], Guoquan Zhang[1,2]; [1]*School of Physics, Nankai Univ., China;* [2]*TEDA Applied Physics Inst., Nankai Univ., China.* We studied quantum correlation and transport of photons in disordered passive parity-time-symmetric lattices, and found that the off-diagonal disorder enhances while the diagonal disorder weakens the loss enhanced transmission effect of photons.

FTh3C.6 • 14:45

Optical Signatures of Disordered Materials for Authentication Applications, Hergen Eilers[1], Benjamin Anderson[1], Ray Gunawidjaja[1]; [1]*Inst. for Shock Physics, Washington State Univ., USA.* Authentication is critical in applications such as provenance verification and tamper-indication. Optical signatures of disordered materials can provide unique information suitable for authentication. Several approaches such as transmission, reflection, fluorescence, and random lasing are reviewed.

FTh3D • Beam Shaping and Enhanced Optical Transmission Plasmonics—Continued

FTh3D.4 • 14:15

Transformation and Illusion Optics of Plasmonic and Nonplasmonic Single Slits, Shih-Hui G. Chang[1], Yu-Lun Su[1]; [1]*National Cheng Kung Univ., Taiwan.* The transmission properties of plasmonic and non-plasmonic single slits can be transformed by wavelength stretching. An equivalent focusing lens between a plasmonic slit array and a dimension scaled non-plasmonic slit array is demonstrated.

FTh3D.5 • 14:30

Direct Observation of Sub 100nm Focusing Using Short Wavelength Plasmons in Homogeneous 2D-Space, Asaf David[1], Bergin Gjonaj[1], Yochai Blau[1], Grisha Spektor[1], Shimon Dolev[1], Guy Bartal[1]; [1]*Electrical Engineering, Technion Israel Inst. of Technology, Israel.* We present direct measurement of short-wavelength plasmons focused into sub-100nm spot in homogeneous 2D space without nanoantennas or nanofocusing. The short-wavelength plasmons are achieved in a Ag-SiN-air platform and mapped directly by apertureless near-field microscope.

FTh3D.6 • 14:45

Nanometer-thick Flat Lens with Adjustable Focus, Alain Hache[1], Cheikhou Ba[2], Tran Vinh Son[1], Real Vallee[2]; [1]*Universite de Moncton, Canada;* [2]*COPL, Universite Laval, Canada.* We demonstrate laser beam focusing at 1300 nm with a flat lens with a thickness of less than 100 nm. The lensing exploits large refractive index changes occurring in vanadium dioxide during phase transition.

FTh3E • Plasmonics—Continued

FTh3E.3 • 14:30

Hyperbolic Tamm Plasmons, Maxim Durach[1], David Keene[1]; [1]*Georgia Southern Univ., USA.* Prediction of a novel photonic mode at a boundary between a hyperbolic metal-dielectric layer and a distributed Bragg reflector (DBR) is reported. The mode exhibits anisotropic dispersion and strong coupling of transverse-magnetic and transverse-electric oscillations.

FTh3E.4 • 14:45

Plasmon-enhanced Four-Wave-Mixing for Super-Resolution Applications, Boris Simkhovich[1], Guy Bartal[2]; [1]*Russell Berrie Nanotechnology Inst., Technion - Israel Inst. of Technology, Israel;* [2]*Electrical Engineering, Technion - Israel Inst. of Technology, Israel.* We introduce a surface-nonlinear optical method to resolve sub-wavelength features by mapping of evanescent-wave band at a given frequency into a propagating-wave band at a new frequency generated by Four-Wave-Mixing in thin metallic film.

FiO

FTh3F • Symposium on Radiation Reaction in Ultra-High Intensity Lasers II—Continued

FTh3F.2 • 14:15 Invited

The Hidden Geometry of Electromagnetism, Yaron Hadad[1]; [1]*Univ. of Arizona, USA*. We will explore the limitations of known *radiation-reaction* models and describe a hidden geometric structure in the electromagnetic field lines. The new structure reveals new insights into *radiation-reaction*, singularities of point charges and high acceleration.

FTh3F.3 • 14:45 Invited

Radiation Reaction of Relativistic Electrons Scattered by Relativistic Intensity Light, Donald P. Umstadter[1]; [1]*Physics and Astronomy, Univ. of Nebraska Lincoln, USA*. Radiation reaction can be studied by means of Thomson scattering between laser-wakefield-accelerated electrons and laser light focused to ultra-high-intensity.

FTh3G • General Optical Design, Fabrication, Testing, and Instrumentation III—Continued

FTh3G.4 • 14:15

Time-of-flight absolute distance measurement by dual-comb second harmonic generation, Hongyuan Zhang[1], Xuejian Wu[1], Haoyun Wei[1], Yan Li[1]; [1]*Tsinghua Univ., China*. A dual-comb system using type II second harmonic generation is proposed for absolute length measurement. Compared with an interferometer, the maximum residual is 100.6 nm in an acquisition time of 500 ms.

FTh3G.5 • 14:30

Real-time Optical Eigenmode Characterisation, Miguel A. Preciado[1], Kishan Dholakia[1], Michael Mazilu[1]; [1]*School of Physics and Astronomy, Univ. of St Andrews, UK*. An optical system is characterised by its transmission eigenmodes. Here, we are using a digital micromirror device to detect these optical eigenmodes experimentally and to achieve applications in aberration correction and imaging.

FTh3G.6 • 14:45

Wavelet Assessment of the Speckle Photo-EMF in an Adaptive Detector for Vibration Measurements, Ángel Salazar[1]; [1]*Universidad Pontificia Bolivariana, Colombia*. For different speckle diameters, the first harmonic of the photocurrent is analyzed in terms of the vibration amplitude of the speckle pattern in a vibration sensor based on speckle photo-electromotive force with a photorefractive crystal.

LS

LTh3H • Filamentation III—Continued

LTh3H.3 • 14:30 Invited

Interaction of Filaments with Their Surroundings, Jean-Claude M. Diels[1], Ladan Arissian[1]; [1]*CHTM, Univ. of New Mexico, USA*. The role of bound electrons, molecules and electrons is analyzed in relation to measurements of polarization before and during the filamentation process. Light-electron interaction is shown to be different for linear versus circular polarization.

LTh3I • Chemical and Biological Sensing III—Continued

LTh3I.3 • 14:30 Invited

Bioimaging and Quantum Sensing Using Nitrogen-Vacancy Centers in Nanodiamonds, Huan-Cheng Chang[1]; [1]*Inst. of Atomic and Molecular Sciences, Academia Sinica, Taiwan*. Fluorescent nanodiamonds containing a high-density ensemble of negatively charged nitrogen-vacancy centers are useful as photostable contrast agents for in vitro and in vivo imaging as well as high-sensitivity quantum sensors for nanoscale thermometry.

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FTh3A • Coherent Combination of Laser Beams—Continued

FTh3A.4 • 15:15
Digital holography for coherent fiber beam combining with a co-propagative scheme, Marie Antier[1], Eric Lallier[1], Christian Larat[1], Jerome Bourderionnet[1], Jerome Primot[2], Arnaud Brignon[1]; *[1]Thales Research & technology, France; [2]ONERA, France.* We present an original technique for passive coherent fiber beam combining based on digital holography, which is compatible with the use of multi-stages of amplification. This concept is experimentally demonstrated and a phase error of λ/20 is measured.

FTh3B • Enabling Technologies for High Speed Optical Communications II—Continued

FTh3B.6 • 15:00
Enhancement of channel capacity of OAM-based FSO link by correction of distorted wave-front under strong turbulence, Ming Li[1,2], Yuzuru Takashima[1], Xiaole Sun[1], Zhongyuan Yu[2], Milorad Cvijetic[1]; *[1]College of Optical Sciences, Univ. of Arizona, USA; [2]State Key Laboratory of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, China.* We studied the channel capacity of OAM-based FSO link employing adaptive optics for correction of a distorted wave-front. The obtained results show that the channel capacity increases significantly even under strong turbulence.

FTh3B.7 • 15:15
1-Tbit/s Orbital-Angular-Momentum Multiplexed FSO Link Through Emulated Turbulence With a Data-Carrying Beacon on a Separate Wavelength for Compensation, Yongxiong Ren[1], Guodong Xie[1], Hao Huang[1], Long Li[1], Nisar Ahmed[1], Yan Yan[1], Martin Lavery[2], Moshe Tur[3], Mark Allen Neifeld[4], Samuel Dolinar[5], Miles Padgett[2], Robert W. Boyd[6], Jeffrey Shapiro[7], Alan Willner[1]; *[1]Dept. of Electrical Engineering, Univ. of Southern California, USA; [2]School of Physics and Astronomy, Univ. of Glasgow, UK; [3]School of Electrical Engineering, Tel Aviv Univ., Israel; [4]Dept. of Electrical and Computer Engineering, Univ. of Arizona, USA; [5]Jet Propulsion Laboratory, California Inst. of Technology, USA; [6]Dept. of Physics and Astronomy, Univ. of Rochester, USA; [7]Research Laboratory of Electronics, MIT, USA.* We investigate the influence of wavelength dependence of turbulence on the compensation performance of OAM beams in a beacon-beam-based-compensation scheme. We then implement this scheme and demonstrate a 1-Tbit/s OAM-multiplexed FSO link through emulated turbulence.

FTh3C • Optics and Photonics of Disordered Systems II—Continued

FTh3C.7 • 15:00
Spatial Light Modulator Controlled Random Lasing in Rhodamine 6G Dye-Doped Polyurethane with Dispersed ZrO2 Nanoparticles, Benjamin Anderson[1], Ray Gunawidjaja[1], Hergen Eilers[1]; *[1]Inst. for Shock Physics, Washington State Univ., USA.* Spatial light modulator controlled resonant feedback random lasing is a promising method for the authentication of tamper evident seals. We report preliminary results of random lasing in Rhodamine 6G dye-doped polyurethane with dispersed ZrO2 nanoparticles.

FTh3C.8 • 15:15
A High Power, Narrow Linewidth and Wavelength Tunable Semiconductor Laser Using a Photopolymer Bragg Grating as One of the Cavity Mirrors, Yu-Hua Hsieh[1], Te-Yuan Chung[1], Long-Chi Du[1], Shiuan-Huei Lin[2]; *[1]Deparment. of Optics and Photonics, National Central Univ., Taiwan; [2]Department of Electrophysics, National Chiao Tung Univ., Taiwan.* A PQ-PMMA Bragg grating served as one of the cavity mirrors in an external V-shaped laser cavity using a tapered-amplifier as the gain medium. The laser achieves singe longitudinal mode with the output power exceed 600 mW, and has 30 nm tunable spectral range.

FTh3D • Beam Shaping and Enhanced Optical Transmission Plasmonics—Continued

FTh3D.7 • 15:00
High Selectivity Plasmonic Color Filter Using a Single Dielectric Film Layer, Daniel Mazulquim[1,2], Kyu J. Lee[1], Leone V. Muniz[2], Ben-Hur V. Borges[2], Luiz G. Neto[2], Robert Magnusson[1]; *[1]Electrical Engineering, Univ. of Texas at Arlington, USA; [2]Electrical Engineering, Univ. of São Paulo, Brazil.* We design, fabricate, and characterize a plasmonic color filter with a transmission bandwidth smaller than 20 nm and an efficiency around 80%. The filter was fabricated using an Al2O3 film by interferometric lithography.

FTh3D.8 • 15:15
Selective Focusing of Laser Pulses by Diffraction-Induced Pulse Splitting in Photonic Crystals, Sergey E. Svyakhovskiy[1], Anton I. Maydykovskiy[1], Viktor O. Kompanets[2], Vladimir A. Bushuev[1], Boris I. Mantsyzov[1], Sergey V. Chekalin[2], Tatiana V. Murzina[1]; *[1]M. V. Lomonosov Moscow State Univ., Russian Federation; [2]Inst. for Spectroscopy RAS, Russian Federation.* Linear focusing and defocusing of femtosecond light pulses in one-dimensional photonic crystals was numerically simulated and experimentally observed. The possibility to produce pairs of pulses and to focus or defocus each pulse selectively has shown.

FTh3E • Plasmonics—Continued

FTh3E.5 • 15:00
Large Area Plasmonic Photoconductive Emitters for Generating High Power Broadband Terahertz Radiation, Nezih T. Yardimci[1,2], Shang-Hua Yang[1,2], Christopher W. Berry[2], Mona Jarrahi[1,2]; *[1]Electrical Engineering, Univ. of California - Los Angeles, USA; [2]Electrical Engineering and Computer Science, Univ. of Michigan, USA.* We present a novel design of large area photoconductive emitters based on plasmonic contact electrodes. A record-high-power radiation of 3.6 mW over 0.1-3 THz frequency range is demonstrated at 150 mW optical pump power.

FTh3E.6 • 15:15
Electrical Excitation Pathways for Graphene Plasmons, Kelvin J. Ooi[1], Hong Son Chu[2], Wee Shing Koh[2], Chang-Yu Hsieh[1], Dawn T. H. Tan[1], Lay Kee Ang[1]; *[1]Engineering Product Development, Singapore Univ. of Technology and Design, Singapore; [2]Electronics and Photonics Department, Inst. of High Performance Computing, A*STAR, Singapore.* We investigate and discuss the viability of graphene plasmons excited through the aloof-scattering of free electrons and inelastic electron tunneling. Excitation efficiencies may be potentially larger compared to that for metal plasmons.

15:30–16:00 Coffee Break, *Tucson and Arizona Ballroom Foyers*

FiO

FTh3F • Symposium on Radiation Reaction in Ultra-High Intensity Lasers II—Continued

FTh3F.4 • 15:15 Invited

Radiation Reaction and the Quantum Langevin Equation, George Ford[1]; [1]*Univ. of Michigan, USA.* The quantum Langevin equation is described. Its form for the case of an electron coupled to the blackbody radiation field is constrained by the second law of thermodynamics. This rules out the Abraham-Lorentz equation but allows a modified equation that has no runaway solutions.

FTh3G • General Optical Design, Fabrication, Testing, and Instrumentation III—Continued

FTh3G.7 • 15:00

Measurement of Amplitude Response of a Fabry-Perot Tunable Optical Filter for Fourier Domain Mode-Locking, Romita Chaudhuri[1], Shanti Bhattacharya[1], Balaji Srinivasan[1]; [1]*Indian Inst. of Technology, Madras, India*. We describe the technique for extracting the amplitude response of a PZT-driven Fabry-Perot filter so as to identify its resonance frequencies, which is essential for high frequency operation of a Fourier Domain Mode-Locked (FDML) laser.

FTh3G.8 • 15:15

High NA Pupil Plane Image Polarimetry for Detection of Surface and Subsurface Damage in Optical Materials, Victor E. Densmore[1], Youngsik Kim[1], Geon-Hee Kim[2], Tom Milster[1]; [1]*College of Optical Sciences, Univ. of Arizona, USA;* [2]*Center for Analytical Instrumentation Development, Korea Basic Science Inst., Republic of Korea.* Abstract: A high-NA solid immersion lens microscope in conjunction with polarization modulated pupil plane imaging is investigated as a means for surface and subsurface damage detection in optical materials.

LS

LTh3H • Filamentation III—Continued

LTh3H.4 • 15:00 Invited

Non-perturbative Time-domain Modeling of Light-matter Interactions for Computer Simulation in Extreme Nonlinear Optics, Miroslav Kolesik[1]; [1]*Univ. of Arizona, USA.* We discuss a new method to calculate nonlinear optical response in strong pulsed fields. This non-perturbative approach utilizes meta-stable, resonance states as a natural tool to treat time-dependent problems accurately and efficiently.

LTh3I • Chemical and Biological Sensing III—Continued

LTh3I.4 • 15:00

pH Sensing With Whispering-Gallery Hollow-Bottle Microresonators, Razvan-Ionut Stoian[1], Barry K. Lavine[2], Albert T. Rosenberger[1]; [1]*Physics, Oklahoma State Univ., USA;* [2]*Chemistry, Oklahoma State Univ., USA.* A hollow-bottle microresonator is used to detect changes in the pH of an internal solution. The refractive index of a swellable polymer coating changes with pH, shifting frequencies of modes with internal evanescent fields.

LTh3I.5 • 15:15

Refractometric Sensing with Crystalline MgF2 Whispering Gallery Mode Resonators, Richard Zeltner[1,2], Florian Sedlmeir[1,2], Gerd Leuchs[1,2], Harald G.L. Schwefel[1,2]; [1]*Max-Planck-Inst Physik des Lichts, Germany;* [2]*Institut of Optics, Information and Photonics, Univ. Erlangen-Nuremberg, Germany.* We report on a refractometric sensor based on crystalline MgF2 Whispering Gallery Mode resonator. High sensitivity, small resonance line widths and good thermal stability provide a limit of detection of 4x10^-6 refractive index units.

15:30–16:00 Coffee Break, *Tucson and Arizona Ballroom Foyers*

FiO

16:00–18:00
FTh4A • General Optical Sciences IV
Presider: Laszlo Veisz; Max-Planck-Institut fur Quantenoptik, Germany

FTh4A.1 • 16:00 Invited
Fiber Components, Fiber Amplifiers and Phase Control for Coherent Combination, Hakan S. Sayinc[1,2], Thomas Theeg[1,2], Gabriel Pelegrina-Bonilla[1,2], Katharina Hausmann[1,2], Henrik Tünnermann[1,2], Peter Wessels[1,2], Jörg Neumann[1,2], Dietmar Kracht[1,2]; [1]*Laser Zentrum Hannover e.V., Germany;* [2]*Centre for Quantum Engineering and Space-Time Research-QUEST, Germany.* Fused fiber components, concepts for fiber amplifiers and phase control mechanisms were investigated to be used in coherent beam combining. The investigated photonic devices promise highly integrated and compact laser sources.

FTh4A.2 • 16:30
Single-Frame Measurement of the Complete Spatiotemporal Intensity and Phase of a Complex Ultrashort Laser Pulse, Zhe Guang[1], Michelle Rhodes[1], Rick Trebino[1]; [1]*Physics, Georgia Inst. of Technology, USA.* We demonstrate a simple single-shot device for completely characterizing a single ultrashort pulse in space and time (x,y,t). We measure spatiotemporally complex pulses and display the resulting four-dimensional intensity and phase using intuitive movies.

16:00–17:45
FTh4B • Enabling Technologies for High Speed Optical Communications III
Presider: Dmitri Foursa; TE SubCom, USA

FTh4B.1 • 16:00 Invited
Wavelength-Selective Switches for Multi-Mode Fiber Systems, Roland Ryf[1], Nicolas K. Fontaine[1]; [1]*Alcatel-Lucent, USA.* Wavelength-selective switches (WSSs) are the key wavelength-routing components in optical meshed networks. We discuss possible architectures for WSSs that support multi-mode fibers, and related tread-offs between key switch characteristics like spectral resolution, number of switching ports, and insertion loss. We also present experimental results for WSSs that support few-mode fibers with 3 spatial modes.

FTh4B.2 • 16:30
Withdrawn.

16:15–18:00
FTh4C • Quantum Electronics III
Presider: Alexander Sergienko; Boston Univ., USA

FTh4C.1 • 16:00
Withdrawn.

FTh4C.2 • 16:15
Compressive Image Reconstruction Optimization for Single-Photon Gaussian Beam Profiles, Philip G. Evans[1], Raphael Pooser[1], Jason C. Schaake[2]; [1]*Quantum Information Science Group, Oak Ridge National Laboratory, USA;* [2]*Dept. of Physics & Astronomy, Univ. of Tennessee, USA.* We perform simulated reconstructions of a 2-D Gaussian beam profile using combinations of three common compressive imaging reconstruction algorithms with semi-random sparse sampling matrices. We identify under what conditions the Gaussian profile is faithfully reconstructed.

FTh4C.3 • 16:30
Enhanced ultraviolet upconversion emission using nanocavities, Ahmed Elhalawany[1], Mercedeh Khajavikhan[1], William Hayenga[1], Sarmad Alhasan[1], Christopher Lantigua[1]; [1]*Univ. of Central Florida, USA.* We investigate the up-conversion emission spectra of Tm3+ and Yb3+ codoped: β-NaYF4-NaYF4 core-shell nanoparticles embedded in plasmonic nanocavities. The results confirm the role of nanocavities in maximizing the conversion efficiency from the NIR to UV.

16:00–17:15
FTh4D • Imaging, Coherence, and Propagation
Presider: P. Scott Carney, Univ. of Illinois at Urbana-Champaign, USA

FTh4D.1 • 16:00
Interferometric Measurement of Light Beam's Degree of Polarization, Kimmo Saastamoinen[1], Lasse-Petteri Leppänen[1], Tero Setälä[1], Ari Tapio Friberg[1]; [1]*Inst. of Photonics, Univ. of Eastern Finland, Finland.* We present Young's interferometric measurements of the degree of polarization associated with specifically constructed, partially polarized light beams and compare the results with those obtained with the conventional polarizer and wave-plate technique.

FTh4D.2 • 16:15
Propagating the carrier frequency of a pulse seamlessly connects spectrometry & coherence, Chandra Roychoudhuri[1,2]; [1]*Physics, Univ. of Connectocut, USA;* [2]*Femto Macro Continuum, USA.* A causal model of propagating the carrier frequency of a pulse, instead of non-causal Fourier frequencies, existing in all space, seamlessly connects spectrometry & coherence with deeper physical insights behind the phenomena.

FTh4D.3 • 16:30
Analysis of Leaky-Wave Microphotonic Structures with a Complex-Wavevector Photonic Band Structure Solver, Jelena Notaros[1], Milos Popovic[1]; [1]*Department of Electrical, Computer, and Energy Engineering, Univ. of Colorado Boulder, USA.* A finite-difference, complex-wavevector photonic band structure solver with perfectly matched layer absorbing boundaries is presented. Modal properties of leaky-wave structures, such as silicon photonic grating couplers and waveguide crossing arrays, are shown.

16:00–18:00
FTh4E • Optical Antennas and Plasmonic Waveguide Devices
Presider: Francisco Garcia-Vidal; Universidad Autonoma de Madrid, Spain

FTh4E.1 • 16:00
Giant Fluorescence Enhancement of Molecules Coupled to Plasmonic Nanoscale Patch Antennas, Maiken H. Mikkelsen[1,2], Alec Rose[1], Thang B. Hoang[1,2], Felicia McGuire[1], Jack J. Mock[1], Cristian Ciraci[1], David R. Smith[1]; [1]*Center for Metamaterials and Integrated Plasmonics, Department of Electrical and Computer Engineering, Duke Univ., USA;* [2]*Department of Physics, Duke Univ., USA.* We demonstrate a colloidally synthesized and tunable plasmonic platform for giant fluorescence enhancement and increased spontaneous emission rate of embedded fluorophores. A transition between fluorescence enhancement and quenching is revealed depending on the plasmonic resonance.

FTh4E.2 • 16:15
Generation of Surface Plasmon Vortex Under Linearly-polarized Optical Excitation in a Gold Metasurface, Chen-Ta Ku[1], Ching-Fu Chen[1], Chen-Bin Huang[1]; [1]*Inst. of Photonics Technologies, National Tsing Hua Univ., Taiwan.* A nanocavity in a gold thin film is optimized and arranged to form a metasurface. We numerically demonstrate that surface plasmon vortex carrying orbital angular momentum can be generated under linearly-polarized optical excitation.

FTh4E.3 • 16:30
Using Particle Swarm Optimization to Design Broadband Optical Nano-antennas for Nonlinear Optics, Lilya Lobachinsky[1], Alon Bahabad[1]; [1]*Tel-Aviv Univ., Israel.* Particle swarm optimization is used to design optical nano-antennas for nonlinear optical interactions in a gas medium adjacent to the nano-antenna. The optimization is specifically designed to address broad band pumping.

FiO

16:00–18:00
FTh4G • General Optical Design, Fabrication, Testing, and Instrumentation IV
Presider: Kevin Rolland-Thompson; Synopsys, Inc, USA

FTh4G.1 • 16:00 Invited

See-through Three-dimensional Screen Using Holographic Optical Elements, Byoungho Lee[1], Jiwoon Yeom[1], Keehoon Hong[1]; [1]*Seoul National Univ., Republic of Korea*. We introduce lens-array holographic optical elements (LAHOEs) for see-through three-dimensional (3D) screen. The LAHOE performs a function of concave mirror-array for Bragg matching condition, and can provide virtual 3D images overlaid with real world scene.

FTh4G.2 • 16:30

Fabrication of Multiplexed Computer Generated Volume Holograms in Photosensitive Glass, Edwin N. Kamau[1,2], Vijay V. Parsi Sreenivas[2], Mike Bülters[1], Claas Falldorf[1], Ralf B. Bergmann[1,2]; [1]*Optical Metrology and Optoelectronic Systems, BIAS - Bremer Institut für angewandte Strahltechnik, Germany;* [2]*Faculty of Physics - Applied Optics, Univ. of Bremen, Germany.* We present a new approach for the fabrication of volume holograms in an optical nonlinear material with voxel sizes on the order of 1µm i.e., with increased degrees of freedom and thus improved multiplexing functionality.

LS

16:00–17:00
LTh4H • Chemical and Biological Sensing IV
Presider: To be determined

LTh4H.1 • 16:00

Temporally Resolved Laser-Induced Breakdown Spectroscopy with Mid-IR Femtosecond Pulses, Kyle Hartig[1], Igor Jovanovic[1]; [1]*The Pennsylvania State Univ., USA*. We report the first implementation of a laser-induced breakdown spectroscopy system driven by 2-µm femtosecond pulses. Ab initio modeling is used to explain the present femtosecond results and the previously reported nanosecond results.

LTh4H.2 • 16:15

Integrating Sphere based Photoacoustic Sensor for Trace Gas Detection, Mikael Lassen[1], Anders Brusch[1], David Balslev-Clausen[1], Jan C. Petersen[1]; [1]*Danish Fundamental Metrology Ltd, Denmark*. A photoacoustic detector has been developed for trace gas detection. The detector is based on an integrating sphere absorption cell and laser and LED light sources. Various materials have been investigated for background noise reduction.

LTh4H.3 • 16:30

Femtosecond pulse train shaping for accurate two-photon excited fluorescence measurements, Jong Kang Park[1], Martin C. Fischer[1], Kimihiro Susumu[2,3], Michael J. Therien[1], Warren S. Warren[1,4]; [1]*Chemistry, Duke Univ., USA;* [2]*Optical Sciences Division, U.S. Naval Research Laboratory, USA;* [3]*Sotera Defense Solutions, USA;* [4]*Radiology, Physics, and Biomedical Engineering, Duke Univ., USA*. We report a simple measurement method that exploits pulse train shaping to suppress linear contributions to the fluorescence, and allows for extraction of the two-photon absorption cross sections.

16:00–18:00
LTh4I • Light-Matter Interaction
Presider: Joshua Hendrickson; US Air Force Research Laboratory, USA

LTh4I.1 • 16:00

Efficient Real-time Detection of Terahertz Pulse Radiation by "Listening to" Photoacoustic Generation, Sung-Liang Chen[1,4], Cheng Zhang[1], You-Chia Chang[2], Jong G Ok[3], Tao Ling[1], Momchil T. Mihnev[2], Theodore B. Norris[1,2], L. Jay Guo[1,2]; [1]*Department of Electrical Engineering and Computer Science, Univ. of Michigan, USA;* [2]*Department of Applied Physics, Univ. of Michigan, USA;* [3]*Department of Mechanical Engieering, Univ. of Michigan, USA;* [4]*Univ. of Michigan - Shanghai Jiao Tong Univ. Joint Inst., China*. We demonstrate real time terahertz detection based on its absorption by carbon nanotubes composite and detection of the generated photoacoustic signal. This method has advantages of real time response, compact size and wide spectrum response.

LTh4I.2 • 16:15

PT symmetry breaking and transverse mode filtering in microring lasers, Hossein Hodaei[1], Mohammad-Ali Miri[1], Matthias Heinrich[1], Demetrios N. Christodoulides[1], Mercedeh Khajavikhan[1]; [1]*Univ. of Central Florida, USA*. We show that the concept of parity-time (PT) symmetry breaking can be utilized to suppress higher order transverse modes in microring lasers.

LTh4I.3 • 16:30

Active control of emission frequency and directionality of semiconductor microdisk lasers, Seng Fatt Liew[1], Brandon Redding[1], Li Ge[2,3], Glenn S. Solomon[4], Hui Cao[1]; [1]*Applied Physics, Yale Univ., USA;* [2]*Engineering Science and Physics, College of Staten Island, CUNY, USA;* [3]*The Graduate Center, CUNY, USA;* [4]*Joint Quantum Inst., NIST and Univ. of Maryland, USA*. We demonstrate lasing mode selection in semiconductor microcavities via adaptive optical pumping. Slight deformation of cavity shape and boundary roughness lead to distinct emission patterns for individual lasing modes, enabling the switching of output directionality.

FTh4A • General Optical Sciences IV—Continued

FTh4A.3 • 16:45
Optical Broadband Angular Selectivity, Yichen Shen[1], Marin Soljacic[1], John Joannopoulos[1], Steven Johnson[2]; [1]*Physics, MIT, USA;* [2]*Mathematics, MIT, USA.* We tailor the overlap of the bandgaps of multiple one-dimensional photonic crystals, each with a different periodicity, in such a way we enables transparency throughout the visible spectrum at one angle, the generalized Brewster angle, and reflection at every other viewing angle.

FTh4A.4 • 17:00
Amplification of Angular Rotations using Weak Measurements, Omar S. Magana Loaiza[1], Mohammad Mirhosseini[1], Brandon Rodenburg[1], Robert W. Boyd[1,2]; [1]*The Inst. of Optics, Univ. of Rochester, USA;* [2]*Department of Physics, Univ. of Ottawa, Canada.* We experimentally demonstrate the first weak-value amplification in the azimuthal degree of freedom. We estimate rotations using shifts in angular position and orbital angular momentum, via spin-orbit coupling and an applied geometric phase.

FTh4A.5 • 17:15
Polarization independent broadband femtosecond optical gating using transient Kerr lens effect, Yu-E Wu[1], Zhenhua Wang[1], Wenhua Li[1], Ligang Huang[1], Feng Gao[1], Wei Li[1], Qiang Wu[1], Xinzheng Zhang[1], Jingjun Xu[1]; [1]*Nankai Univ., China.* A convenient polarization-independent, broadband femtosecond optical gating technique utilizing transient Kerr lens effect is demonstrated by measuring the chirp structures of linearly polarized or non-polarized white light continuum generated in water or from a photonic crystal fiber, respectively.

FTh4B • Enabling Technologies for High Speed Optical Communications III—Continued

FTh4B.3 • 16:45
All Optical Bifocal Lens Array Architecture for Demultiplexing Spatial Domain/Space Division Multiplexed Optical Channels, Syed H. Murshid[1], Bilas Chowdhury[1], Gregory Lovell[1]; [1]*Electrical and Computer Engineering, Florida Inst. of Technology, USA.* Architecture and CAD analysis of an array of lenses, which simulates spatial domain/space division multiplexed optical channels and then spatially demultiplexes the independent optical channels to the corresponding fibers or detectors, is presented.

FTh4B.4 • 17:00
Nanosecond Liquid Crystalline Technologies for High Speed Optical Communications: Electro-optic Switching Through Nanosecond Electric Modification of Order Parameter, Volodymyr Borshch[1], Bing-xiang Li[1,2], Sergij V. Shiyanovskii[1], Oleg D. Lavrentovich[1]; [1]*Liquid Crystal Inst. and Chemical Physics Interdisciplinary Program, Kent State Univ., USA;* [2]*College of Electronic and Information Engineering, Nanjing Univ. of Aeronautics and Astronautics, China.* We experimentally demonstrate nanosecond electric modification of the order parameter (NEMOP). Nanosecond electro-optic switching is equally fast for both filed-on and field-off driving what allows using liquid crystals for high speed optical communication devices.

FTh4B.5 • 17:15
Asymmetric inversion of Airy pulses induced by the interaction between the initial chirp and the group-velocity dispersion in a single mode fiber, Lucien Mandeng Mandeng[1], Clément Tchawoua[1]; [1]*Universite de Yaounde I, Cameroon.* We present the inversion of the time domain asymmetric profile of the Airy pulses induced by the interplay between the group-velocity dispersion (GVD) and the initial chirp in a classical nonlinear single mode fiber (SMF).

FTh4C • Quantum Electronics III—Continued

FTh4C.4 • 16:45
Enhancing the Conversion Efficiency of Second Harmonic Generation Using Counterpropagating Light, Rachel Myer[1], Allison Penfield[1], Etienne Gagnon[1], Amy L. Lytle[1]; [1]*Franklin & Marshall College, USA.* We have observed modulation of the conversion efficiency of second harmonic generation by 1-2% of the spectral intensity using a single counterpropagating pulse to locally disrupt the phase of the nonlinear polarization wave.

FTh4C.5 • 17:00
Pulse Formation via Parametric Seeding in Whispering-Gallery-Mode Microresonators with Kerr Nonlinearity, Hossein Taheri[1], Ali A. Eftekhar[1], Ali Adibi[1]; [1]*Georgia Inst. of Technology, USA.* We numerically study parametric seeding via pump phase modulation in whispering-gallery-mode microresonators based on a variant of the Lugiato-Lefever equation. Our results suggest a method for deterministic pulse formation at practical modulation depths.

FTh4C.6 • 17:15
The General Solution of Cooperative Emission in Arbitrary Dimension, Tyler Hill[1], Barry Sanders[2], Hui Deng[1]; [1]*Physics, Univ. of Michigan, USA;* [2]*Inst. for Quantum Science and Technology, Univ. of Calgary, Canada.* We study fluorescence of emitters coupled to radiation fields allowing for arbitrary interatomic spacing, dipole orientations, and spatial dimension, including the first study of two dimensions. The asymptotic analysis shows coherence increases with reduced dimension.

FTh4D • Imaging, Coherence, and Propagation—Continued

FTh4D.4 • 16:45
Group velocity dispersion of CdSSe/ZnS core/shell colloidal quantum dots, Amelia V. Spivey[1]; [1]*Physics, Univ. of Puget Sound, USA.* We measure the group velocity dispersion (GVD) coefficient of two different sizes of commercially available CdSSe/ZnS semiconductor core/shell colloidal quantum dots in the ~700-900 nm range using white light Michelson interferometry.

FTh4D.5 • 17:00
Enhancement and Extinction in Surface-Enhanced Stimulated Raman Spectroscopy, Xiong Kai Benjamin Chng[1], Thomas van Dijk[1], Rohit Bhargava[1], P. Scott Carney[1]; [1]*Univ. of Illinois at Urbana-Champaign, USA.* We present an analysis of surface-enhanced stimulated Raman spectroscopy (SESRS) as an extension to surface-enhanced Raman spectroscopy (SERS). Due to the four-wave mixing process, the effects of enhancement and extinction are more profound in SESRS.

FTh4E • Optical Antennas and Plasmonic Waveguide Devices—Continued

FTh4E.4 • 16:45
Enhanced plasmon resonance and light absorption in diabolo metal bar optical antennas, Junpeng Guo[1], Hong Guo[1], Zeyu Pan[1], Blake S. Simpkins[2], Joshua D. Caldwell[2]; [1]*Univ. of Alabama in Huntsville, USA;* [2]*Naval Research Laboratory, USA.* Enhanced plasmon optical resonance and light absorption in diabolo metal bar optical antennas are investigated with numerical simulations and experiment.

FTh4E.5 • 17:00
Ultra-Compact Integrated Nanoplasmonic Air-Gap Coupler, Rami A. Wahsheh[1], Zhaolin Lu[2], Mustafa Abushagur[2]; [1]*Communications Engineering Department, Princess Sumaya Univ. for Technolog, Jordan;* [2]*Microsystems Engineering, Rochester Inst. of Technology, USA.* We present novel design and fabrication steps of an ultra-compact air-gap coupler based on plasmonic waveguides. The theoretical result at 1550 nm is about 70%. The proposed coupler operates at broad frequency range.

FTh4E.6 • 17:15
Polarization management in plasmonic waveguide devices, Qin Chen[1], Lin Jin[1]; [1]*Suzhou Inst. of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, China.* Polarization management is important for photonic integrated circuit and polarization division multiplexing. We present polarization insensitive sub-wavelength hybrid plasmonic waveguides and compact mode-coupling plasmonic polarization rotator on silicon-on-insulator platform.

FiO

FTh4G • General Optical Design, Fabrication, Testing, and Instrumentation IV—Continued

FTh4G.3 • 16:45
Shape Adaptive Grinding of Optical Surfaces for Scientific Applications and Consumer Products, Anthony Beaucamp[1], Yoshiharu Namba[1], Phillip Charlton[2], Arthur Graziano[2]; [1]*Chubu Univ., Japan;* [2]*Zeeko LTD, UK.* Shape Adaptive Grinding (SAG) is a new process capable of producing optical mirror quality surfaces (Ra <0.5nm) on CVD silicon carbide coatings. The methodology and capability of the SAG process are presented in this paper.

FTh4G.4 • 17:00
Machining High Aspect Ratio Features with Single Femtosecond Laser Pulses, Brian K. Canfield[1], Trevor Bowman[1], Lino Costa[1], Deepak Rajput[1], Alexander Terekhov[1], William H. Hofmeister[1], Lloyd M. Davis[1]; [1]*Univ. of Tennessee Space Inst., USA.* Exceptionally deep submicron-diameter holes and long microchannels are machined in fused silica by single femtosecond pulses using spherical, cylindrical, and aspheric lenses. These features result from a combination of longitudinal spherical aberration and filamentation.

FTh4G.5 • 17:15
Saturation of Multiplexed Volume Bragg Grating Recording, Sergiy Kaim[1], Sergiy Mokhov[1], Daniel Ott[1], Ivan Divliansky[1], Julien Lumeau[2], Vadim Smirnov[3], Boris Y. Zeldovich[1], Leonid Glebov[1]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*Institut Fresnel, France;* [3]*OptiGrate Corp, USA.* Recording of VBG in Photo-Thermo-Refractive glass is limited to maximum refractive index change about 0.002. We discuss various shapes of saturation curves and their influence on amplitudes of recorded basic and cross-modulation gratings.

LS

LTh4H • Chemical and Biological Sensing IV—Continued

LTh4H.4 • 16:45
Novel architectures for plasmon-enhanced vibrational spectroscopy and biomolecular sensing, Cristiano D'Andrea[1], Barbara Fazio[1], Joerg Bochterle[2], Maximilien Cottat[3], Andrea Toma[4], Antonino Foti[1], Elena Messina[1], Onofrio M. Marago'[1], Enzo Di Fabrizio[5], Marc Lamy de La Chapelle[3], Annemarie Pucci[2], Pietro G. Gucciardi[1]; [1]*CNR - IPCF Messina, Italy;* [2]*KIP, Heidelberg Univ., Germany;* [3]*Laboratoire CSPBAT, Université Paris 13, France;* [4]*Nanostructures, Istituto Italiano di Tecnologia, Italy;* [5]*KAUST, Saudi Arabia.* Here we illustrate recent progress in nano- bio- sensors technology includes the development of multifunctional devices capable integrate Raman and IR on the same chip, work in liquid environment and feature high molecular specificity

LTh4I • Light-Matter Interaction—Continued

LTh4I.4 • 16:45
Measurement of Laser Scattering from Large Free-Electron Wavepackets, Michael Ware[1], Justin B. Peatross[1]; [1]*Brigham Young Univ., USA.* We report results from an experimental measurement of laser scattering from free large free-electron wavepackets created through ionization of helium. This measurement confirms earlier theoretical predictions.

LTh4I.5 • 17:00
Hyper Rayleigh Scattering from Helium: Search for Even Laser Harmonics, Justin B. Peatross[1], Michael J. Ware[1]; [1]*Brigham Young Univ., USA.* We report on experiments characterizing hyper Rayleigh scattering from high-pressure helium. While odd harmonic scattering of intense laser light is expected, observation of even harmonics would support the Bohmian interpretation of quantum mechanics.

LTh4I.6 • 17:15
Determination of the Graphite Incubation Parameter in the Ultrafast Regime using the D-Scan Technique, Ricardo E. Samad[1], Francisco C. Maia[2], Narcizo M. Souza[2], Wagner de Rossi[1], Nilson D. Vieira[1]; [1]*Centro de Lasers e Aplicações, IPEN-CNEN/SP, Brazil;* [2]*Laboratório Nacional de Luz Síncrotron - LNLS, Brazil.* Graphite ablation threshold for ultrashort pulses was measured for pulses superpositions spanning 4 orders of magnitude using the D-Scan technique. Three ablation regimes were identified, and for incubation effects, graphite accumulates defects as a metal.

FTh4A • General Optical Sciences IV—Continued

FTh4A.6 • 17:30
Multiband optical perfect absorber based on plasmonic double gratings, Fengyun Zhao[1], Chuanhong Liu[1], Zhaoyu Zhang[1]; [1]*Peking Univ., China*. An optical perfect absorber based on double gratings is proposed. The excitation of LSPR and the coupling of SPPs and LSPR result in three distinctive absorption peaks, with absorbance all more than 97%.

FTh4A.7 • 17:45
QED Radiation Pressure On Electrons and Ultra-relativistic "Ghost" Of Relict Radiation, Alexander E. Kaplan[1], Boris Y. Zeldovich[2]; [1]*ECE, Johns Hopkins Univ., USA;* [2]*CREOL, Univ. of Central Florida, USA*. A universal theory of radiation pressure by a relic (cosmic microwave background) radiation, using fully relativistic+quantum approach suggests a possibility of formation of a peak of electron density in cosmic rays directly related to CMB.

FTh4B • Enabling Technologies for High Speed Optical Communications III—Continued

FTh4B.6 • 17:30
Experimental Analysis of Multiplexing/demultiplexing Laguerre Gaussian Beams with Different Radial Index, Guodong Xie[1], Yongxiong Ren[1], Hao Huang[1], Nisar Ahmed[1], Long Li[1], Yan Yan[1], Martin Lavery[1,2], Miles Padgett[2], Alan Willner[1]; [1]*Department of Electrical Engineering, U. of Southern California, USA;* [2]*School of Physics and Astronomy, Univ. of Glasgow, UK*. Different orders of Laguerre-Gaussian (LG) beam could form two-dimensional orthogonal basis set for laser beams in free space. The orthogonality of LG beams with the same phase change in azimuthal direction but different in radial direction is experimentally studied.

FTh4C • Quantum Electronics III—Continued

FTh4C.7 • 17:30
Determination of Nonlinear Optical Coefficients from Micropowders in the Presence of Scattering: A revision of the Kurtz-Perry Method, Ibon Aramburu[1], Josu Ortega[2], Cesar Folcia[3], Jesus Etxebarria[3]; [1]*Applied Physics I, Faculty of Engineering (ETSI), Univ. of the Basque Country, UPV/EHU, Spain;* [2]*Applied Physics II, Univ. of the Basque Country, UPV/EHU, Spain;* [3]*Condensed Matter Physics, Univ. of the Basque Country, UPV/EHU, Spain*. The shortcomings of the Kurtz-Perry method are discussed. Several procedures that overcome these limitations are proposed. Experiments demonstrate that those procedures can provide reliable values for the NLO coefficients even in the presence of scattering.

FTh4C.8 • 17:45
Interplay of Optical Feedback and Current Modulation in Multimode VCSELs, Hong Lin[1], Aliza Khurram[1]; [1]*Bates College, USA*. We experimentally investigated polarization dynamics in a current-modulated VCSEL with optical feedback. Feedback features can be enhanced or suppressed by modulation. VCSELs are more sensitive to modulation in multimode regime than in single mode regime.

FTh4E • Optical Antennas and Plasmonic Waveguide Devices—Continued

FTh4E.7 • 17:30
Efficient End-fire Coupling of Surface Plasmons in Metallic Waveguide, Caitlin Fisher[1], Lindsay C. Botten[2,3], Christopher G. Poulton[3], Ross C. McPhedran[1], C. Martijn de Sterke[1]; [1]*CUDOS, School of Physics, Univ. of Sydney, Australia;* [2]*CUDOS, National Computational Infrastructure, Australian National Univ., Australia;* [3]*CUDOS, School of Mathematical Sciences, Univ. of Technology, Australia*. We theoretically investigate the end-fire coupling mechanism of surface plasmons into an interface, bounded by an ideally grounded waveguide, with respect to incident beam parameters, media permittivities and waveguide width. Efficiencies of ~80% were observed.

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FiO

FTh4G • General Optical Design, Fabrication, Testing, and Instrumentation IV—Continued

FTh4G.6 • 17:30
All Optical Three Dimensional Spatio-Temporal Correlator for Video Clip Recognition, Mehjabin Sultana Monjur[1], Selim Shahriar[1,2]; [1]*Department of Electrical Engineering and Computer Science, Northwestern Univ., USA;* [2]*Department of Physics and Astronomy, Northwestern Univ., USA.* We describe an all-optical three-dimensional spatio-temporal correlator (STC) which can recognize rapidly a video clip of a small duration contained in a much larger video file in a temporally and spatially shift invariant manner.

Thank you for attending FiO/LS. Look for your post-conference survey via email and let us know your thoughts on the program.

FTh4G.7 • 17:45
Nonlinear Excitation Associated with Direct Laser Writing in SU-8, Stephen M. Kuebler[1,2,3], Henry E. Williams[1], Carlos Diaz[1], Gabriel Padilla[1], Florencio E. Hernandez[1,2]; [1]*Chemistry Dept., Univ. of Central Florida, USA;* [2]*CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA;* [3]*Physics Dept., Univ. of Central Florida, USA.* Multi-photon direct laser writing (mpDLW) experiments, Z-scan spectroscopy, and quantum chemical calculations indicate that the initiators used in the photo-polymerizable resin SU-8 are capable of three-photon excitation at or near the vacuum wavelength of 800 nm and that this excitation mode affects its performance when the material is used to micro-fabricate three-dimensional structures by mpDLW. These findings can be leveraged to improve its use for fabricating three-dimens ional micro-structures.

LS

LTh4I • Light-Matter Interaction—Continued

LTh4I.7 • 17:30
Propagation Velocity of Surface Polariton, S. R. Seshadri[1]; [1]*Member, American Physical Society, USA.* A plane interface separating vacuum from free electron gas supports an inhomogenous plane wave known as surface polariton. The energy transport velocity which equals the wave-packet velocity is shown to be not physically meaningful.

LTh4I.8 • 17:45
Fermions Dressed by Massless Vector Bosons, John Gardiner[1], Stephen Erickson[1], Mercedes Wright[2], Michael J. Ware[1], Scott Glasgow[2]; [1]*Physics, Brigham Young Univ., USA;* [2]*Mathematics, Brigham Young Univ., USA.* We use a non-perturbative, space-time resolved, simulation of quantum electrodynamics to explore the properties of electrons dressed with photons. We observe differences in the dynamics of dressed and bare electron wave packets, including differences in dispersion, speed, and mass.

FiO/LS Sessions, Symposia and Invited Speakers by Topic

FiO 1: Optical Design and Instrumentation

Technical Sessions

Invited Speakers

FiO 2: Optical Sciences

Technical Sessions

FiO 3: Optics in Biology and Medicine

FiO 4: Optics in Information Processing

FiO 5: Fiber Optics and Optical Communications

Technical Sessions

Invited Speakers

FiO 6: Integrated Photonics

Technical Sessions

Invited Speakers

FiO 7: Quantum Electronics

Technical Sessions

Invited Speakers

FiO 8: Vision and Color

Technical Sessions

Invited Speakers

Laser Science

Technical Sessions

Invited Speakers

Symposium on the 50th Anniversary of Optical Sciences

Technical Sessions

Invited Speakers

Symposium on Translational Biophotonics - Focus on Cancer

Technical Sessions

Invited Speakers

Symposium on 50 Years of Lasers in Ophthalmology and the New ANSI Safety Standard

Technical Sessions

Invited Speakers:

Symposium on Laser Particle Acceleration and Novel Acceleration Methods

Technical Sessions

Invited Speakers:

Symposium on Radiation Reaction in Ultra-High Intensity Lasers

Technical Sessions

Invited Speakers:

Key to Authors and Presiders