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Program updates and changes may be found on the Conference Program Update Sheet distributed in the attendee registration bags. Check the Conference App for regular updates.

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Conference Schedule-at-a-Glance

Note: Dates and times are subject to change. Check the conference app for regular updates. All times reflect eastern time zone.

	Sunday 17 September	Monday 18 September	Tuesday 19 September	Wednesday 20 September	Thursday 21 September
GENERAL					
Registration	15:00–18:00	07:00–18:00	07:00–17:30	07:00–17:30	07:30–11:30
Speaker Preparation Room	15:00–18:00	07:00–17:30	07:00–17:30	07:00–17:30	07:30–11:30
WORKinOPTICS.com Kiosks & E-Center	15:00–18:00	07:00–17:30	07:00–17:30	07:00–17:30	07:30–11:30
Coffee Breaks		10:00–10:30 15:30–16:00			10:00–10:30
PROGRAMMING					
LS Symposium on Undergraduate Research	12:00–18:00				
FiO + LS Visionary Speakers		08:00–08:45		08:00–08:45	08:00–08:45
FiO + LS Technical Sessions		09:00–15:30	15:00–18:15	09:00–18:15	09:00–12:30
Joint FiO + LS Plenary Session			08:00–09:30		
Postdeadline Paper Sessions					13:30–15:30
SCIENCE & INDUSTRY SHOWCASE					
Exhibits			09:30–16:00	10:00–15:00	
Coffee Breaks Sponsored by OSA Industry Development Associates			09:30–10:00 13:00–13:30	10:00–10:30 13:00–13:30	
Poster Sessions and E-Posters			10:00–12:00 13:00–15:00	10:00–12:00 13:00–15:00	
Rapid-fire Oral Presentations			10:00–11:00 13:00–14:00	10:00–11:00 13:00–14:00	
Meet OSA's Journal Editors			11:45–12:45		
Pizza Lunch Sponsored by OSA Publishing			12:00–13:00		
OSA Student Chapter Competition			13:00–15:00		
Congressional Fellowship Information Session				12:00-13:00	
SPECIAL EVENTS					
Women of Light, a Special Program for Women in Optics Funded by OSA Foundation	09:00–15:00				
OSA Student Member Party	18:30–20:30				
Capitol Hill Visits		09:00–12:00			
Challenges and Emerging Opportunities in Molecular Probes and Nanobio-Optics		12:30–13:30			
Grant Writing 101 Workshop		12:30–14:00			
OSA Nonlinear Optics Technical Group Workshop & Networking Session		16:00–17:30			
Unconscious Bias Workshop		16:00–17:30			
Evening with the Agencies & Reception		16:00–18:00			
FiO + LS Awards Banquet		18:30–21:00			
Environmental Sensing Technical Group Networking Event			16:30–17:00		
OSA Annual Business Meeting			17:30–18:15		
DLS Annual Business Meeting			17:30–18:30		
FiO + LS Conference Reception Sponsored by THORLABS			18:30–20:30		
The "Rush Hour": What Does a Scientist Owe Policymakers?				09:00–10:00	
OSA Members, Family and Friends Tour				09:30–12:00	
OSA Optical Material Studies Technical Group Special Talk				12:00–13:00	
Polarization Optics - Design and Fabrication Trends and Challenges				12:00–13:00	
OIDA VIP Industry Leaders Networking Speed Meeting Lunch Sponsored by GoFoton				12:00–13:30	
Meet the APS Journal Editors Reception				15:30–17:00	
Pairing Photons to Electrons: An OSA Nanophotonics Technical Group Networking				16:30–17:00	
Networking with the OSA Biomedical Optics Technical Groups				18:30–20:00	

Welcome to Frontiers in Optics 2017

Whether you are in an autonomous vehicle looking to avoid collisions with nearby objects, or sitting on Earth and trying to detect collisions of black holes in the furthest galaxies, the Frontiers in Optics + Laser Science APS/DLS (FIO + LS) offers something for you. We are pleased to welcome to Washington, D.C., the home of The Optical Society and The American Physical Society - Division of Laser Science.

This year's conference introduces a meeting experience that has been thoughtfully revised — taking the best of the past and adding vital, innovative elements. The result is a conference with invaluable opportunities to learn from and meet with your peers and colleagues. 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 + LS 2017.

The world-class technical program features more than 75 invited speakers, 200 contributed talks and almost 500 poster presentations by celebrated members of the community describing some of the most exciting advances in their fields.

As technology advances at an ever-increasing pace, the potential applications for optics continue to grow and bring us closer to the edge of amazing discovery and automation. Our plenary speakers, Jason Eichenholz, CTO and Founder of Luminar, will discuss LIDAR and technologies driving the emerging autonomous vehicle industry. Laura Cadonati, LIGO Scientific Collaboration will share recent discoveries in gravitational wave science. Add nine Visionary Speakers who address cutting-edge research on topics from nanophotonics to optics in computing; and a special advocacy presentation from former U.S. Congressman and current CEO of AAAS, Rush Holt.

We will toast the achievements of OSA and APS Division of Laser Science award and honor recipients at the inaugural FiO + LS Awards Banquet on Monday night. Those to be recognized include Margaret Murnane, *University of Colorado at Boulder, USA,* 2017 winner of OSA's highest honor, the 2017 OSA Frederic Ives Medal / Jarus W. Quinn Prize and John C. Mather, *NASA's Goddard Space Flight Center, USA,* OSA 2017 Honorary Member. The OSA awards program spans all areas of optics and photonics, as well as contributions made through service, education and leadership. Nominations for 2018 are due 1 October 2017, so there is still time to recognize the achievements of your colleagues. Visit www.osa.org/awards for details.

While at FiO + LS, we encourage you to visit the new Science & Industry Showcase. The FiO exhibition transforms into The Science & Industry Showcase – in which exhibiting companies are partnered with innovative demonstrations, networking events, poster presentations, e-posters and rapid-fire oral presentations. Take the time to learn about new products, find technical and business solutions and gain the most up-to-date market perspective of your industry.

Again, we welcome you to FiO + LS 2017 and encourage you to enjoy the dynamic programming incorporated into the next few days ahead.

With best regards,
Steve & Susana

Steve Cundiff
FiO Chair
University of Michigan, USA

Susana Marcos
FiO Chair
Consejo Sup Investigaciones Cientificas, Spain

Welcome to Laser Science 2017

The leadership of the Division of Laser Science (DLS) of the American Physical Society (APS) is pleased to welcome you to our 33rd annual meeting, Laser Science (LS) 2017, in Washington, D.C. We are grateful for the help of our colleagues and technical program organizers, Josh Vura-Weis and Hui Cao in organizing a broad range of topics in physics 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. 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 with over 50 Laser Science presentations, there are many exciting special Visionary Speakers and events scheduled for the meeting this year. Special attention is appropriate for the Symposium on Undergraduate Research on Sunday, 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.

The technical sessions for the Laser Science meeting are organized around several broad themes: High Harmonic Generation: Time, Energy and Complexity; Frontiers in X-ray Laser Spectroscopy; Plasmonics and Nanophotonics; and Novel Lasers.

Celebrate the achievements of award and honor recipients from OSA and APS Division of Laser Science and connect with colleagues at the inaugural FiO + LS Awards Banquet on Monday night. Those to be recognized include Louis F. DiMauro, *The Ohio State University, USA*, 2017 winner of the Arthur L. Schawlow Prize in Laser Science.

The DLS Business meeting will be held Tuesday, 19 September from 17:30–18:30.

We welcome you to the Laser Science 2017 Meeting and encourage you to take full advantage of this year's technical sessions, visionary and plenary talks, as well as the new Science & Industry Showcase featuring leading suppliers to the laser science community, Rapid-fire Oral Presentations and Poster Sessions including e-posters.

Enjoy!

Mark G. Raizen
LS Chair
University of Texas at Austin, USA

Roseanne J. Sension
LS Chair
University of Michigan, USA

General Information

WiFi Access Instructions

To access the complimentary WiFi services during the FiO + LS Conference, use the following information to log in.

SSID: FiO2017
Password: opticsindc17

Registration

Concourse Foyer

Sunday, 17 September	15:00–18:00
Monday, 18 September	07:00–18:00
Tuesday, 19 September	07:00–17:30
Wednesday, 20 September	07:30–17:30
Thursday, 21 September	07:30–11:30

Speaker Preparation Room

Albright Room, Terrace Level

Speakers and presenters are encouraged to stop by the Speaker Preparation Room during registration hours *(listed above)* to test their presentations prior to their session. The room will be equipped with laptops, LCD projectors and screens.

Media Room

Boundary Room, Terrace Level

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

Monday, 18 September	12:00–17:00
Tuesday, 19 September	08:00–17:00
Wednesday, 20 September	08:00–17:00
Thursday, 21 September	08:00–12:00

Business Center

FedEx Office, Terrace Level

The Washington Hilton's in-house Business Center, operated by FedEx, offers one-stop shopping for all of your business needs. The FedEx Office is open Monday - Friday, 07:00–19:00, Saturday 09:00–15:00, closed on Sundays. Guests of the Washington Hilton have extended access with their guest room key to self-service computer stations available 24 hours a day, 7 days a week.

Lost and Found

For lost and found please check first at the conference registration counter in the Concourse 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.

First Aid and Emergency Information

In the event of an emergency at the Washington Hilton, please dial #60 from any courtesy phone. If you happen to dial 911 on your own, please call #60 as well to inform the hotel about the emergency.

Nearest Hospital, Fire Station & Police Station

George Washington University Hospital
900 23rd Street, NW
Washington, DC 20037
+1.202.715.4000

DC Fire Department Engine 9
1617 U Street, NW
Washington, DC 20009
+1.202.673.3209

DC Metropolitan Third District Police Station
1620 V Street, NW
Washington, DC 20009
+1.202.673.6815

E-Center

Concourse Foyer

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

WORKinOPTICS.com Kiosk

Concourse Foyer

WORKinOPTICS.com provides a state-of-the-art platform to efficiently connect employers and job seekers within the optics and photonics community.

Your next job opportunity or new hire is just a click away.

- Post your resume at no charge to reach top employers.
- OSA Industry Development Associates (OIDA) Members receive 20 free job postings.

WORKinOPTICS

Sponsoring Society Booths

Concourse Foyer

Sunday, 17 September	15:00–18:00
Monday, 18 September	08:00–18:00
Tuesday, 19 September	08:00–17:30
Wednesday, 20 September	08:00–17:30
Thursday, 21 September	08:00–11:30

Founded in 1899, the American Physical Society (APS) is a non-profit membership organization working to advance and diffuse the knowledge of physics. APS publishes the world's most widely read physics research and review journals: *Physical Review Letters, Physical Review X, Reviews of Modern Physics, Physical Review A-E, Physical Review Accelerators and Beams, Physical Review Applied, Physical Review Fluids, Physical Review Materials, Physical Review Physics Education Research, and Physics.* Please stop by our table near Registration to learn more about the prestigious *Physical Review* collection and our newest journal *Physical Review Materials*, a new broad-scope international journal for the multidisciplinary community engaged in materials research.

Through world-renowned publications, meetings and membership programs, OSA provides quality information and inspiring interactions that power achievements in the science of light. More than 20,000 OSA Members, residing in over 100 countries and spanning academic, government and industry, call OSA their professional home. Stop by to meet OSA staff, and learn more about our publications, conferences and meetings and membership for individuals and companies. Conference attendees who join or renew as an Individual 1-year member will receive 50 percent off the cost of annual dues.

OSA CAM Lounge

Concourse Foyer

CAM (Centennial Authentic Moments) is an ongoing program of collecting scientific selfies where members talk about what it means to be an OSA Member, who/what inspired them to get into optics and what excites them about their current work in three minutes or less. The collection of these short videos will be featured on OSA's website, social media and various conferences.

Monday, 18 September	08:00-17:00
Tuesday, 19 September	08:00–17:00
Wednesday, 20 September	08:00–17:00

OSA Advocacy Booth

Concourse Foyer

Visit the OSA Advocacy Booth to learn more about how you can get involved in OSA's advocacy programs, talk directly with a member of the OSA Government Relations Team, and have the opportunity to write your members of Congress about research and development funding.

OSA Member Lounge

Concourse Foyer

OSA Members are invited to take a brief respite from the meeting at the Member Lounge. Whether it's to plan your schedule, join or renew your membership, or print your boarding pass, the lounge offers comfortable seating and an opportunity to network with your fellow attendees.

Conference attendees who join or renew as an Individual 1-year member will receive 50% off the cost of annual dues.

Sunday, 17 September	15:00–18:00
Monday, 18 September	08:00–18:00
Tuesday, 19 September	08:00–17:30
Wednesday, 20 September	08:00–17:30
Thursday, 21 September	08:00–11:30

OSA Technical Groups Booth

International Terrace, Terrace Level

Connect with your OSA community during FiO by visiting us at the OSA Technical Groups Booth, located in the International Terrace. OSA Technical Groups offer members the chance to connect with colleagues in their area of expertise through innovative events and focused networking opportunities. Stop by the booth for a chance to meet your technical group leaders and find out more about all of the OSA Technical Group events happening this week.

Stay Connected

Access Technical Digest Papers

Technical attendees have FREE continuous online access to the FiO + LS 2017 technical digest including Postdeadline papers. These 1 or 2-page summaries of 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 "Access Digest Papers" link on the right side of the web page
3. Log in using your email address and password used for registration. 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.

Conference Program Update

Technical program changes will be communicated in the onsite Conference Program Update Sheet distributed with your onsite registration materials. In addition, all updates will be made in the FiO + LS conference app. We encourage you to review them carefully to stay informed on changes to the program.

Onsite program changes will be posted on an update board located at the registration desk. Check daily for new information and/or reference the FiO + LS conference app.

Poster Presentation PDFs

Authors presenting posters have the option to submit the PDF of their poster, which will be attached to their papers in OSA Publishing's Digital Library. If submitted, poster PDFs will be available about three weeks after the conference end date. While accessing the papers in OSA Publishing's Digital Library, look for the multimedia symbol (above).

Exhibit Buyers' Guide

The Exhibit Buyers' Guide is composed of descriptions and contact information for exhibiting companies at this year's conference, and Science & Industry Showcase 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 conference app. We encourage you to review the conference app carefully to stay informed of changes to the guide.

Join the Social Conversation at FiO + LS 2017!

We will be tweeting about program highlights and the latest updates throughout the conference using Twitter. Follow @Opticalsociety on Twitter and tweet about your conference experience using #FIO17 in your tweets. Stop by the OSA booth for more details. Join the conversation.

FiO + LS Conference App

Manage your conference experience by downloading the FiO + LS Conference App to your smartphone or tablet.

Download the app one of three ways:

1. Visit www.frontiersinoptics.com/app
2. Search for 'OSA Events' in the app store
3. Scan the QR code below

Schedule

Search for conference presentations by day, topic, speaker or program type. Plan your schedule by setting bookmarks on programs of interest. Technical attendees can access technical papers within session descriptions.

Science & Industry Showcase

Search for exhibitors or view the complete list. Bookmark exhibitors as a reminder to stop by their booth. Tap on the map icon within a description, and you'll find their location on the show floor map.

Access Technical Digest Papers

Full technical registrants can navigate directly to the technical papers right from the FiO + LS conference app. Locate the session or talk in "Event Schedule" and click on the "Download PDF" link that appears in the description. IMPORTANT: You will need to log in with your registration email and password to access the technical papers. Access is limited to Full Conference attendees only.

Need assistance?

Contact our support team, available 24 hours a day Monday through Friday, and from 09:00 to 21:00 EDT on weekends, at +1.888.889.3069 option 1.

Conference Plenary Session

Plenary Presentations

Tuesday, 19 September, 08:00–09:30
International Ballroom Center, Terrace Level

Jason Eichenholz
Luminar Technologies, USA

Building the Vision for Autonomous Mobility

Autonomous mobility is the disruptive technology of our era, and at its core are optical sensing challenges. Join OSA Fellow and Co-Founder of Luminar, Jason Eichenholz, in an exploration of the past, present, and future of mobility as seen through the eyes of a laser physicist.

About the Speaker: Jason Eichenholz is a serial entrepreneur and pioneer in laser, optics and photonics product development and commercialization. Over the past 25 years, he led the development of hundreds of millions of dollars of new photonics products.

Before joining Luminar as CTO and co-founder, Eichenholz was the CEO and founder of Open Photonics, an open innovation company dedicated to the commercialization of optics and photonics technologies. Prior to that, he served as the Divisional Technology Director at Halma PLC. In that role he was responsible for supporting innovation, technology and strategic development for the Photonics and Health Optics Divisions. Before joining Halma, he was the CTO and Board Member of Ocean Optics Inc. as well as the Director of Strategic Marketing at Newport/Spectra-Physics.

Eichenholz is a fellow of The Optical Society (OSA) and SPIE. He has served as the principal investigator for Air Force and DARPA funded research and development programs and holds 10 U.S. patents on new types of solid-state lasers, displays and photonic devices. Eichenholz has a MS and PhD in Optical Science and Engineering from CREOL – The College of Optics and Photonics at the University of Central Florida and a BS in Physics from Rensselaer Polytechnic Institute.

Laura Cadonati
Georgia Institute of Technology, USA

LIGO, Virgo, and the Dawn of a New Era in Gravitational Wave Astronomy

Gravitational waves, ripples in the fabric of space-time produced by catastrophic astrophysical events, are arguably the most elusive prediction of Einstein's theory of General Relativity, so feeble that Einstein himself thought their detection was impossible. Nevertheless, one hundred years later, the Laser Interferometer Gravitational-wave Observatory (LIGO) has announced the observation of gravitational waves produced by the collision of two black holes. This groundbreaking discovery marks the opening of a new window on the Universe and a new era of gravitational wave astrophysics, where gravitational waves provide new insights into black holes and neutron stars, and may even reveal new objects.

As LIGO and its sister project Virgo wrap up their latest data acquisition run, plans are progressing towards a network of ground based detectors that will be tuning in the gravitational wave signatures traveling to us from billion light years away. I will present the current status of the detectors, recent results, their implications for gravitational wave astronomy and the outlook for future generations of gravitational wave detectors.

About the Speaker: Laura Cadonati is a gravitational wave astrophysicist, member of the Center for Relativistic Astrophysics at Georgia Tech. She has been a widely-recognized leader in the LIGO Scientific Collaboration in the years preparing for and including the discovery of gravitational waves, the most elusive prediction of Einstein's theory of General Relativity. Cadonati's research focuses on the detection, characterization and astrophysical interpretation of short-duration gravitational wave signals that are produced by cataclysmic astrophysical events such as the collisions of black holes or core collapse supernovae. She received her undergraduate degree in Italy, with a Laurea in Physics at the University of Milano, and a PhD in Physics from Princeton University. She is a Fellow of the American Physical Society and past-chair for the Division of Gravity of the American Physical Society. She is deputy spokesperson for the LIGO Scientific Collaboration and was awarded an NSF Career Award.

Visionary Speakers

Monday, 18 September, 08:00–08:45

Majed Chergui
Ecole Polytechnique Fédérale de Lausanne, Switzerland

Theme: Laser Science Frontiers in X-ray Laser Spectroscopy

Opportunities with Novel Ultrafast Deep-UV to X-ray Tools

Novel methods and instrumentation from the X-ray to the deep-ultraviolet range have emerged in recent years that offer unique opportunities to probe a wide variety of systems, with elemental-selectivity, structural sensitivity and high temporal resolution in the femtosecond regime. After briefly introducing these methods, we will give examples relevant to future electronic and structural dynamics of chemical and biological systems and of solid materials.

About the Speaker: Majed Chergui is Professor at the Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland. He is known for developing novel ultrafast spectroscopic methods. In particular, he pioneered ultrafast X-ray spectroscopy and more recently, 2-dimensional deep-UV spectroscopy. With these tools and others, he has solved several problems in chemistry, physics and biology. He is also the founding editor-in-chief of "Structural Dynamics" (AIP Publishing). In recent years, he received the Earle K. Plyler Prize for Molecular Spectroscopy & Dynamics of the American Physical Society and the Edward Stern Award of the International X-ray Absorption Society.

Jungsang Kim
Duke University, USA

Theme: Optics in Computing

Quantum Computing using Trapped Atomic Ions

Quantum computers are capable of solving some computational problems that are believed to be intractable using conventional computers. Recent progress in the development of high quality quantum bits and their successful manipulation have led to significant confidence that a moderate scale quantum computers can be constructed on leading physical platforms such as trapped ions and superconducting circuits. In this presentation, I will discuss the prospect of constructing a scalable quantum processor using trapped ions and progress made to date, leveraging state-of-the-art technical progress leveraging micro-fabricated ion traps, optical micro machines, advanced optical modulators and laser systems.

About the Speaker: Jungsang Kim leads the Multifunctional Integrated Systems Technology group at Duke University. His main area of current research is quantum information sciences, where his group uses trapped atomic ions and a range of photonics technologies in an effort to construct scalable quantum information processors and quantum communication networks. His research focuses on the introduction of new technologies—such as micro fabricated ion traps, optical micro-electromechanical systems, advanced single photon detectors, compact cryogenics and vacuum technologies—toward a functional integration of quantum information processing systems.

Scott McEldowney
Oculus Research, USA

Theme: Virtual Reality and Augmented Vision

Building the Vision for Autonomous Mobility

About the Speaker: Scott McEldowney is lead optics researcher for Oculus Research in Redmond, Washington, USA. He leads a multidisciplinary team of researchers conducting advanced research in near-eye display and advanced imaging systems. Prior to that, McEldowney was a Principal Optical Engineer for Microsoft incubating new hardware technologies that included the development of the Hololens and Kinect. He holds a MS degree in Mechanical Engineering and a PhD in Optical Sciences from the College of Optical Sciences at the University of Arizona.

Wednesday, 20 September, 08:00–08:45

Evelyn Hu
Harvard University, USA

Theme: Nanophotonics and Plasmonics

Nanophotonic Systems: Active Fabrics of Light

Profound advances in controlling material structures and quality at the nanoscale has resulted in our enhanced ability to modulate, store, amplify and transmit photonic information within ever-smaller "footprints." The engineering of materials at the nanoscale has given rise to an abundance of optical metamaterials and metasurfaces with extraordinary, heterogeneous photonic properties by design, such as "near-zero index" materials and "flat" lenses and photonic controllers. The integration of heterogeneous photonic materials and components produces photonic networks and systems that can be regarded as seamless "fabrics" of light, fabrics that may embody sensing, computation and information transfer in new compact forms. Moreover, current research in optomechanics indicates the possibility of efficient transduction of photon and phonon energies (mechanical vibrations and heat), forming fabrics that are not only compact and multi-functional, but also efficient. Concurrently, a variety of two-dimensional materials such as graphene and transition metal dichalcogenides have also emerged as exceptional photonic, as well as electronic materials. These materials have the promise of being naturally interwoven into emerging fabrics of light, with easy integration onto electronic circuits. The promise of these fabrics of light lies in "smart textiles" for individuals that could sense, analyze, compute and communicate information about the

environment as well as harvest the energy that would power those functions. Moreover, these smart fabrics could be integrated pervasively, atop vehicles, infrastructures (bridges, buildings), as well as natural objects to harvest energy, carry out complex sensing and analysis of the local environment.

About the Speaker: Evelyn Hu received a PhD and MA degrees in Physics from Columbia University and a BA in Physics from Barnard College. Prior to her appointment at Harvard, she was Scientific Co-director, California Nanosystems Institute, and a Professor in the Departments of Electrical and Computer Engineering and Materials at the University of California, Santa Barbara. Previously, she worked at AT&T Bell Laboratories.

Wilhelm Kaenders
TOPTICA Photonics AG, Germany

Quantum Physics: Science, Technology, but also Business and Politics?!

The quantum character of the physical world today is not only a tested scientific reality but it provides also an increasingly interesting playfield for new technology development. Many countries have started national programs, often driven by strategic and defense/security interest to identify and progress into quantum technology applications. The open skies-policy of fundamental research has been the key for success of the field and provides opportunities for existing and new businesses, but there are political challenges at the horizon, in particular for small companies.

About the Speaker: Being infected by Cold Atom Physics as a PhD student at the Institute of Quantum Optics in Hannover, and being part of the technology of Hänsch's group at the Max-Planck-Institute in Garching, Wilhelm Kaenders started a successful business activity with tunable diode laser technology. "Frequency Division" in the early days and "Frequency Combing" today have started the Passion of Precision and are still the driving force in TOPTICA's extended scientific product range on its way to mature markets. As cofounder of TOPTICA, he serves together with Thomas Weber as "Vorstand".

James K. Thompson
University of Colorado at Boulder JILA, USA

Theme: Laser Science Novel Lasers

Breaking Quantum and Thermal Limits: Things we can do with many quantum objects that we cannot do with just one

During the twentieth century, the field of laser and atomic science learned to master the quantum states of individual atoms and ions, enabling quantum-based precision sensors of time, acceleration, and gravity, as well as new probes of the fundamental nature of our universe. A new frontier is to move beyond the current single-atom paradigm of precision measurement, and now learn to harness interactions and correlations between many atoms for realizing even more precise probes of nature. I will discuss two lines of research in this area that may allow us to overcome quantum and thermal limits on today's best precision measurements. First, I will discuss using collective measurements to break through the standard quantum limit, a fundamental quantum fuzziness of any measurement using independent atoms. The collective measurement projects a laser-cooled ensemble of rubidium atoms into an entangled state in which atoms conspire to partially cancel one another's quantum noise such that we can directly observe up to 18 dB of phase resolution beyond the standard quantum limit. Next, I will discuss our work to break through long-standing thermal limitations on laser linewidth by utilizing a novel gain medium: the 1 millihertz linewidth optical transition in laser-cooled strontium atoms. I will describe our first observation of pulsed lasing and measurements that indicate that this type of laser could be more than 100,000 times less sensitive to both the technical and thermal brownian motion of the cavity mirrors that limit today's best stable lasers. We also observe that the cavity can create long range spin-exchange interactions between the strontium atoms, perhaps useful one day for both creating entanglement between the atoms and creating a many-body energy gap to protect the atomic coherence against dephasing. These are just two examples of answering a question that will be answered in many diverse and hopefully surprising ways in the next decade: for precisely measuring our universe, what are things we can do with many quantum objects that we fundamentally cannot do with just one?

About the Speaker: James Thompson's laboratory at JILA and the University of Colorado focuses on trying to advance the frontiers of fundamental measurement science using many-body systems where interactions and entanglement enable the breaking of thermal and quantum limits. He attended Florida State University, earning a BA and MS in Physics, and received his PhD in Physics in 2003 from the Massachusetts Institute of Technology (MIT), where he also did his post doctoral work. He has received the 2004 American Physical Society's DAMOP thesis award and the Department of Commerce Bronze medal. His work includes the most precise direct test to date of Einstein's relationship E=mc2, the most precise mass comparisons ever performed, lasers using millihertz linewidth atomic transitions, narrow bandwidth entangled photons, and the achievement of 18 dB of observed spin-squeezing.

Thursday, 21 September, 08:00–08:45

Michael Godwin
OSRAM Opto Semiconductors, USA

Theme: Automotive

Digital Lighting Trends in Automotive Applications: Bits, Bytes and Photons

Novel methods and instrumentation from the X-ray to the deep-ultraviolet range have emerged in recent years that offer unique opportunities to probe a wide variety of systems, with elemental-selectivity, structural sensitivity and high temporal resolution in the femtosecond regime. After briefly introducing these methods, we will give examples relevant to future electronic and structural dynamics of chemical and biological systems and of solid materials.

About the Speaker: Michael S. Godwin is Director of Automotive LED Marketing with OSRAM Opto Semiconductors. He focuses on the automotive interior market globally and exterior market in North America. Prior to this position, Godwin has held positions in Interior Marketing in Regensburg, Germany, and Business Development, General Marketing Manager and Product Marketing Manager in Michigan.

Godwin joined OSRAM Opto Semiconductors in 1999 and assisted in establishing marketing and application teams in the automotive and multi market industries. Through efforts with his team, OSRAM was awarded the Automotive News PACE award (2002); Finalist distinction for industry 1st white lighting on the Lincoln Navigator/Aviator (2006); PACE winner for Color on Demand (2011); Audi A8 winner OSTAR Headlamp and Audi A7 OSLON Black Flat Multichip product family (2015).

He previously held positions in sales management, manufacturing and quality management with leading lighting, electrical interconnect and automotive sensor companies.

Godwin received his BS in Materials Science and Metallurgical Engineering from Michigan Technological University in 1987.

Vladimir M. Shalaev
Purdue University and Birck Nanotechnology Center, USA

Theme: Laser Science Plasmonics and Nanophotonics

Plasmonic Metamaterials Reimagined

The fields of nanophotonics, plasmonics and optical metamaterials have enabled unprecedented ways to control the flow light at both the micro- and nanometer length scales, unfolding new optical phenomena, with a potential to reshape the existing optical technologies and create new ones. In this presentation, emerging plasmonic, metamaterial and metasurfaces concepts as well as material platforms will be discussed with the focus on practical photonic technologies for communication, quantum optics, bio-medical and energy applications.

About the Speaker: Vladimir M. Shalaev, Scientific Director for Nanophotonics at Birck Nanotechnology Center and Distinguished Professor of Electrical and Computer Engineering at Purdue University, specializes in nanophotonics, plasmonics and optical metamaterials. He has received several awards for his research in the field of nanophotonics and metamaterials, including the Max Born Award from The Optical Society for his pioneering contributions to the field of optical metamaterials, the Willis E. Lamb Award for Laser Science and Quantum Optics, the Rolf Landauer medal of the ETOPIM (Electrical, Transport and Optical Properties of Inhomogeneous Media) International Association, the UNESCO Medal for the development of nanosciences and nanotechnologies, OSA and SPIE Goodman Book Writing Award, and the IEEE Photonics Society William Streifer Scientific Achievement Award. He is a Fellow of the IEEE, APS, SPIE, MRS and OSA. Shalaev has authored three books, 30 invited book chapters and over 500 research publications.

Marc Taubenblatt
IBM, USA

Theme: Optics in Computing

Optical Interconnects in Large Scale Computing Systems...What's Next?

All good exponentials must come to an end...but we find new ways to continue progress. When processor clock speeds could not be further increased due to chip power limitations, we continued performance progress with multiple cores per chip, and now with accelerator chips, and all along scaling data centers and HPC systems to ever larger numbers of components. Optical interconnects have played a pivotal role in providing the interconnection bandwidth to allow scaling these systems, with per channel data rates increasing from hundreds of Mb/s to many 10's Gb/s. in the last few decades. Off-switch chip bandwidth will soon exceed 10 Tb/s. Before long, electrical links will begin to reach practical per channel limits, and switch chip power will limit off-chip bandwidth. Tighter integration of optics with switch and compute chips, optical switching and advanced modulation formats are a few examples where optics can offer potential paths forward, though not without pitfalls. What's next for optical interconnects?

About the Speaker: Marc Taubenblatt is currently Senior Manager, Optical Communications and High Speed Test, at IBM's T.J. Watson Research Center, focusing on optical interconnects and high speed electrical packaging for computer systems and data centers, test and innovative diagnostic techniques for high performance computer chips and thermal solutions for HPC and Data Center systems. He has had responsibility for coordinating the IBM Research WW optical interconnect strategy for the past 17 years. In addition, he currently manages a government sponsored research program on advanced computing technology. Taubenblatt has served on the IBM Research technical strategy staff, where he co-led the Global Technology Outlook, an IBM Research Division wide effort in forecasting future technology trends. Before that, he managed the IBM Research Microelectronics Manufacturing Research Program, a cross-research R&D program in collaboration with IBM's microelectronics division, focusing on projects directly influencing semiconductor fabrication cost and efficiencies.

Taubenblatt received a BS degree in Electrical Engineering from Princeton University and MS and PhD degrees in Electrical Engineering from Stanford University. He has been at IBM Research for over 31 years and is also a member of the IBM Academy of Technology and a Principal Research Staff Member.

Awards, Honors and Special Recognitions

FiO + LS Awards Banquet

Monday, 18 September
Reception: 18:30
Program: 19:00–21:00
International Ballroom Center, Terrace Level

Join your colleagues and the OSA Board of Directors at the inaugural FiO + LS Awards Banquet. Celebrate the achievements of award and honor recipients from OSA and APS Division of Laser Science and connect with colleagues.

For the most up-to-date information on the banquet program, please visit frontiersinoptics.com/awardsbanquet.

Note: This is a ticketed event. Limited tickets will be available for purchase on-site at FiO registration up until 12:00 on Monday, 18 September.

OSA 2017 Awards and Honors

Frederic Ives Medal/Jarus W. Quinn Prize

Margaret Murnane, *University of Colorado at Boulder, USA*

The Ives Medal/Quinn Prize recognizes overall distinction in optics and is OSA's highest award. OSA honors Margaret Murnane for pioneering and sustained contributions to ultrafast science ranging from femtosecond lasers to soft x-ray high-harmonic generation to attosecond studies of atoms, molecules and surfaces.

Margaret Murnane is a Fellow of JILA and a faculty member in Physics at the University of Colorado. She runs a trans-disciplinary research group with her husband, Henry Kapteyn. She received her B.S and M.S. degrees from University College Cork, Ireland, and her Ph.D. from UC Berkeley. She joined the faculty at Washington State University in 1990. In 1996, she moved to the University of Michigan, and in 1999 to the University of Colorado. Henry and Margaret also co-founded KMLabs, the first laser company to commercially offer 10fs Ti:sapphire lasers as well as coherent high harmonic systems.

Her research revolutionized ultrafast laser and x-ray science. With her husband and their students, she first designed lasers that operated at the fundamental limits of stability and pulse duration. Murnane then developed a new understanding of extreme nonlinear optics, making it possible to efficiently upshift femtosecond lasers into the x-ray region via high-order harmonic generation (HHG). By producing spatially and temporally coherent beams that are fast enough to capture all motion in our natural world relevant to function, HHG is impacting quantum materials, molecular, nano and imaging science worldwide.

OSA Honorary Member

John C. Mather, *NASA's Goddard Space Flight Center, USA*

The Optical Society's Honorary Membership is the Society's most distinguished membership status and is confirmed by the OSA Board of Directors. John C. Mather was elected in 2016 for his contribution to NASA's Cosmic Background Explorer (COBE) project which measured the cosmic background radiation and its anisotropy with amazing precision from 50 to 600 GHz. This is regarded as the starting point of cosmology as a precision science.

Esther Hoffman Beller Medal

Martijn de Sterke, *University of Sydney, Australia*
The Beller Medal recognizes outstanding contributions to optical science and engineering education. OSA recognizes Martijn de Sterke for far-reaching contributions to optics and photonics education in Australia and the world through exceptional dedication to classroom teaching, outstanding PhD student advising and a sustained commitment to outreach activities.

Michael S. Feld Biophotonics Award

Paras N. Prasad, *State University of New York at Buffalo, USA*
The Feld Biophotonics Award recognizes individuals for their innovative and influential contributions to the field of biophotonics, regardless of their career stage. OSA recognizes Paras N. Prasad for pioneering research in biophotonics, particularly in application of nonlinear optical and multiphoton processes, and for promoting biophotonics and educating future researchers through his seminal monographs and reviews.

Paul F. Forman Team Engineering Excellence Award

Guide Star Alliance, *representing TOPTICA Photonics AG, Germany and MPB Communications, Inc., Canada*
The Forman Team Engineering Excellence Award recognizes team technical achievements in optical engineering. OSA recognizes Guide Star Alliance for the development of the first high-power, fully remote-controlled, turn-key sodium guide star laser system with optimized photon return enabling next-generation adaptive optics under the extreme conditions of telescope sites.

Joseph Fraunhofer Award/Robert M. Burley Prize

Yeshaiahu (Shaya) Fainman, *University of California San Diego, USA*
The Fraunhofer Award/Burley Prize recognizes significant research accomplishments in the field of optical engineering. OSA presents this award to Yeshaiahu (Shaya) Fainman for pioneering, seminal and wide ranging contributions to nanoscale engineering linear and nonlinear optical materials and devices for optical information processing systems.

Edwin Land Medal

Alan C. Bovik, *The University of Texas at Austin, USA*
The Land Medal recognizes pioneering work empowered by scientific research to create inventions, technologies, and products. It is co-sponsored by OSA and the Society for Imaging Science and Technology. Alan Bocik is honored for substantially shaping the direction and advancement of modern perceptual image quality computation, and for energetically engaging industry to transform his ideas into global practice.

Emmett N. Leith Medal

Jumpei Tsujiuchi, *Japan*
The Leith Medal recognizes seminal contributions to the field of optical information processing. OSA honors Jumpei Tsujiuchi for early pioneering work in optical information processing, holography and optical metrology, including the first demonstration of coherent optical processing for image restoration.

Adolph Lomb Medal

Dirk Robert Englund, *Massachusetts Institute of Technology, USA*
The Lomb Medal recognizes noteworthy contributions made to optics at an early career stage. Dirk Robert Englund is receiving this medal for pioneering contributions to scalable solid-state quantum memories in nitrogen-vacancy diamond, high-dimensional quantum key distribution, and photonic integrated circuits for quantum communication and computation.

C. E. K. Mees Medal

Ming C. Wu, *University of California, Berkeley, USA*
The Mees Medal recognizes an original use of optics across different fields. OSA recognizes Ming C. Wu for the invention of optoelectronic tweezers that enable massively parallel manipulation of individual biological cells controlled by digital optical projectors.

William F. Meggers Award

Shaul Mukamel, *University of California Irvine, USA*
The Meggers Award recognizes outstanding work in spectroscopy. Mukamel is being recognized for developing the theoretical framework of coherent multidimensional spectroscopy for electronic excitations in the optical regime and proposing extensions to the x-ray spectral regime.

OSA Treasurer's Award

Scott Dineen, *The Optical Society, USA*
The OSA Treasurer's Award recognizes an OSA employee who contributes significantly to organizational excellence, promotes and enacts innovative solutions and/or exemplifies inspirational leadership.

OSA Fellows

Brian E. Applegate, *Texas A&M University, USA*
For significant contributions to development of novel multimodal molecular and functional optical imaging approaches and innovations in 3-D cochlear optical vibrometry, and for service to the optics community.

Roel G. F. Baets, *Ghent University – IMEC, Belgium*
For major contributions to silicon photonics and service to the photonics community.

John J. Degnan, *Sigma Space Corp, USA*
For leadership in the advancement of laser technology and its applications in satellite and precision interplanetary distance ranging, 3D imaging and atmospheric lidar, free space optical communication and medical instrumentation.

David W. Hahn, *University of Florida, USA*
For pioneering contributions to the analysis of aerosol particles, including single particle analysis, using laser-induced breakdown spectroscopy while also advancing the fundamental understanding of plasma-analyte interactions.

N. Asger Mortensen, *University of Southern Denmark, Denmark*
For pioneering contributions to the field of photonic crystal fibers and the theory of nonlocal phenomena in nanoplasmonics.

Zhe-Yu Jeff Ou, *Indiana University-Purdue University Indianapolis, USA*
For pioneering work in multi-photon interference, quantum entanglement of continuous variables, and narrow-band two-photon sources of light, for the work on precision phase measurement in quantum metrology, and quantum amplification.

Keith D. Paulsen, *Dartmouth College, USA*
For applications of diffuse optical tomography reconstruction methods and surgical guidance with stereovision and fluorescence.

Tomasz S. Tkaczyk, *Rice University, USA*
For development of cost effective technologies in optics, opto-mechanics, electronics, and materials to engineer novel imaging instruments, multi-dimensional snapshot imaging modalities, and systems for early detection and treatment of cancer.

Rashid Zia, *Brown University, USA*
For seminal contributions to the field of nanophotonics, including pioneering work on surface plasmon waveguides, optical-frequency magnetic dipole transitions, and energy-momentum spectroscopy.

APS/Division of Laser Science 2017 Awards and Honors

Arthur L. Schawlow Prize in Laser Science

Louis F. DiMauro, *The Ohio State University, USA*

For groundbreaking work in several areas of high field and ultrafast optical science, from high harmonic generation and free electron lasers to attosecond science.

Louis F. DiMauro, Ph.D., is professor of physics and the Edward and Sylvia Hagenlocker Chair at The Ohio State University (Columbus). He received his B.A. in 1975 from Hunter College, the City University of New York, and his Ph.D. from the University of Connecticut (Storrs) in 1980 and was a postdoctoral fellow at the State University of New York, Stony Brook, before arriving at AT&T Bell Laboratories near Summit, New Jersey, in 1981. DiMauro joined the staff at Brookhaven National Laboratory in Upton, New York, in 1988 rising to the rank of senior scientist. In 2004 he joined the faculty at OSU, the same year he was awarded the Brookhaven National Laboratory/ Brookhaven Science Associates Science & Technology Prize, the 2012 OSU Distinguished Scholar Award, and the 2013 Optical Society (OSA) Meggers Prize. DiMauro is a fellow of the American Physical Society, The Optical Society (OSA), and the American Association for the Advancement of Science. He has served on numerous national and international committees, government panels, served as the 2010 APS Division of Atomic, Molecular and Optical Physics chair and vice-chair of the National Academy of Sciences Committee on Atomic, Molecular and Optical Sciences. His research interest is in experimental ultra-fast and strong-field physics. In 1993, DiMauro and his collaborators introduced the widely accepted semiclassical model in strong-field physics. His current work is focused on the generation, measurement, and application of attosecond X-ray pulses, and the study of fundamental scaling of strong field physics.

Carl E. Anderson Division of Laser Science Dissertation Award

The Carl E. Anderson Award for Outstanding Doctoral Dissertation in Laser Science 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. The winner will be announced at the DLS business meeting Tuesday.

The following presentations will be given during this special session:

Tal Galfsky, *The City University of New York CUNY Graduate Center, USA*
Control of Light-matter Interaction Using Photonic Hypercrystals

Dennis Gardner, *University of Colorado Boulder, USA*
First Demonstration of Sub-Wavelength Imaging at Short Wavelengths

Vivishek Sudhir, *Ecole Polytechnique Federale De Lausanne, Switzerland*
Quantum Limits on Measurement and Control of a Mechanical Oscillator

Shuo Sun, *University of Maryland, College Park, USA*
Nanophotonic Spin-photon Quantum Transistor

OSA Foundation 2017 Prizes and Special Recognitions

OSA Foundation Grant Recipients

The OSA Foundation would like to congratulate our FiO grant recipients. Through the following programs we have been able to provide nearly 20 grants, scholarships and prizes to help students attending FiO.

You can help to inspire and support the next generation of science and engineering innovators by making a donation to the OSA Foundation. 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.

OSA Foundation Boris P. Stoicheff Memorial Scholarship

2017 Recipient: Ali K. Jahromi, *University of Central Florida, USA*

Established in 2011 by the OSAF and the Canadian Association of Physicists Educational Trust Fund (CAPETF), this program pays tribute to Boris P. Stoicheff, an internationally renowned laser spectroscopist who also served as President of OSA (1976) and CAP (1983-84).This $3,000 USD scholarship is awarded annually to a graduate student who has demonstrated both research excellence and significant service to the optics or physics community.

Past student recipients for this program can be found online at osa.org/stoicheff. 2017 recipient will also be announced at the FiO + LS Awards Banquet.

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 seven FiO subcommittees. Winners receive a complimentary OSA three-year student membership, an award stipend of $300 USD and an award certificate.

Past student recipients for this program can be found online at osa.org/wolf. 2017 recipients will also be announced at the FiO + LS Awards Banquet.

Congratulations to our finalists competing at FiO:

FiO 1: Fabrication, Design and Instrumentation
Gun-Yeal Lee, *Seoul National University, Republic of Korea*
David Miller, *University of Colorado at Boulder, USA*
Haoyi Yu, *RMIT University, Australia*

FiO 2: Optical Interactions
Lorenzo De Angelis, *Delft University of Technology, Netherlands*
Rodrigo Gutiérrez-Cuevas, *University of Rochester, USA*
Fatholah Salehi, *University of Maryland, USA*

FiO 3: Quantum Electronics
Anand Bahl, *University of Arizona, USA*
Jeremy Pigeon, *UCLA, USA*
Yu Shiozawa, *The University of Tokyo, Japan*

FiO 4: Photonics
Ali Kazemi Jahromi, *University of Central Florida, CREOL, USA*
Alexander Lind, *National Institute of Standards and Technology, University of Colorado Boulder, USA*
Kai Wang, *Friedrich-Schiller-Universität Jena, The Australian National University, Australia*

FiO 5: Biomedical Optics
Joana Paiva, *INESC TEC - INESC Technology and Science, Sciences Faculty of University of Porto, Portugal*
Seth Smith-Dryden, *University of Central Florida, USA*
Florian Stroehl, *University of Cambridge, United Kingdom*

FiO 6: Information Acquisition, Processing and Display
Yijun Bao, *Georgia Institute of Technology, USA*
Mahed Batarseh, *University of Central Florida, USA*
Zhean Shen, *CREOL, USA*

FiO 7: Vision and Color
No finalists from FiO 7

OSA Foundation 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 Frontiers in Optics. Grants are awarded to the presenter and usually the first author of the paper.

Past student recipients for this program can be found online at osa.org/incubic. 2017 recipients will also be announced at the FiO + LS Awards Banquet.

Travel Grant Recipients:

Yijun Bao, *Georgia Institute of Technology, USA*
Joshua A. Burrow, *University of Dayton, USA*
Shun Fujii, *Keio University, Japan*
Gun-Yeal Lee, *Seoul National University, Republic of Korea*
M.V Jabir, *Physical Research Laboratory, India*
Ezgi Sahin, *Singapore University of Technology and Design, Singapore*
Maria Solyanik, *George Washington University, USA*
Nathália B. Tomazio, *University of Sao Paulo/Sao Carlos Institute of Physics, Brazil*
Yunyi Yang, *Centre for Micro-Photonics/Swinburne University of Technology, Australia*
Han Zhang, *University of Texas at Arlington, USA*

OSA Foundation Jean Bennett Memorial Student Travel Grant

2017 Recipient: Aonan Zhang, *Nanjing University, China*

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 University Department of Physics and individual contributors.

Past student recipients for this program can be found online at osa.org/bennett. 2017 recipient will also be announced at the FiO + LS Awards Banquet.

OSA Student Chapter & Local Section Excellence Prize

OSA annually recognizes chapters and sections for excellence supporting their local communities and their members. Winners will be announced at FiO + LS.

Finalists will compete for top honors in two categories:

Community/Youth Education Outreach

This category is for chapters and sections who have made a difference in their local communities. These are chapters/sections who visit schools and science fairs, create their own outreach kits as well as using the the Optics Suitcase in order to teach youth about the science of light.

Professional Development

The Professional Development category is for chapters/sections that are well-oiled machines. These are chapters/sections that hold technical conferences and lecture series with the polish of many professional conferences as well as chapters/sections who are able to guarantee a special experience for members and support diversity and inclusion within both the chapter/section and the optics and photonics community.

Science & Industry Showcase

Tuesday, 19 September, 09:30–16:00
Wednesday, 20 September, 10:00–15:00
Columbia, Terrace Level

The FiO exhibition transforms into The Science & Industry Showcase – in which exhibiting companies are partnered with innovative demonstrations, networking events, poster presentations, e-posters and Rapid-fire Oral Presentations. Learn about new products, find technical and business solutions and gain the most up-to-date market perspective of your industry. Don't miss this opportunity to visit companies representing a broad range of the best products and applications in the optics and photonics industry. There is no charge to attend the Showcase—it's open to all registered attendees!

Beyond R2D2: Advances in Robotics

Booth #119

The Laboratory for Computational Sensing and Robotics (LCSR) at the Johns Hopkins University will showcase cutting-edge research projects in Medical Robotics. The LCSR exhibition will include live demonstrations of surgical robots for eye surgery. It will also highlight other robotic work that include Extreme Environments Robotics, Human-Machine Systems for Manufacturing, BioRobotics and more. See these demonstrations at Booth #119 during Showcase hours.

Poster Sessions & E-Posters

Tuesday, 19 September, 10:00–12:00, 13:00–15:00
Wednesday, 20 September, 10:00–12:00, 13:00–15:00

Attend the Poster Sessions and view more than 500 posters scheduled for presentation. Poster presentations communicate new research findings in an intimate setting that encourages lively and detailed discussion between presenters and attendees.

A select number of presentations will be offered as e-posters—which supplements the author's introduction, motivation, results and conclusions with digital capabilities that aid deeper discussion. Look for the ***E-Poster*** symbol to see who will be presenting e-posters.

Rapid-fire Oral Presentations

Science Showcase Theater

Held in the Science Showcase Theater during the first hour of each poster session, a select number of poster presenters offer Rapid-fire Oral Presentations, which consist of a brief oral presentation accompanied by slides. This format enables poster presenters to preview key results from their research in brief, five-minute segments. In the session's second hour, presenters are available for more in-depth discussions adjacent to their accompanying posters. The ***RAPID*** symbol indicates Rapid-fire Oral Presentations. See the abstracts for a detailed schedule.

Meet OSA's Journal Editors

Tuesday, 19 September, 11:45–12:45
Science Showcase Theater

Come celebrate the anniversaries of *Optics Letters* and *Optics Express* at the OSA Journals lunchtime reception. Enjoy complimentary pizza, cake and refreshments while conversing with OSA Publishing's Editors-in-Chief, Deputy Editors and Associate Editors. Bring your questions about submitting manuscripts, ideas for Feature Issues or other questions and concerns about the journals.

Pizza Lunch

Tuesday, 19 September, 12:00–13:00

Join your colleagues for a FREE pizza lunch. This is a great opportunity to meet the exhibitors and OSA Journal Editors.

Sponsored by OSA Publishing

OSA Student Chapter Competition

Tuesday, 19 September, 13:00–15:00

Each year OSA student members are invited to participate in a unique competition that tests their skills in the field. This year students have been challenged to develop a hands on outreach activity for K-12 youth education. The goal is to engage children in the optics and photonics field through a variety of hands on activities.

Congressional Fellowship Information Session

Wednesday, 20 September, 12:00–13:00
Science Showcase Theater

Learn more about the Congressional Science Policy Fellowships from a past Congressional Fellow. The Congressional Science Policy Fellowships provide a unique opportunity for PhD scientists and engineers to spend one year working for a U.S. member of Congress or Congressional committee to learn about the policy making process while also bringing their scientific backgrounds and perspectives to the Congressional office. OSA cosponsors two Congressional Fellows per year. This information session will feature a past Congressional Fellow who will discuss the fellowship experience, how it has had an impact on their career, why scientists and engineers should consider applying for the fellowship, and answer questions from interested attendees. To learn more about the fellowships or the applications process, visit www.osa.org/congressionalfellowships.

FiO 2017 Participating Companies:

(as of 8/20/17)

	Booth Number
Accumold	219
American Association for the Advancement of Science	Sponsor
Asphericon	215
Association for Research in Vision and Ophthalmology	212
Bruker Nano Surfaces Division	204
De Gruyter	221
Energetiq Technology, Inc.	315
General Photonics Corp.	318
High Tech Rochester Luminate Accelerator	304
Imagine Optic/Axiom Optics	205
Inrad Optics	312
IOP Publishing Ltd.	305
Liquid Instruments	115
Material Research Society (MRS)	Publication Bin
Menlo Systems, Inc.	112
Microtech Instruments, Inc.	120
MKS (Newport Corp)	125
National Institute of Standards and Technology (NIST), Center for Nanoscale Science &Technology	313
NKT Photonics	203
Ophir-Spiricon, LLC	310
Optimax Systems, Inc.	201
OSA Industry Development Associates (OIDA)	Sponsor
OSA Publishing	Sponsor
Photonic Cleaning Technologies	314
Photonics Media/Laurin Publishing	118, Publication Bin
Physics Today	213, Publication Bin
piezosystem jena, Inc.	303
SPIE: The International Society for Optics and Photonics	114
Springer Nature	302
Synopsys, Inc.	409, Sponsor
OSA – The Optical Society	419
Thorlabs	107
Vermont Photonics Inc.	208
WORKinOPTICS	304
Wuhan National Lab for Optoelectronics	300
Zygo Corporation	214

Special Events

Women of Light, a Special Program for Women in Optics hosted by WiSTEE Connect

Sunday, 17 September, 09:00–15:00
OSA Headquarters, 2010 Massachusetts Ave., NW, Washington, D.C.

The overall goal of the "Global Women of Light" Symposium is to shine light on women's careers in science, technology, engineering, mathematics and entrepreneurship; recruit women across career ranks and disciplines; and build a sustainable community of women in both academia and industry from which career growth, mobility and leadership opportunities may be sought.

WiSTEE Connect is an organization that serves to connect female students, faculty members, scientists, and engineers in Science, Technology, Engineering and Entrepreneurship (STEE) from universities, government labs and private companies. The vision of WiSTEE Connect is to promote women leadership in STEE and assist women involved in these areas to gain regional and/or global connections and recognition. This organization helps to bridge the gap between science and entrepreneurship while providing a forum through which women in these fields may learn, connect and lead.

Funded by OSA Foundation

Laser Science Symposium on Undergraduate Research

Sunday, 17 September, 12:00–18:00
Jefferson East, Concourse Level

Organizers: Chad Hoyt, *Bethel University, USA,* and Harold Metcalf, *Stony Brook University, USA*

The Symposium on Undergraduate Research has been a feature of the annual meeting of the Division of Laser Science of the American Physical Society (APS-DLS) for sixteen years, and has showcased the research work of more than 500 students during that time. Students' presentations often describe their work during the previous summer. The NSF has played a vital role by providing the research opportunities for many of the students through its REU programs, as well as by direct support of the event. The symposium has been generously supported by the DLS, OSA, NSF, SPS, and Univ. MD (JQI), along with corporate sponsors Thorlabs, Photonics Industries, East Coast Optical Technologies, and Bristol Instruments.

OSA Student Member Party

Sunday, 17 September, 18:30–20:30
The Brixton, 901 U. St. NW Washington, DC

OSA Student Members who are student full technical registrants of FiO + LS are invited to attend the OSA Student Member Party. This party will celebrate the next generation of leaders in the optics and photonics community with food, drinks and entertainment.

Capitol Hill Visits

Monday, 18 September, 09:00–12:00
Senate and House Office Buildings, Washington D.C.

As Congress determines spending levels in the FY 2018 Budget, it is important for members of Congress to hear directly from their constituents about the importance of research and development funding. To facilitate those interactions, OSA will be holding U.S. Capitol Hill visits to advocate for R&D funding. Prior RSVP was required to participate. If you RSVP'd for Capitol Hill visits and have questions, contact Brandy Dillingham at bdillingham@osa.org.

Grant Writing 101 Workshop

Monday, 18 September, 12:30–14:00
Fairchild Room, Terrace Level

Join the leaders of the OSA Tissue Imaging and Spectroscopy Technical Group, Paul Campagnola and Kyle Quinn, for a workshop aimed at helping young investigators develop competitive grant proposals. Best practices and tips for writing strong grant proposals will be shared with workshop attendees. An RSVP is required for this workshop as lunch will be provided. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Tissue Imaging and Spectroscopy Technical Group, OSA Foundation

Challenges and Emerging Opportunities in Molecular Probes and Nanobio-Optics

Monday, 18 September, 12:30-13:30
Georgetown East, Concourse Level

Join the OSA Molecular Probes and Nanobio-Optics Technical Group for a panel discussion exploring challenges and emerging opportunities in molecular probes and nanobio-optics. Short presentations from our featured panelists will be followed by a moderated question and answer session, helping facilitate the exchange of information with our community. An RSVP is required for this technical group event as lunch will be provided. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Molecular Probes and Nanobio-optics Technical Group

OSA Nonlinear Optics Technical Group Workshop & Networking Session

Monday, 18 September, 16:00-17:30
Georgetown West, Concourse Level

This special workshop will bring together researchers interested in the area of nonlinear optics for a discussion on new and emerging topics in the field. Immediately following the presentations from the workshop's featured speakers, attendees are invited to join the OSA Nonlinear Optics Technical Group for a small reception where they can network with colleagues over refreshments. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Nonlinear Optics Technical Group

Workshop: Understanding Unconscious Bias

Monday, 18 September, 16:00–17:30
Georgetown East, Concourse Level

Speaker: Sara Bendoraitis, *American University, USA*

Research demonstrates that we all have unconscious biases. These biases can result in best and brightest talent made to feel unwelcome, invisible and not important to the success of the organization. This training will explore concepts and engage participants to better understand implicit bias, increase awareness and understanding the impact on organizational culture and identify ways to promote greater engagement with diversity and inclusion.

Sponsored by OSA Foundation

Evening with the Agencies

Monday 18 September, 16:00–18:00
Jefferson West, Concourse Level

This program, featuring representatives from US and international agencies, will provide attendees with the opportunity to hear about the latest in science funding as well as network with key program managers. Panelists will share their thoughts on the current state of science funding and the most important thing prospective grantees should remember when applying for funding. A networking reception will follow the presentation.

FiO + LS Awards Banquet - Making Connections & Celebrating Achievement

Monday, 18 September, 18:30–21:00
International Ballroom Center, Terrace Level

Celebrate the achievements of award and honor recipients from OSA and APS Division of Laser Science. Join your colleagues and the OSA Board of Directors at the inaugural FiO + LS Award Banquet.

Those recognized will include the 2017 OSA Frederic Ives Medal /Jarus W. Quinn Prize winner Margaret Murnane, and the 2017 APS Arthur L. Schawlow Prize in Laser Science recipient Louis F. DiMauro, as well as other 2017 OSA and APS/LS winners and honorees.

Note: This is a ticketed event. Limited tickets will be available for purchase on-site at FiO registration up until 12:00 on Monday, 18 September.

Environmental Sensing Technical Group Networking Event

Tuesday, 19 September, 16:30–17:00
OSA Technical Group Booth, International Terrace, Terrace Level

Members of the OSA Environmental Sensing Technical Group are invited to join us for a networking event on Tuesday afternoon at the OSA Technical Group booth in the International Terrace. The event will provide an opportunity to connect with fellow attendees who share an interest in this field and to learn more about this technical group. Refreshments will be provided; please RSVP to TGactivities@osa.org if you plan to join us for this networking event.

Sponsored by OSA Environmental Sensing Technical Group

OSA Annual Business Meeting

Tuesday, 19 September, 17:30–18:15
Kalorama, Lobby Level

Learn more about OSA and join the OSA Board of Directors for the Society's annual business meeting. An update on the Society's 2016 activities will be presented and the results of the Board of Directors election will be announced.

DLS Annual Business Meeting

Tuesday, 19 September, 17:30–18:30
Holmead East, Lobby Level

All members and interested parties are invited to attend the annual business meeting of the APS 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 an opportunity to help define the operations of the DLS and the LS Conference.

FiO + LS Conference Reception

Tuesday, 19 September, 18:30–20:30
International Ballroom Center, Terrace Level

Join your peers and colleagues in acknowledging the innovators and inventions that inspire the future. Meet with conference attendees from around the world, and enjoy light hors d'oeuvres. The reception is sure to be a high point in a memorable conference week.

Sponsored by THORLABS

The "Rush Hour": Science Policy talk by Rush Holt, CEO of AAAS and former U.S. member of Congress

Wednesday, 20 September, 09:00–10:00
Georgetown West, Concourse Level

What Does a Scientist Owe Policymakers?

At a time when there are widespread concerns about the place of science in our society and government, we should consider: What is the obligation of a scientist, engineer, or technologist to policymakers? Sometimes, we simply disparage the ill-founded pronouncements of politicians, decisions producing inadequate funding for research, or regulations hampering research, when instead we might ask what we can do to help avoid such short-sighted actions.

Coffee and pastries will be served beginning at 08:45.

OSA Members, Family and Friends Tour – National Gallery of Art

Wednesday, 20 September, 09:30–12:00

The mission of the National Gallery of Art is to serve the United States of America by preserving, collecting, exhibiting, and fostering understanding of works of art at the highest possible museum and scholarly standards. Join OSA members on a behind the scenes tour of the East Building, where you will be guided by expert docents who will highlight conservation techniques of works on and off display.

Shuttle transportation will pick up at the Hilton's front entrance at 09:30 and will return from the tour at 12:00.

OIDA VIP Industry Leaders Speed Meetings Lunch

Wednesday, 20 September, 12:00–13:30
Kalorama, Lobby Level

This session brings together industry executives to share their business experience with early career professionals, recent graduates and students. Learn how they started their careers, lessons learned and how they are using their degrees in executive positions. Informal networking over lunch is followed by a transition to "speed meetings" — brief, small-group visits with each executive to discuss industry trends or career topics.

Sponsored by GoFoton

OSA Optical Material Studies Technical Group Special Talk

Wednesday, 20 September, 12:00–13:00
Georgetown West, Concourse Level

Join the OSA Optical Material Studies Technical Group for a special talk focused on recent advances in meta and plasmonic materials. Dr. Vladimir Shalaev of Purdue University and Birck Nanotechnology Center will be the featured speaker and will present his talk 'Catching Light Rays: Refractory Plasmonic Metamaterials for Energy Conversion, Data Storage & Medical Applications'.

An RSVP is required for this technical group event as lunch will be provided. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Optical Material Studies Technical Group

Polarization Optics - Design and Fabrication Trends and Challenges

Wednesday, 20 September, 12:00–13:00
Georgetown East, Concourse Level

This OSA Technical Group event will bring together panelists from academia and industry to explore current trends in polarizing optics design and talk about the challenges related to polarization optics. The topics of the discussion forum will be guided by our featured panelists and moderated by Catalin Florea, Chair of the Optical Fabrication and Testing Technical Group, and Hossein Alisafaee, Chair of the Polarization Technical Group. An RSVP is required for this event as lunch will be provided. Contact TGactivities@osa.org to register, pending availability.

Sponsored by OSA Polarization Technical Group OSA Optical Fabrication and Testing Technical Group

Meet the APS Journal Editors Reception

Wednesday, 20 September, 15:30–17:00
International Terrace, Terrace Level

APS physics

The editors of the *Physical Review* 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.

Pairing Photons to Electrons: An OSA Nanophotonics Technical Group Networking

Wednesday, 20 September, 16:30–17:00
OSA Technical Group Booth, International Terrace, Terrace Level

The OSA Nanophotonics Technical Group will host a special networking event that aims to pair young researchers, the electrons, with more experienced individuals in the nanophotonics community, the photons. Photons and electrons interested in participating in this interactive session will need to register in advance to be paired with one another.

Please contact TGactivities@osa.org for details.

Sponsored by OSA Nanophotonics Technical Group

Networking with the OSA Biomedical Optics Technical Groups

Wednesday, 20 September, 18:30–20:00
OSA Headquarters, 2010 Massachusetts Ave., NW, Washington, D.C.

You are invited to join members of several OSA Biomedical Optics Technical Groups for a happy hour networking event at OSA Headquarters on Wednesday evening. Jointly hosted by the Photobiomodulation Technical Group, Therapeutic Laser Applications Technical Group and Tissue Imaging and Spectroscopy Technical Group, this event will provide researchers working within biomedical optics with the opportunity to meet and learn from fellow attendees in adjoining fields. Refreshments will be provided.Please RSVP to tgactivities@osa.org if you plan to join us for this networking event.

Sponsored by OSA Technical Groups

FiO + LS Committee

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

Frontiers in Optics General Chairs

Steve Cundiff, *University of Michigan, USA*
Susana Marcos, *Consejo Sup Investigaciones Cientificas, Spain*

FiO Theme Coordinators

Automotive

Alex Bowers, *Schepens Eye Research Institute, USA*
Ruben Mohedano, *LPI Europe, Spain*
Chris Trowbridge, *Argo, USA*

Nanophotonics and Plasmonics

Dirk Englund, *MIT, USA*

Optics in Computing

Katharine Shmidtke, *Facebook, USA*

Virtual Reality and Augmented Vision

Bernard Kress, *Microsoft, Inc., USA*

FiO Program Committees

FiO 1: Fabrication, Design and Instrumentation

Byoungho Lee, *Seoul National University, Korea,* **Subcommittee Chair**
Jessica DeGroote Nelson, *Optimax Systems, Inc., USA*
Pietro Ferraro, *Inst. of Applied Sciences and Intelligent System - CNR, Italy*
Groot Gregory, *Synopsys, Inc., USA*
Yoshio Hayasaki, *Utsunomiya University, Japan*
Joohwan Kim, *NVIDIA Corporation, USA*
John Koshel, *University of Arizona, USA*
Pascal Picart, *Laboratoire d'Acoustique de l'Universite du Maine, France*
Jamie Leigh Ramsey, *Rochester Precision Optics, USA*
Yunlong Sheng, *Université Laval, Canada*
Simon Thibault, *Université Laval, Canada*
Changhe Zhou, *Shanghai Inst. of Optics and Fine Mechanics, China*

FiO 2: Optical Interactions

Kishan Dholakia, *University of St. Andrews, UK,* **Subcommittee Chair**
Greg Gbur, *University of North Carolina at Charlotte, USA*
Carlos Lopez-Mariscal, *Underwater Photonics, Mexico*
Takashige Omatsu, *Chiba University, Japan*
Halina Rubensztein-Dunlop, *University of Queensland, Australia*
Donna Strickland, *University of Waterloo, Canada*

FiO 3: Quantum Electronics

Dan Gauthier, *The Ohio State University, USA,* **Subcommittee Chair**
Paul M. Alsing, *Air Force Research Laboratory, Rome, Italy*
Antonio Badalato, *University of Ottawa, Canada*
Serge Massar, *Universite Libre de Bruxelles, Belgium*
Christine Silberhorn, *Universitat Pderhorn, Germany*
Brian Smith, *University of Oregon, USA*
Michael Vasilyev, *University of Texas at Arlington, USA*

FiO 4: Photonics

Greg Raybon, *Nokia/Alcatel-Lucent, USA,* **Subcommittee Chair**
Paul Barclay, *University of Calgary, Canada,* **Subcommittee Chair**
Tymon Barwicz, *IBM, USA*
Mina Esmaeelpour, *Stanford University, USA*
Lara Garrett, *TEsubcom, USA*
Roger Helkey, *University of California Santa Barbara, USA*
Femius Koenderink, *AMOIF, Netherlands*
Dangyuan Lei, *Hong Kong Polytechnique Montreal, Canada*
Qiang Lin, *University of Rochester, USA*
Michelle Povinelli, *University of Southern California, USA*

FiO 5: Biomedical Optics

David Busch, *University of Pennsylvania, Children's Hospital of Philadelphia, USA,* **Subcommittee Chair**
Caroline Boudoux, *Wellman Center for Photomedicine, Canada*
Félix Fanjul-Vélez, *Universidad de Cantabria, Spain*

FiO 6: Information Acquisition, Processing and Display

Wei Lee, *National Chiao Tung University, Taiwan,* **Subcommittee Chair**
Johannes Courtial, *University of Glasgow, UK*
Ben Gallant, *Daydream Virtual Reality Group, Google Inc., USA*
Hong Hua, *University of Arizona, USA*
Bahram Javidi, *University of Connecticut, USA*
Amy Oldenburg, *University of North Carolina at Chapel Hill, USA*
Anne Sentenac, *Fresnel Institute, France*
Kenji Yamamoto, *National Institute of Information and Communications Technology, Japan*

FiO 7: Vision and Color

Gabriel Diaz, *Rochester Institute of Technology, USA,* **Subcommittee Chair**
Jeff Mulligan, *NASA Ames Research Group, USA*
Marina Zanolli, *Oculus Research, USA*

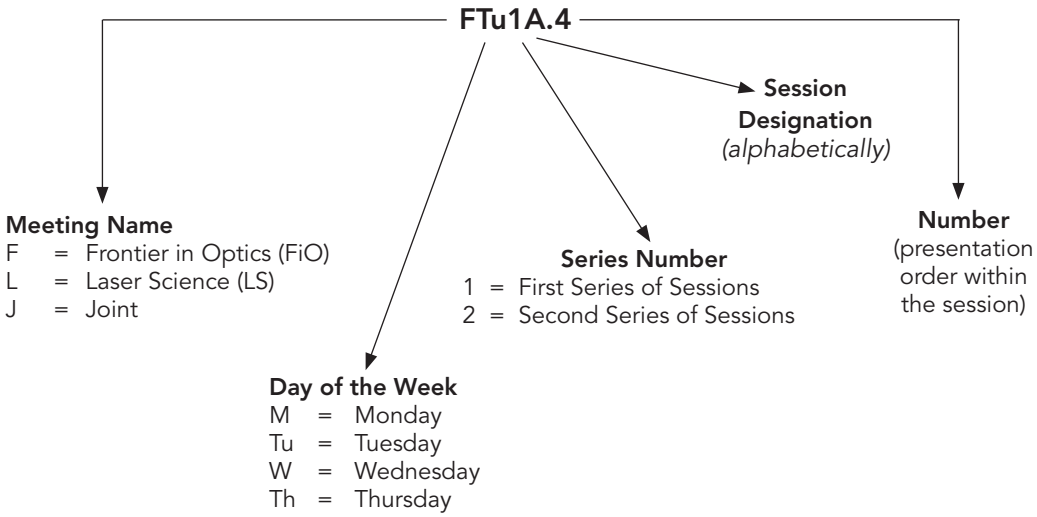
Laser Science Chairs

Mark G. Raizen, *University of Texas at Austin, USA*
Roseanne J. Sension, *University of Michigan, USA*

Laser Science Program Committees

1. **High-harmonic Generation: Time, Energy, and Complexity**
   Josh Vura-Weis, *University of Illinois-Urbana Champaigne, USA,* **Organizer**
2. **Frontiers in X-ray Laser Spectroscopy**
   Roseanne J. Sension, *University of Michigan, USA*
3. **Plasmonics and Nanophotonics**
   Mark G. Raizen, *University of Texas at Austin, USA*
4. **Novel Lasers**
   Hui Cao, *Yale University, USA,* **Organizer**

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 FW2A.1 indicates that this paper is part of the FiO + LS Meeting and is being presented on Wednesday (W) in the second series of sessions (2), and is the first parallel session (A) in that series and the first paper (1) presented in that session.

Agenda of Sessions — Sunday, 17 September

15:00–18:00	**Registration,** *Concourse Foyer*
07:00–17:00	**OSA Student Chapter Leadership Conference (Invitation Only),** *International Ballroom East, Concourse Level*
09:00–15:00	**Women of Light: A Special Program for Women in Optics,** *OSA Headquarters, 2010 Massachusetts Ave., NW*
12:00–18:00	**Laser Science Symposium on Undergraduate Research,** *Jefferson East, Concourse Level*
18:30–20:30	**OSA Student Member Party,** *The Brixton, 901 U Street, NW*

All locations listed are in the Washington Hilton unless otherwise noted.

Locations may change, please check the conference app and update sheet for the latest scheduling updates.

Key to Shading

Frontiers in Optics Laser Science Joint

Agenda of Sessions — Monday, 18 September

	International Ballroom West	International Ballroom East	Georgetown West	Georgetown East	Jefferson West	Jefferson East
07:00–18:00	**Registration,** *Concourse Foyer*					
08:00–08:45	**FM1A • Visionary Speaker: Jungsang Kim**	**FM1B • Visionary Speaker: Scott McEldowney**				**LM1C • Visionary Speaker: Majed Chergui**
08:45–09:00	**Break**					
09:00–12:00	**Capitol Hill Visits,** *Senate and House Office Buildings, Washington D.C.*					
09:00–10:00	**FM2A • Modulators and Resonators**	**FM2B • Advances with Pulsed Laser Sources**	**FM2C • Optical Systems for Automotive Applications**	**FM2D • Quantum Measurement and Communication**	**FM2E • Quantum Absorbers and Emitters**	**LM2F • Frontiers in X-ray Laser Spectroscopy**
10:00–10:30	**Coffee Break,** *International Terrace, Terrace Level*					
10:30–12:30	**FM3A • Silicon Photonics I**	**FM3B • Trapping and Advanced Beam Shaping**	**FM3C • Computational/ Transformation Optics and Optics in Computing**	**FM3D • Nanophotonics I**	**FM3E • Quantum Memories and Interfaces**	**LM3F • Carl E. Anderson Outstanding Dissertation Award in Laser Science**
12:30–13:30	**Lunch Break** *(on your own)*					
12:30–13:30	**Challenges and Emerging Opportunities in Molecular Probes and Nanobio-Optics,** *Georgetown East, Concourse Level*					
12:30–14:00	**Grant Writing 101 Workshop,** *Fairchild Room, Terrace Level*					
13:30–15:30	**FM4A • Plamonics and Metamaterials**	**FM4B • Studies with Complex Media, Imaging and Light**	**FM4C • General Information Acquisition, Processing and Display**	**FM4D • Biomedical Optics in Scattering Media**	**FM4E • High-Dimension Quantum Systems and Simulation**	**LM4F • X-Ray Science With Table Top and XFEL Lasers**
15:30–16:00	**Coffee Break,** *International Terrace, Terrace Level*					
16:00–17:30	**Workshop: Understanding Unconscious Bias,** *Georgetown East, Concourse Level*					
16:00–17:30	**OSA Nonlinear Optics Technical Group Workshop & Networking Session,** *Georgetown West, Concourse Level*					
16:00–18:00	**Evening with the Agencies & Reception,** *Jefferson West, Concourse Level*					
18:30–21:00	**FiO + LS Awards Banquet,** *International Ballroom Center, Terrace Level*					

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Key to Shading

Frontiers in Optics Laser Science Joint

Agenda of Sessions — Tuesday, 19 September

	International Ballroom West	International Ballroom East	Georgetown West	Georgetown East	Jefferson West	Jefferson East
07:00–17:30	**Registration,** *Concourse Foyer*					
08:00–09:30	**JTu1A • Joint Plenary Session,** *International Ballroom Center, Terrace Level*					
09:30–10:00	**Exhibits and Coffee Break,** *Science & Industry Showcase, Columbia, Terrace Level*					
10:00–12:00	**JTu2A • Science & Industry Showcase Exhibits, Poster Session & E-Posters Rapid-Fire Oral Presentations I in Theater** *Columbia, Terrace Level*					
11:45–12:45	**Meet OSA's Journal Editors,** *Science Showcase Theater, Columbia, Terrace Level*					
12:00–13:00	**Pizza Lunch,** *Science & Industry Showcase, Columbia, Terrace Level*					
13:00–13:30	**Coffee Break,** *Science & Industry Showcase, Columbia, Terrace Level*					
13:00–15:00	**JTu3A • Science & Industry Showcase Exhibits, Poster Session & E-Posters Rapid-Fire Oral Presentations II in Theater** *Columbia, Terrace Level*					
15:00–16:30	**FTu4A • Integrated Optics**	**FTu4B • Advanced Spectroscopy and New Approaches**	**FTu4C • Display Technology for VR/AR Applications**	**FTu4D • Novel Phenomena in Photonic Devices**	**FTu4E • Quantum Electronics in the Automotive Sector**	**LTu4F • High Harmonic Sources and Applications**
16:30–16:45	**Break**					
16:30–17:00	**Environmental Sensing Technical Group Networking Event,** *OSA Technical Group Booth, International Terrace, Terrace Level*					
16:45–18:15	**FTu5A • Pulse and Comb Sources**	**FTu5B • Advanced Imaging and Interactions with Materials**	**FTu5C • Real-time Optical Guidance of Cancer Therapy**	**FTu5D • Nanophotonic Systems**	**FTu5E • Quantum Measurement and Sensors**	**LTu5F • Applications of Ultrafast X-rays**
17:30–18:15	**OSA Annual Business Meeting,** *Kalorama, Lobby Level*					
17:30–18:30	**APS Division of Laser Science Annual Business Meeting,** *Holmead East, Lobby Level*					
18:30–20:30	**FiO + LS Conference Reception,** *International Ballroom Center, Terrace Level*					

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Key to Shading

Frontiers in Optics Laser Science Joint

Agenda of Sessions — Wednesday, 20 September

	International Ballroom West	International Ballroom East	Georgetown West	Georgetown East	Jefferson West	Jefferson East
07:30–17:30	**Registration,** *Concourse Foyer*					
08:00–08:45	**FW1A • Visionary Speaker: Evelyn Hu**	**FW1B • Visionary Speaker: Wilhelm Kaenders**				**LW1C • Visionary Speaker: James K.Thompson**
08:45–09:00	**Break**					
09:00–10:00	**FW2A • Quantum Communications**	**FW2B • Trapping and Shaping of Light**	**FW2C • Optics in Computing and Imaging**	**FW2D • The "Rush Hour": Science Policy talk by Rush Holt**	**FW2E • Precision Measurement Using Laser-atom Interactions**	**LW2F • Nanophotonics II**
10:00–10:30	**Coffee Break,** *Science & Industry Showcase, Columbia, Terrace Level*					
10:00–12:00	**JW3A • Science & Industry Showcase Exhibits, Poster Session & E-Posters Rapid-Fire Oral Presentations III in Theater** *Columbia, Terrace Level*					
12:00–13:00	**Lunch Break** *(on your own)*					
12:00–13:00	**Congressional Fellowship Program Information Session,** *Science Showcase Theater, Columbia, Terrace Level*					
12:00–13:00	**OSA Optical Material Studies Technical Group Special Talk,** *Georgetown West, Concourse Level*					
12:00–13:00	**Polarization Optics - Design and Fabrication Trends and Challenges,** *Georgetown East, Concourse Level*					
12:00–13:30	**OIDA VIP Industry Leaders Speed Meetings Lunch,** *Kalorama, Lobby Level*					
13:00–13:30	**Coffee Break,** *Science & Industry Showcase, Columbia, Terrace Level*					
13:00–15:00	**JW4A • Science & Industry Showcase Exhibits, Poster Session & E-Posters Rapid-Fire Oral Presentations IV in Theater** *Columbia, Terrace Level*					
15:00–16:30	**FW5A • Silicon Photonics II**	**FW5B • Shaping, Phase, and Microscopy**	**FW5C • Optical Systems for VR/AR**	**FW5D • Advanced Microscopy and Imaging**	**FW5E • Quantum Nonlinear Optics and Nanophotonics**	**LW5F • High-harmonic Generation: Time, Energy, and Complexity**
15:30–17:00	**Meet the APS Journal Editors Reception,** *International Terrace, Terrace Level*					
16:30–17:00	**Pairing Photons to Electrons: An OSA Nanophotonics Technical Group Networking,** *OSA Technical Group Booth, International Terrace, Terrace Level*					
16:45–18:15	**FW6A • Optical Fibers and Transmission**	**FW6B • Novel Studies of Waveguides and Atomic Interactions**	**FW6C • Nanophotonics Devices and Instrumentation**	**FW6D • Super-resolution and Extreme Microscopy**	**FW6E • Quantum Electronics of Ultrafast Signals and Atmospheric Propagation**	**LW6F • Novel Lasers I**
18:30–20:00	**Networking with the OSA Biomedical Optics Technical Groups,** *OSA Headquarters, 2010 Massachusetts Ave., NW*					

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Key to Shading

Frontiers in Optics Laser Science Joint

Agenda of Sessions — Thursday, 21 September

	International Ballroom West	International Ballroom East	Georgetown West	Georgetown East	Jefferson West	Jefferson East
07:30–11:30	**Registration,** *Concourse Foyer*					
08:00–08:45	**FTh1A • Visionary Speaker: Marc Taubenblatt**	**FTh1B • Visionary Speaker: Michael Godwin**				**LTh1C • Visionary Speaker: Vladimir M. Shalaev**
08:45–09:00	**Break**					
09:00–10:00	**FTh2A • Tailoring Light with Nanophotonic Structures**	**FTh2B • High Harmonics and Novel Photomemission**	**FTh2C • Optical Coherence Tomography in Biomedical Optics**	**FTh2D • Fabrication for Nanophotonics**	**FTh2E • Optics in Computing**	**LTh2F • Plasmonics**
10:00–10:30	**Coffee Break,** *International Terrace, Terrace Level*					
10:30–12:30	**FTh3A • Nanophotonics for Computing and Sensing**	**FTh3B • Optomechanics and Sensors**	**FTh3C • Vision and Color**	**FTh3D • Instrumentation for Optical Devices and Systems**	**FTh3E • Quantum Simulation, Communication and Entanglement**	**LTh3F • Plasmonics and Lasing**
12:30–13:30	**Lunch Break** *(on your own)*					
13:30–15:30				**FTh4A • Postdeadline Papers**	**FTh4B • Postdeadline Papers**	**LTh4C • Novel Lasers III**

All locations listed are in the Washington Hilton unless otherwise noted.

Locations may change, please check the conference app and update sheet for the latest scheduling updates.

Key to Shading

Frontiers in Optics | Laser Science | Joint

07:00–18:00 Registration, *Concourse Foyer*

08:00–08:45 FM1A • Visionary Speaker: Jungsang Kim, *International Ballroom West*
FM1B • Visionary Speaker: Scott McEldowney, *International Ballroom East*
LM1C • Visionary Speaker: Majed Chergui, *Jefferson East*

08:45–09:00 Break

09:00–12:00 Capitol Hill Visits, *Senate and House Office Buildings, Washington D.C.*

09:00–10:00
FM2A • Modulators and Resonators

FM2A.1 • 09:00
Electro-Optic Switching and Regenerative Oscillation of a Localized Gap Plasmomechanical Resonator, Brian J. Roxworthy[1], Vladimir Aksyuk[1]; [1]*Center for Nanoscale Sciene and Technology, National Inst. of Standards and Technology, USA*. We present a plasmomechanical system comprising localized gap-plasmon resonators embedded into tunable nanomechanical devices. We show low-voltage tuning of localized plasmons and observe plasmon-driven regenerative mechanical oscillations.

FM2A.2 • 09:15
Graphene electro-absorption optical modulator design onto a D-shaped optical fiber, Maria Cecília S. Araújo[1], Rafael E. De Oliveira[1], Lucia A. Saito[1]; [1]*Mackenzie Presbyterian Univ., Brazil*. We present the design of a graphene electro-optical modulator with a dielectric layer of Al_2O_3 built onto a D-shaped optical fiber. The all-fiber optical modulator is optimized by controlling the dielectric thickness, achieving ~1GHz bandwidths.

FM2A.3 • 09:30
Sub-wavelength Plasmonic Graphene-based Slot Electro-optic Modulator, Zhizhen Ma[1], Mohammad H. Tahersima[1], Rubab Amin[1], Sikandar Khan[1], Volker J. Sorger[1]; [1]*George Washington Univ., USA*. We proposed a novel structure for plasmonic graphene modulator. Extinction ratio (ER) larger than 1 dB/um is shown using single layer graphene. Also, by engineering more layers of graphene, an even higher ER is demonstrated.

FM2A.4 • 09:45
Sub 1-Volt Graphene-based Plasmonic Electroabsorption Modulator on Silicon, Sikandar Khan[1], Zhizhen Ma[1], Joohyeon Jeon[2], Cheol J. Lee[2], Volker J. Sorger[1]; [1]*George Washington Univ., USA;* [2]*Dept. of Micro/Nano Systems, Korea Univ., South Korea*. We experimentally show a sub-volt graphene-based hybrid plasmonic waveguide-integrated electro-absorption modulator showing an extinction ratio (0.25 dB/μm) compact footprint (5 μm^2) enabled by improved both electrostatics and mode overlap factor.

09:00–10:00
FM2B • Advances with Pulsed Laser Sources
Presider: Tyler Neely; The University of Queensland, Australia

FM2B.1 • 09:00
Laser wakefield acceleration with mid-IR laser pulses, Daniel C. Woodbury[1], Linus Feder[1], Valentina Shumakova[2], Claudia Gollner[2], Bo Miao[1], Robert Schwartz[1], Andrius Baltuška[2,3], Audrius Pugzlys[2,3], Howard Milchberg[1]; [1]*Univ. of Maryland at College Park, USA;* [2]*Vienna Univ. of Technology, Austria;* [3]*Center for Physical Sciences & Technology, Lithuania*. We present the first results from laser plasma wakefield acceleration driven by ultrashort mid-infrared laser pulses (100fs, λ=3.9μm). The onset of relativistic self-focusing and electron acceleration scale with critical laser power and target width.

FM2B.2 • 09:15
MeV electron acceleration at 1 kHz with <10 mJ Laser Pulses, Fatholah Salehi[1], Andy Goers[1], George Hine[1], Linus Feder[1], Donghoon Kuk[1], Bo Miao[1], Daniel C. Woodbury[1], Ki-Yong Kim[1], Howard Milchberg[1]; [1]*Univ. of Maryland, USA*. We demonstrate laser driven acceleration of electrons to MeV scale energies at 1 kHz repetition rate using few mJ pulse energies focused on near critical density He and H_2 gas jets.

FM2B.3 • 09:30
Temperature determination in a supersonic gas jet from self-absorption free excitation spectra of carbon monoxide, Andre de Bruyn[1], Christin Steenkamp[1], Erich G. Rohwer[1], Anton Du Plessis[1]; [1]*Univ. of Stellenbosch, South Africa*. In this study the effect of self-absorption on rotational excitation spectra in the VUV region and the role that self-absorption plays in determining the rotational temperature of a supersonic gas jet is reported.

FM2B.4 • 09:45
Commissioning experiments of VEGA-2 at Centro de Laseres Pulsados (CLPU), M Huault[2], G Zeraouli[2], J G. Ajates[2], J Apinaniz[2], E Garcia[2], I Hernandez[2], S Malko[2], C Mendez[2], J A. Perez[2], J D. Pisonero[2], C Salgado[2], X Vaisseau[2], O Varela[2], Giancarlo Gatti[2], Luca Volpe[2], Luis Roso[2], Robert Fedosejevs[4], A Longman[4], Ronnie Shepherd[3], Wendell T. Hill[1]; [1]*Univ. of Maryland at College Park, USA;* [2]*CLPU, Spain;* [3]*LLNL, USA;* [4]*Univ. of Alberta, Canada*. The results of commissioning experiments -- betatron radiation and protons acceleration from gaseous and solid targets -- at the petawatt user facility, Centro de Laseres Pulsados in Salamanca, Spain, are reviewed along with facility capabilities.

09:00–10:00
FM2C • Optical Systems for Automotive Applications
Presider: Byoungho Lee; Seoul National University, South Korea

FM2C.1 • 09:00 Invited
The Photonics Supply Chain for Autonomous Vehicles - Technology, Tools and Talent, Ira Moskowitz[1]; [1]*The Innovation Inst. at the MassTech Collaborative, USA*. This presentation will explore the opportunities as well as the challenges of the photonics supply chain for self-driving cars, emphasizing the most essential technologies that will be required such as photonic integrated LIDAR circuits.

FM2C.2 • 09:30 Invited
Flat-panel See-through Display for Augmented Reality Using Symmetric Integral Imaging System, Yasuhiro Takaki[1]; [1]*Tokyo Univ of Agriculture and Technology, Japan*. Optical see-through 3D displays having a flat-panel shape have been developed, which can be used for future smart phones and tablets. The symmetric integral imaging system is employed. Produced 3D images can occlude real scenes.

10:00–10:30 Coffee Break, *International Terrace, Terrace Level*

07:00–18:00 Registration, *Concourse Foyer*

08:00–08:45 FM1A • Visionary Speaker: Jungsang Kim, *International Ballroom West*
FM1B • Visionary Speaker: Scott McEldowney, *International Ballroom East*
LM1C • Visionary Speaker: Majed Chergui, *Jefferson East*

08:45–09:00 Break

09:00–12:00 Capitol Hill Visits, *Senate and House Office Buildings, Washington D.C.*

09:00–10:00
FM2D • Quantum Measurement and Communication

Presider: Bonnie Schmittberger; University of Maryland, USA

FM2D.1 • 09:00
Experimental contextuality of quantum and classical systems, Aonan Zhang[1], Lijian Zhang[1], Brian J. Smith[2]; [1]*National Lab of Solid State Microstructures and College of Engineering and Applied Sciences, Nanjing Univ., China;* [2]*Dept. of Physics and Oregon Center for Optical, Molecular, and Quantum Science, Univ. of Oregon, USA.* Contextuality of quantum and classical systems is examined. Differing definitions of events result in a range of violations of non-contextual hidden-variable models. This highlights classical-correlation resources and the quantum-classical divide.

FM2D.2 • 09:15
Experimental demonstration of loop state-preparation-and-measurement tomography, Mark Beck[1], Aidan F. McCormick[1], Steven J. van Enk[2]; [1]*Whitman College, USA;* [2]*Univ of Oregon, USA.* We demonstrate, using qubits encoded in the polarization of heralded individual photons, that loop state-preparation-and-measurement tomography is capable of detecting correlated errors between the preparation and the measurement of a quantum system.

FM2D.3 • 09:30
Weather-proof Quantum Communications, Yong Meng Sua[1], Heng Fan[1], Amin Shahverdi[1], jiayang chen[1], Rainer Martini[1], Yuping Huang[1]; [1]*Stevens Inst. of Technology, USA.* We identify a weather-proof channel for quantum communications using 3950 nm photons, and report on their generation and detection via parametric conversion with coincidence to accidental ratio of 54±7 and spectral brightness of $4.4x10^2$ pair/s/nm/mW.

FM2D.4 • 09:45
Phase sensing with a truncated SU(1,1) interferometer, Prasoon Gupta[1], Brian E. Anderson[1], Bonnie L. Schmittberger[1], Travis Horrom[1], Carla Hermann-Avigliano[1], Kevin Jones[2], Paul D. Lett[1,3]; [1]*Univ. of Maryland, College Park, USA;* [2]*Williams College, USA;* [3]*National Inst. of Standards and Technology, USA.* We present an SU(1,1) interferometer variation by replacing the second nonlinear interaction with the homodyne detection and demonstrate an improvement in phase sensitivity over the standard quantum limit.

09:00–10:00
FM2E • Quantum Absorbers and Emitters

Presider: Amy Helmy; University of Toronto, Canada

FM2E.1 • 09:00
Combined Atomic Force Microscopy and Photoluminescence Imaging to Increase the Yield of Quantum Dot Photonic Devices, Luca Sapienza[1,2], Jin Liu[2], Jin Dong Song[3], Stefan Falt[4], Werner Wegscheider[4], Antonio Badolato[5], Kartik Srinivasan[2]; [1]*Univ. of Southampton, UK;* [2]*National Inst. of Standards and Technology, USA;* [3]*Center for Opto-Electronic Materials and Devices Research,, KIST, South Korea;* [4]*ETH, Switzerland;* [5]*Dept. of Physics, Univ. of Ottawa, Ottawa, , Canada.* We present a combined optical and AFM characterization technique that determines whether single InAs/GaAs quantum dots appear in proximity to topographic surface features that can be detrimental to quantum photonic device performance.

FM2E.2 • 09:15
Metallic Nano-Rings for Free-Space Extraction of Light from Single Quantum Dots, Oliver Trojak[1], Jin Dong Song[2], Luca Sapienza[1]; [1]*Univ. of Southampton, UK;* [2]*Korea Inst. of Science and Technology, South Korea.* We show 25× enhancements of the free-space collection of light from single In/As quantum dots, via metallic nano-rings deposited on the sample surface. Such a lensing effect is broadband, scalable and compatible with any substrate/emitter.

FM2E.3 • 09:30 Invited
Single Photon Absorption by Single Photosynthetic Light Harvesting Systems, Birgitta Whaley[1]; [1]*Univ. of California Berkeley, USA.* I present a unified theoretical analysis of quantum dynamics of single photon absorption and subsequent excitonic energy transfer in photosynthetic light harvesting complexes with implications for spatio-temporal dynamics of absorption from sunlight.

09:00–10:00
LM2F • Frontiers in X-ray Laser Spectroscopy

Presider: Philippe Wernet; Helmholtz-Zentrum Berlin, Germany

LM2F.1 • 09:00 Invited
Finding Intersections Between Electronic Excited States with Ultrafast X-ray Scattering and Spectroscopy, Kelly Gaffney[2,1], Kasper Kjaer[3]; [1]*Stanford Univ., USA;* [2]*SSRL and PULSE Inst., SLAC National Accelerator Lab, USA;* [3]*Centre for Molecular Movies, Dept. of Physics, Technical Univ. of Denmark, Denmark.* We use ultrafast x-ray emission spectroscopy and x-ray scattering to study spin crossover in $[Fe(bipyridine)_3]^{2+}$. These measurements enable the projection of intersections between ligand field excited states onto the Fe-ligand bond length coordinate.

LM2F.2 • 09:30
Polarized XANES Elucidate Femtosecond Bond Elongation, Nicholas A. Miller[1], Roseanne J. Sension[1]; [1]*Univ. of Michigan, USA.* Ultrafast x-ray spectroscopy characterizes the excited state structural relaxation in vitamin B12. Polarized XANES separates in-plane and out-of-plane contributions. These contributions show discrete relaxation of axial, then equatorial ligands.

LM2F.3 • 09:45
X-Ray Amplification by Stimulated Brillouin Scattering, Matthew Edwards[1], Julia M. Mikhailova[1], Nathaniel J. Fisch[1]; [1]*Princeton Univ., USA.* Parametric amplification using stimulated Raman or Brillouin scattering in plasma may generate extraordinarily intense x-ray pulses. Particle-in-cell simulations suggest that ion-based Brillouin amplification provides efficient x-ray amplification.

10:00–10:30 Coffee Break, *International Terrace, Terrace Level*

10:30–12:30
FM3A • Silicon Photonics I
Presider: Volker Soger; George Washington University, USA

FM3A.1 • 10:30 Invited

Progress on Multilayer Silicon Nitride-on-Silicon Integrated Photonic Platforms, Joyce K. Poon[1]; [1]*Univ. of Toronto, Canada*. This talk presents my group's progress in multilayer silicon nitride-on-silicon integrated photonic platforms. These platforms are useful for the implementation of very large-scale, three-dimensional silicon photonic circuits.

FM3A.2 • 11:00

Connecting Visible and Telecommunications Wavelengths with Silicon Nitride Nanophotonics, Xiyuan Lu[1], Qing Li[1], Daron Westly[1], Kartik Srinivasan[1]; [1]*NIST, USA*. We report a nanophotonic device connecting visible and telecom wavelengths through degenerate four-wave mixing in the silicon nitride platform. This device is promising for extending classical/quantum nanophotonic applications to new spectral bands.

FM3A.3 • 11:15

Fully-Differential, Hybrid, Multi-channel 4x25Gbps Direct Direction Receiver in 0.25µm BiCMOS SiGe Technology, Sergiy Gudyriev[1], J. Christoph Scheytt[1], Christian Kress[1], Lei Yan[2], Christian Meuer[2], Lars Zimmermann[3]; [1]*Heinz Nixdorf Inst., Germany;* [2]*Sicoya Gmbh, Germany;* [3]*IHP Microelectronics, Germany.* A hybrid multi-channel receiver featuring fully-differential transimpedance input stages for 25Gbps data rate per channel is presented along with measurement results. OMA of -16dBm at a BER of 10^{-4} is estimated at the photodiode for all channels.

FM3A.4 • 11:30

On-chip large dispersion using cladding-modulated Bragg gratings, Ezgi Sahin[1,2], Kelvin J. Ooi[1], Ching Eng Png[2], Dawn T. H. Tan[1]; [1]*Photonics Devices and Systems Group, Engineering Product Development, Singapore Univ. of Technology and Design, Singapore;* [2]*Dept. of Electronics and Photonics, Inst. of High Performance Computing, A*Star , Singapore*. A cladding-modulated Bragg grating is realized for creating ultra-large dispersion. Normal dispersion as large as -11.5 ps/nm is demonstrated on a silicon chip. Devices possess absolute group delay dispersion × bandwidth product up to 218 ps.

10:30–12:30
FM3B • Trapping and Advanced Beam Shaping
Presider: Benjamin Perez-Garcia; Underwater Photonics, Mexico

FM3B.1 • 10:30 Invited

Exploring Exotic Polarization Topologies in Complex 3D Electromagnetic Fields, Peter Banzer[1]; [1]*Max-Planck-Inst Physik des Lichts, Germany.* If electromagnetic fields are spatially confined, exotic polarization phenomena and topologies can be observed. Here, we discuss the appearance and experimental study of optical polarization Möbius strips and ribbons at the nanoscale.

FM3B.2 • 11:00

Direct observation of optical trapping of a single quantum dot with an all-silicon nanoantenna, Zhe Xu[1], Wuzhou Song[1,2], Kenneth B. Crozier[1,3]; [1]*School of Physics, Univ. of Melbourne, Australia;* [2]*School of Materials Science and Engineering, Huazhong Univ. of Science and Technology, China;* [3]*Dept. of Electrical and Electronic Engineering, Univ. of Melbourne, Australia*. Silicon nanoantennas are used to trap individual streptavidin-coated CdSe/ZnS quantum dots (QDs) with minimal thermal effects. Using fluorescence microscopy, we track the position and light emission from optically-trapped QDs as a function of time.

FM3B.3 • 11:15

Lasing with Propagation Invariant Shaped Beams, Nir . Davidson[1], Ronen Chriki[1], Slava Smartsev[1], Gilad Barach[1], Chene Tradonsky[1], Asher Friesem[1]; [1]*Weizmann Inst. of Science, Israel*. Propagation invariant shaped beams are generated in a modified degenerate cavity laser. Such a cavity allows direct access to both the x-space and k-space components, thereby enabling control of the propagation properties of shaped beams.

FM3B.4 • 11:30

Determining Topological Charge of an LG beam using a wedged optical flat, Behzad Khajavi[1,2], Enrique J. Galvez[2]; [1]*Physics and Astronomy, Florida Atlantic Univ., USA;* [2]*Physics and Astronomy, Colgate Univ., USA*. We present a method to determine the magnitude and sign of the topological charge of an optical beam carrying orbital angular momentum using a wedged optical flat and two confocal lenses.

10:30–12:30
FM3C • Computational/Transformation Optics and Optics in Computing
Presider: Johannes Courtial; University of Glasgow, UK

FM3C.1 • 10:30 Invited

Computational Optical Imaging for 3D Capture and Display Devices, Ginni Grover[1]; [1]*Intel Labs, USA*. Computational optical systems allow novel architectures for capturing real world in multiple dimensions and showing it on displays which enable 3D perception. In this talk, I explore integral displays, issues of human perception and capture methods.

FM3C.2 • 11:00

A Composite Algorithm for Optimized Baseline Correction in Raman Spectroscopy, Andrew Huzortey[1], Benjamin Anderson[1], Alfred Owusu[1]; [1]*Univ. of Cape Coast, Ghana*. We propose a novel algorithm for the pretreatment and recovery of Raman signals from fluorescence contaminated spectra. This algorithm combines the 2nd derivative and iterative smoothening routines for optimized baseline estimation and correction

FM3C.3 • 11:15

Iterative tomographic deconvolution phase microscopy, Yijun Bao[1], Thomas K. Gaylord[1]; [1]*Georgia Inst. of Technology, USA*. The existing refractive index imaging method, tomographic deconvolution phase microscopy, is improved by applying an iterative optimization algorithm. The required number of illumination angles is greatly reduced, while the accuracy remains high.

FM3C.4 • 11:30

Spatiotemporal Holography Using Flutter Shutter Camera, Muralidhar Madabhushi Balaji[1], Prasanna Rangarajan[1], Indranil Sinharoy[1], Duncan MacFarlane[1], Marc Christensen[1]; [1]*Southern Methodist Univ., USA*. A spatiotemporal approach for recovering holograms is proposed in this paper. Flutter-shutter camera is used for temporal demodulation. The proposed method needs lesser measurements than phase shifting interferometry to extract the hologram.

FiO | LS

10:30–12:30
FM3D • Nanophotonics I
Presider: Shu-Wei Huang; University of California, Los Angeles, USA

FM3D.1 • 10:30
Highly sensitive biomolecular detection using compact high-Q silicon spiral resonators, Ahmad Usman[1], Razi Dehghannasiri[1], Ali Eftekhar[1], Ali Adibi[1]; [1]*Georgia Inst. of Technology, USA*. We present highly sensitive and compact label-free biosensors employing spiral resonators on SOI with high-Q TM modes providing high-sensitivity and large sensing area. The sensor performance is characterized using avidin-biotin surface chemistries.

FM3D.2 • 10:45
Dual-band focusing metasurfaces based on stacked graphene ribbons, Wei Ma[1], Zhong Huang[1,2], Xiaokang Bai[1], Peng Zhan[2], Yongmin Liu[1]; [1]*Northeastern Univ., USA;* [2]*Nanjing Univ., China*. We theoretically demonstrated focusing reflective metasurfaces based on stacked graphene ribbons. The dual-band performance originates from the weak inter-layer coupling, where the focusing effect can be independently tuned for two target wavelengths

FM3D.3 • 11:00
Electrically controlled reconfigurable metadevice employing nanostructured vanadium dioxide, Zhihua Zhu[1], Phil Evans[2], Richard Haglund[1], Jason Valentine[1]; [1]*Vanderbilt Univ., USA;* [2]*Oak Ridge National Lab, USA*. We demonstrate a near infrared metadevice modulator using VO_2 nanostructures. This device shows a modulation depth up to 33%, wavelength shift of 360 nm, and 1.27 ms recovery time when VO_2 undergoes semiconductor-to-metal phase change.

FM3D.4 • 11:15
Negative index in a dispersive chiral material with first-order sideband dispersion under dielectric losses, Monish R. Chatterjee[1], Salah G. Bugoffa[1]; [1]*Univ. of Dayton, USA*. Recent work on conductively lossy dispersive chiral materials showed NIM behavior and spiral spatial polarization. We introduce *dielectric* losses to explore NIM characteristics to determine negative index sidebands under realistic dielectric losses.

FM3D.5 • 11:30
Nanophotonic Devices for Three-Dimensional Control of Optical Beams, Stephen M. Kuebler[1], Rashi Sharma[2], Jennefir L. Digaum[1], Noel Martinez[3], Cesar L. Valle[3], Raymond C. Rumpf[3]; [1]*CREOL, Univ. of Central Florida, USA;* [2]*Chemistry, Univ. of Central Florida, USA;* [3]*EM Lab, College of Engineering, Univ. of Texas-El Paso, USA*. Spatially-variant photonic crystals (SVPCs) are new nanophotonic devices that control the propagation of optical beams in three dimensions. This work reports the fabrication and characterization of the first SVPC that operate at 1550 nm.

10:30–12:30
FM3E • Quantum Memories and Interfaces
Presider: Mark Beck; Whitman College, USA

FM3E.1 • 10:30 Invited
Multidimensional Tomography of Photon-pair Sources Using Stimulated Emission, Virginia O. Lorenz[1]; [1]*Physics, Univ. of Illinois at Urbana-Champaign, USA*. The efficient characterization of photonic quantum sources enables precise source engineering for quantum information applications. I present our demonstrations of the stimulated emission tomography technique to efficiently characterize sources in multiple degrees of freedom.

FM3E.2 • 11:00
A Noiseless Quantum Optical Memory at Room Temperature, Krzysztof T. Kaczmarek[1], Patrick M. Ledingham[1], Benjamin Brecht[1], Sarah E. Thomas[1,5], Guillaume S. Thekkadath[3], Oscar Lazo-Arjona[1], Joseph H. Munns[1,5], Eilon Poem[4], Amir Feizpour[1], Dylan J. Saunders[1], Joshua Nunn[2], Ian A. Walmsley[1]; [1]*Univ. of Oxford, UK;* [2]*Univ. of Bath, UK;* [3]*Univ. of Ottawa, Canada;* [4]*Weizmann Inst. of Science, Israel;* [5]*Imperial College London, UK*. We demonstrate a noise-free, room-temperature quantum memory for broadband light. We store heralded single photons with a bandwidth of 1GHz and retrieve them with a heralded g2(0)=0.028(9), which is the lowest value measured so far.

FM3E.3 • 11:15
Demonstration of Real-Time Quantum Non-Demolition Interaction, Yu Shiozawa[1], Shota Yokoyama[2], Toshiyuki Kaji[1], Ryosuke Nakamura[1], Warit Asavanant[1], Kenzo Makino[1], Takahiro Serikawa[1], Shigenari Suzuki[1], Jun-ichi Yoshikawa[1,3], Akira Furusawa[1]; [1]*The Univ. of Tokyo, Japan;* [2]*Univ. of New South Wales, Australia;* [3]*Quantum-Phase Electronics Center, The Univ. of Tokyo, Japan*. We experimentally demonstrate real-time quantum non-demolition (QND) interaction between optical quantum states in terms of satisfying the criteria for QND measurement and generating quantum entanglement.

FM3E.4 • 11:30
Temporal and Spectral Manipulations of Correlated Photons using a Time-Lens, Sunil Mittal[1,2], Venkata Vikram Orre[1,2], Alessandro Restelli[1], Reza Salem[3], Elizabeth A. Goldschmidt[4,1], Mohammad Hafezi[1,2]; [1]*Joint Quantum Inst., Univ. of Maryland at College Park, USA;* [2]*Dept. of Electrical and Computer Engineering and IREAP, Univ. of Maryland, College Park, USA;* [3]*PicoLuz, LLC, USA;* [4]*U. S. Army Research Lab, USA*. We use a time-lens to magnify the two-photon wavefunction associated with time-bin entangled photons and measure their joint-temporal intensity with a resolution far exceeding the limitations imposed by detector timing jitter.

10:30–12:30
LM3F • Carl E. Anderson Dissertation Award in Laser Science
Presider: Kristan Corwin; Kansas State University, USA

LM3F.1 • 10:30 Invited
Control of Light-matter Interaction Using Photonic Hypercrystals, Tal Galfsky[1,2], Zheng Sun[1,2], Jie Gu[1,2], Nicholas Proscia[1,2], Evgenii E. Narimanov[3], Vinod M. Menon[1,2]; [1]*City Univ. of New York, USA;* [2]*Physics, CUNY Graduate Center, USA;* [3]*Electrical and Computer Engineering, Purdue Univ., USA*. We demonstrate broadband enhancement of light emission from quantum dots, single photon emitters and 2D semiconductors using photonic hypercrystals (PHC). Both out-coupling and spontaneous emission rate are increased from the different emitters.

LM3F.2 • 11:00 Invited
Quantum Limits on Measurement and Control of a Mechanical Oscillator, Vivishek Sudhir[1]; [1]*Ecole Polytechnique Federale De Lausanne, Switzerland*. The motion of a macroscopic mechanical oscillator – a glass nanostring – has been measured, using a cavity-enhanced optical interferometer, with a sensitivity that is 40 dB below that at the standard quantum limit, forming the most precise measurement of the zero-point motion of a mechanical oscillator yet.

LM3F.3 • 11:30 Invited
Nanophotonic Spin-photon Quantum Transistor, Shuo Sun[1], Hyochul Kim[1]; [1]*Inst. for Research in Electronics and Applied Physics, Univ. of Maryland, College Park, USA*. We demonstrate an optical transistor operating at the most fundamental quantum limit, where a single spin controls the polarization of a single photon, and reversibly a single photon flips the orientation of the spin.

FM3A • Silicon Photonics I—Continued

FM3A.5 • 11:45
Nanosecond polarization modulation in phase transition material thin films, Alain Hache[1], Jean-Francois Bisson[1], Tran Vinh Son[1], Truong Vo-Van[2]; [1]*Universite de Moncton, Canada;* [2]*Physics, Concordia Univ., Canada*. Thin layers (50-150 nm) of vanadium dioxide are shown to modulate polarization of incident light when a phase transition is induced by laser pulses. High modulation amplitudes through polarizers are obtained at nanosecond time scales.

FM3A.6 • 12:00 Invited
How Monolithic Photonic Integration Can Help to Overcome Frontiers in Optics., Sven Otte[1]; [1]*Sicoya GmBH, Germany.* The era of exponential data growth just started which generates technical and business requirements for optical component vendors. Here we are presenting monolithically integrated Silicon Photonic engines that help to overcome these frontiers.

FM3B • Trapping and Advanced Beam Shaping—Continued

FM3B.5 • 11:45
The dating game at dimension zero: creation and annihilation of phase singularities in optical random waves, Lorenzo De Angelis[1,2], Filippo Alpeggiani[1,2], Andrea Di Falco[3], Kobus Kuipers[1,2]; [1]*Kavli Inst. of Nanoscience, Delft Univ. of Technology, Netherlands;* [2]*Center for Nanophotonics, AMOLF, Netherlands;* [3]*SUPA, School of Physics and Astronomy, Univ. of St Andrews, UK*. Phase singularities can be created and annihilated, but always in pairs. With optical near-field measurements, we track singularities in random waves as a function of wavelength, and discover correlations between creation and annihilation events.

FM3B.6 • 12:00
Spatiotemporal Optical Vortices, Nihal Jhajj[1], George Hine[1], Ilia Larkin[1], Eric Rosenthal[1], Sina Zahedpour[1], Jared Wahlstrand[2], Howard Milchberg[1]; [1]*Univ. of Maryland at College Park, USA;* [2]*NIST, USA*. Nonlinearly propagating beams undergoing optical collapse are shown to universally self-generate a new type of optical vortex: the spatiotemporal optical vortex (STOV). Beams with STOVs have orbital angular momentum transverse to propagation.

FM3B.7 • 12:15
Photonic topologically protected bulk propagation, Eran Lustig[1], Steffen Weimann[2], Yonatan Plotnik[1], Miguel Bandres[1], Yaakov Lumer[3], Alexander Szameit[2], Mordechai Segev[1]; [1]*Technion, Israel;* [2]*Univ. of Rostock, Germany;* [3]*Univ. of Pennsylvania, USA*. We present photonic topological insulators displaying topologically protected bulk propagation, robust to large-scale defects. These topological insulators are described in synthetic dimensions and open the door for shaping topological propagation.

FM3C • Computational/Transformation Optics and Optics in Computing—Continued

FM3C.5 • 11:45
Frequency Modulated Continuous Wave Compressive Depth Mapping, Daniel Lum[1], John Howell[1]; [1]*Univ. of Rochester, USA*. We present an achitecture for converting a frequency modulated continuous wave LiDAR into a compressing sensing depth mapping device. Our protocol requires only two compressed sensing image reconstructions to extract depth maps.

FM3C.6 • 12:00
Deep Learning, Dynamic Sampling and Smart Energy-dispersive Spectroscopy, Yan Zhang[1], Dilshan Godaliyadda[2], Nicola Ferrier[1], Emine Gulsoy[3], Charles Bouman[2], Charudatta Phatak[1]; [1]*Argonne National Lab, USA;* [2]*Purdue Univ., USA;* [3]*Northwestern Univ., USA*. A convolutional neural network (CNN) classifier is trained using simulated energy-dispersive spectroscopy data. The CNN incorporated within a dynamic sampling method is to reduce radiation exposure and data acquisition time for elemental mapping.

FM3C.7 • 12:15
Monte Carlo Simulation of Coherence Propagation through Scattering Media, Zhean Shen[1], Sergey Sukhov[1], Aristide Dogariu[1]; [1]*CREOL, USA*. Traditional Monte Carlo (MC) technique of photon transport in random medium is able to describe only single point properties. Here we propose the method of extending MC to simulate two-point property, spatial coherence.

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

12:30–13:30 Challenges and Emerging Opportunities in Molecular Probes and Nanobio-Optics, *Georgetown East, Concourse Level*

12:30–14:00 Grant Writing 101 Workshop, *Fairchild Room, Terrace Level*

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FM3D • Nanophotonics I—Continued

FM3D.6 • 11:45
Broadband graphene oxide anti-reflection coating on silicon nanostructures, Yunyi Yang[1], Han Lin[1], Baohua Jia[1], Yinan Zhang[2], Minghui Hong[3]; [1]*Swinburne Univ. of Technology, Australia;* [2]*Jinan Univ., China;* [3]*National Univ. of Singapore, Singapore.* We show the ultra-thin graphene oxide films are conformably coated on silicon nanowires through a layer-by-layer method. The coating can achieve up to 20% reduction in the overall reflection with a broadband wavelength.

FM3D.7 • 12:00
Imaging of acoustic pressure field in opto-mechano-fluidic resonators with a single particle probe, Jeewon Suh[1], Kewen Han[1], Gaurav Bahl[1]; [1]*Mechanical Science and Engineering, Univ. of Illinois at Urbana-Champai, USA.* We present a technique for mapping the acoustic pressure fields within microfluidic optomechanical resonators using a single particle probe. These mappings help improve the detection capabilities of high-throughput opto-mechano-fluidic sensors.

FM3D.8 • 12:15
Dielectric veins type photonic crystal as a zero-index-metamaterial, Nishant Shankhwar[1], Yogita Kalra[1], Ravindra K. Sinha[2]; [1]*Delhi Technological Univ., India;* [2] *CSIR-Central Scientific Instruments Organisation (CSIO), India.* In this paper we present a dielectric veins type two dimensional photonic crystal which acts as a zero-index-material. The underlying principles is the existence of a Dirac cone at the center of the Brillouin zone

FM3E • Quantum Memories and Interfaces—Continued

FM3E.5 • 11:45
Scalable Ion-Photon Quantum Interface based on Integrated Diffractive Mirrors, Steven Connell[1], Mojtaba Ghadimi[1], Valdis Blums[1], Benjamin G. Norton[1], Paul Fisher[1], Jason M. Amini[2], Curtis Volin[2], CS Pai[2], Dave Kielpinski[1], Mirko Lobino[1,3], Erik W. Streed[1,4]; [1]*Griffith Univ., Australia;* [2]*Georgia Tech Research Inst., USA;* [3]*Queensland Micro and Nanotechnology Centre, Griffith Univ., Australia;* [4]*Inst. for Glycomics, Griffith Univ., Australia.* We demonstrate the viability of diffractive mirrors monolithically integrated with a microfabricated ion trap for quantum networking and an ion-fibre coupling of 4.1(6)% giving an 8.6x increase in entanglement rates from previous state-of-the-art.

FM3E.6 • 12:00 Invited
Ion-photon Interfaces for Quantum Networks, Tracy Northup[1]; [1]*Univ. of Innsbruck, Austria.* I will discuss the cavity-mediated transfer of quantum information between ions and photons, with the goal of linking distant qubits in a quantum network, focusing on multi-ion encodings and adiabatic passage along channels.

LM3F • Carl E. Anderson Dissertation Award in Laser Science—Continued

LM3F.4 • 12:00 Invited
First Demonstration of Sub-Wavelength Imaging at Short Wavelengths, Dennis F. Gardner[1], Elisabeth R. Shanblatt[1], Michael Tanksalvala[1], Xiaoshi Zhang[2], Benjamin R. Galloway[1], Christina L. Porter[1], Robert Karl[1], Charles Bevis[1], Bosheng Zhang[1], Matthew H. Seaberg[1], Giulia F. Mancini[1], Daniel E. Adams[1], Henry C. Kapteyn[1,2], Margaret M. Murnane[1,2]; [1]*Univ. of Colorado Boulder, USA;* [2]*KM Labs, USA.* Combining table-top 13.5nm HHG EUV with novel ptychography algorithms, we demonstrate diffraction-limit high-NA and subwavelength resolution imaging at EUV wavelengths for the first time, a record resolution for full-field light-based microscopy.

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

12:30–13:30 Challenges and Emerging Opportunities in Molecular Probes and Nanobio-Optics, *Georgetown East, Concourse Level*

12:30–14:00 Grant Writing 101 Workshop, *Fairchild Room, Terrace Level*

13:30–15:30
FM4A • Plamonics and Metamaterials
Presider: Hanjo Rhee; Sicoya, Germany

FM4A.1 • 13:30 Invited
All-dielectric Nanophotonics and Metasurfaces Govern by Mie Resonances, Yuri S. Kivshar[1]; [1]*Nonlinear Physics Center, RSPE, The Australian National Univ., Australia*. We demonstrate that Mie resonances can play a crucial role in all-dielectric meta-optics enhancing many optical effects near magnetic dipole resonances and driving new physical effects due to electric and magnetic multipolar interference.

FM4A.2 • 14:00
Brewster Plasmons: The Antiresonant Plasmonic Degrees of Freedom, Gilad Rosenblatt[1], Boris Simkhovich[2], Guy Bartal[1,2], Meir Orenstein[1]; [1]*Dept. of Electrical Engineering, Technion - Israel Inst. of Technology, Israel;* [2]*The Russell Berrie Nanotechnology Inst., Technion - Israel Inst. of Technology, Israel*. We experimentally and theoretically prove the existence of a new class of plasmonic modes, distinct from surface plasmons, we call Brewster plasmons. We measure dispersion and demonstrate far-field coupling to both surface and Brewster plasmons.

FM4A.3 • 14:15
Dual-width Plasmonic Nanogap Gratings electrodes for GaAs Metal-Semiconductor-Metal Photodetectors Enhancement, Ahmad A. Darweesh[1], Stephen Bauman[1], zach Brawley[1], Joseph Herzog[1]; [1]*Univ. of Arkansas, USA*. A dual-width plasmonic nanograting structure with a 5 nm gap has been designed and simulated. Optical enhancement was calculated for the application of improving the performance of metal-semiconductor-metal photodetectors. (MSM-PDs)

FM4A.4 • 14:30
Full-color imaging with PSF-engineered metasurfaces and computational reconstruction, Shane A. Colburn[1], Alan Zhan[1], Arka Majumdar[1]; [1]*Univ. of Washington, USA*. We build a full-color imaging system comprising a single metasurface by designing a wavelength-invariant point spread function across the whole visible band combined with post-capture deconvolution with a single linear filter.

13:30–15:30
FM4B • Studies with Complex Media, Imaging and Light
Presider: Frederique Vanholsbeeck; University of Auckland, New Zealand

FM4B.1 • 13:30 Invited
3D Computational Microscopy in Scattering Media, Laura Waller[1]; [1]*Univ. of California Berkeley, USA*. We describe new computational methods for 3D microscopy in scattering media: single-shot 3D fluorescence imaging and detection-side aperture coding of angle (Fourier) space for capturing 4D phase-space (e.g. light field) datasets.

FM4B.2 • 14:00
Noise reduction in Brillouin microscopy via spectral coronagraphy, Eitan Edrei[1], Malte C. Gather[2], Giuliano Scarcelli[1]; [1]*Bioengineering, Univ. of Maryland, USA;* [2]*Univ. of St Andrews, UK*. We have adapted the design of coronagraphs used for exosolar planet imaging to the spectral domain for high extinction Brillouin spectroscopy. Our design enables spectral mapping near reflecting interfaces and within scattering samples.

FM4B.3 • 14:15
Imaging a Mask Object Embedded in Thick Tissue Using Speckle Intensity Correlations Over Object Position, Qiaoen Luo[1], Kevin J. Webb[1]; [1]*Purdue Univ., USA*. Spatial speckle intensity correlation measurements in relation to object position are used to image a moving mask embedded between tissue-mimicking phantoms, demonstrating the practicality of this approach for imaging in heavy scatter.

FM4B.4 • 14:30
Non-Hermitian invisibility based on constant-intensity waves, Andre Brandstotter[1], Konstantinos Makris[2], Stefan Rotter[1]; [1]*Inst. for Theoretical Physics, Vienna Univ. of Technology, Austria;* [2]*Physics Dept., Univ. of Crete, Greece*. We demonstrate the possibility of scattering media that are unidirectional invisible and are not necessarily parity-time symmetric. The required gain-loss distribution is related to the phase of the corresponding constant-intensity scattering state.

13:30–15:30
FM4C • General Information Acquisition, Processing and Display
Presider: Wei Lee; Taiwan University, Taiwan

FM4C.1 • 13:30 Invited
Non-contact Scanning Diffuse Correlation Tomography for Blood Flow Monitoring During Bone Healing, Regine Choe[1]; [1]*Univ. of Rochester, USA*. Vascularization is a key step in bone healing, but is seldom measured due to technical difficulties. We demonstrate the capabilities of diffuse correlation tomography to monitor spatiotemporal blood flow changes associated with bone healing.

FM4C.2 • 14:00
Single Chip LIDAR with Discrete Beam Steering by Digital Micromirror Device, Braden Smith[1], Brandon Hellman[1], Adley Gin[1], Alonzo Espinoza[1], Yuzuru Takashima[1]; [1]*The Univ. of Arizona, USA*. MEMS-based beam steering by Digital Micromirror Device illuminated by pulsed laser enables single-chip LIDAR. We demonstrate 48° field of view, 3.4k points/sec scan rate, and <1cm accuracy for 1.2 m distance across five steering angles.

FM4C.3 • 14:15
Polarization Splitter Design with Quasi-Conformal Transformation Optics, Poliane A. Teixeira[1], Daniely Silva[1], Lucas Gabrielli[2], Mateus Junqueira[1], Danilo Spadoti[1]; [1]*Federal Univ. of Itajubá, Brazil;* [2]*School of Electrical and Computer Engineering, Univ. of Campinas, Brazil*. TO is used to develop 2D polarization beam splitter. A quasi-conformal mapping is applied, resulting in a medium with inhomogeneous uniaxial permittivity and without magnetic response. This splitter is broadband and has modal preservation.

FM4C.4 • 14:30 Invited
High Resolution Imaging with a Moving Coded Aperture, Abhijit Mahalanobis[1]; [1]*Lockheed Martin Corporation, USA*. It is well known that a translating mask can optically encode low resolution measurements from which higher resolution images can be computationally reconstructed.

FiO

LS

13:30–15:30
FM4D • Biomedical Optics in Scattering Media
Presider: David Busch; Children's Hospital of Philadelphia, USA

FM4D.1 • 13:30
Evaluation of Out-of-Plane Sensitivity and Artifacts in Photoacoustic Imaging, William C. Vogt[1], Congxian Jia[1], Keith A. Wear[1], Brian S. Garra[1], T. Joshua Pfefer[1]; [1]*US Food and Drug Administration, USA*. Photoacoustic Imaging (PAI) systems are rapidly emerging biomedical diagnostic devices. We investigated PAI out-of-plane artifacts using biorealistic tissue phantoms, which can support device optimization, clinical translation, and inter-comparison.

FM4D.2 • 13:45
Localization of Arteries Using Diffuse Light for Assisting Surgery, Brian Bentz[1], Timothy Wu[2], Vaibhav Gaind[3], Kevin J. Webb[1]; [1]*Purdue Univ., USA;* [2] *Private Practice in Periodontology, USA;* [3]*KLA-Tencor, USA*. We present an approach for the localization of arteries in the roof of the mouth that has the potential to reduce complications during oral surgery. The method is demonstrated using a printed tissue-simulating mouth phantom.

FM4D.3 • 14:00
Intraoperative Monitoring of Spinal Cord Blood Flow, David R. Busch[1], Wei Lin[2], Alisa Cutrone[3], Brandon J. Kovarovic[2], Jakub Tatka[4], Arjun G. Yodh[1], James Barsi[4], Thomas F. Floyd[3,2]; [1]*Physics and Astronomy, Univ. of Pennsylvania, USA;* [2]*Biomedical Engineering, Stony Brook Univ., USA;* [3]*Anesthesiology, Stony Brook Univ., USA;* [4]*Orthopedics, Stony Brook Univ., USA*. Spinal cord ischemia is commonly associated with both trauma and surgery. We demonstrate a catheter-based optical tool to continuously monitor spinal cord blood flow intraoperatively in a ovine model of spinal surgery.

FM4D.4 • 14:15 Invited
Functional NIRS for attention monitoring, Angela Harrivel[1]; [1]*Crew Systems and Aviation Operations Branch, NASA Langley Research Center, USA*. We applied functional Near Infrared Spectroscopy and adaptive noise filtering to quantify brain activity in attentional networks. We then employed pattern classification toward real-time monitoring of attentional performance during operational tasks.

13:30–15:30
FM4E • High-Dimension Quantum Systems and Simulation
Presider: Valerian Thiel; University of Oxford, UK

FM4E.1 • 13:30 Invited
Quantum State Engineering on Chip, Amr S. Helmy[1]; [1]*ECE, Univ. of Toronto, Canada*. Dispersion in integrated optics enable quantum devices with versatile attributes. Dispersion unlocks novel capabilities including in-situ control over spectral/polarization entanglement, tunable time-ordering, and entanglement-sensitive coincidence.

FM4E.2 • 14:00
Finding excited states of physical Hamiltonians on a silicon quantum photonic device, Raffaele Santagati[1], Jianwei Wang[1], Antonio Gentile[1], Stefano Paesani[1], Nathan Wiebe[2], Jarrod McClean[3], Damien Bonneau[1], Joshua Silverstone[1], Sam Morley-Short[1], Peter Shadbolt[1], David Tew[4], Xiao-Qi Zou[5], Jeremy O'Brien[1], Mark Thompson[1]; [1]*Quantum Engineering Technology Labs, Univ. of Bristol, UK;* [2]*Quantum Architectures and Computation Group, Microsoft Research, USA;* [3]*Computational Research Division, Lawrence Berkeley National Lab,, USA;* [4]*School of Chemistry, Univ. of Bristol, UK;* [5]*State Key Lab of Optoelectronic Materials and Technologies and School of Physics, Sun Yat-sen Univ., China*. We introduce the concept of eigenstate-witness to implement a new protocol for finding excited-states of physical Hamiltonians. We experimentally demonstrate it on a silicon quantum photonic device embedding arbitrary controlled unitary operations.

FM4E.3 • 14:15
Boltzmann sampling for an XY model using a non-degenerate optical parametric oscillator network, Yutaka Takeda[1,2], Shuhei Tamate[2], Yoshihisa Yamamoto[3,4], Hiroki Takesue[5], Takahiro Inagaki[5], Shoko Utsunomiya[1,2]; [1]*Dept. of Physics, Faculty of Science, Tokyo Univ. of Science, Japan;* [2]*National Inst. of Informatics, Japan;* [3]*ImPACT Program, Japan Science and Technology Agency, Japan;* [4]*E. L. Ginzton Lab, Stanford Univ., USA;* [5]*NTT Basic Research Labs, NTT Corporation, Japan*. We built a non-degenerate optical parametric oscillator (NOPO) network to simulate a one-dimensional XY model in thermal equilibrium. We experimentally found that the effective temperature can be controlled via an external noise injection.

FM4E.4 • 14:30 Invited
Exploring Many-Body Dynamics on a Programmable 50 Atom Quantum Simulator, Mikhail Lukin[1]; [1]*Harvard Univ., USA*. We will describe recent experiments aimed at exploring dynamics of strongly interacting many-body systems on a programmable quantum simulator.

13:30–15:30
LM4F • X-Ray Science with Table Top and XFEL Lasers
Presider: Kyung-Han Hong; Massachusetts Institute of Technology, USA

LM4F.1 • 13:30 Invited
Chemical and Bio-chemical X-ray Spectroscopy at Current and Future X-ray Lasers, Philippe Wernet[1]; [1]*Helmholtz-Zentrum Berlin, Germany.* It is demonstrated how x-ray laser spectroscopy with femtosecond x-ray pulses offers unique insight into photochemical dynamics and bio-chemical processes with the ability to probe the valence electronic structure at atomic length and time scales.

LM4F.2 • 14:00
Carrier- and Element-Specific Femtosecond XUV Transient Absorption of Hybrid Lead Halide Perovskites, Ming-Fu Lin[1], Max Verkamp[1], Joshua Leveillee[2], Elizabeth Ryland[1], Kristin Benke[1], Kaili Zhang[1], Andre Schleife[2], Josh Vura-Weis[1]; [1]*Dept. of Chemistry, UIUC, USA;* [2]*Dept. of Materials Science and Engineering, Univ. of Illinois at Urbana-Champaign, USA*. XUV transient absorption spectroscopy is used to measure carrier dynamics in hybrid lead halide perovskites. Distinct signals are observed for photoinduced electrons and holes, allowing the dynamics of each carrier to be tracked independently.

LM4F.3 • 14:15
High Harmonic Generation in Acetone for Time-Resolved Spectroscopy Applications, Phillip D. Keathley[1], Guillaume Laurent[1,2], Sergio Carbajo[1], Jeffrey Moses[1], Franz Kaertner[1,3]; [1]*Massachussetts Inst. of Technology, USA;* [2]*Physics, Auburn, USA;* [3]*Center for Free Electron Laser Science, DESY, Germany.* High harmonic generation in acetone was used to generate EUV harmonics spanning 10-30 eV. A flux of 1.5x10^6 ph/pulse/harmonic was measured near 17 eV, and polarization gating was used to generate an isolated 2.6 fs pulse spanning 16-18 eV.

LM4F.4 • 14:30 Invited
Ultrafast X-ray Studies of Chemical and Interfacial Dynamics, Oliver Gessner[1]; [1]*Lawrence Berkeley National Lab, USA*. Ring-opening dynamics in heterocyclic aromatic molecules and charge-transfer dynamics at molecule-semiconductor interfaces are studied by femtosecond and picosecond time-resolved inner-shell spectroscopy techniques.

FM4A • Plamonics and Metamaterials—Continued

FM4A.5 • 14:45
Optimization of Nonlinear Optical Processes in Arrays of Metallic Nanocavities, Yael Blechman[1], Euclides Almeida[1], Basudeb Sain[1], Yehiam Prior[1]; [1]*Dept. of Chemical Physics, Weizmann Insitute of Science, Israel.* We challenge the conventional wisdom that enhancement of nonlinear optical processes in plasmonic nanomaterials can be fully predicted by their linear properties.

FM4A.6 • 15:00
Wave-guiding and Cavity Engineering in Core-shell Nanowires with Two Dimensional Electron Gas Plasmons, Kiana Montazeri[1], Zhihuan Wang[1], Bahram Nabet[1]; [1]*Drexel Univ., USA.* Effect of confined electron gas plasmons on waveguiding and optical resonance properties of core-shell nanowires are analyzed, showing how the cavity can be engineered for specific resonance wavelengths such as 830 or 1550 nm.

FM4A.7 • 15:15
Periodic Black Phosphorene Nanoribbons Infrared Edge Plasmon Enhanced Absorbance, Desalegn T. Debu[1], Stephen J. Bauman[1], Joseph B. Herzog[1]; [1]*Univ. of Arkansas, USA.* This work demonstrates enhanced infrared light absorption due to edge confined strong plasmon enhancement in anisotropic black phosphorene nanoribbons. The absorption spectra peak position of nanoribbon is tunable in a wide infrared wavelength range.

FM4B • Studies with Complex Media, Imaging and Light—Continued

FM4B.5 • 14:45
Universality of Stochastic Interactions Between Laser Beams, Amir Sagiv[1], Adi Ditkowski[1], Gadi Fibich[1]; [1]*Tel Aviv Univ., Israel.* We show that laser beams lose their initial phase in nonlinear propagation. Therefore, prediction and control of long-range interactions between beams become impossible. The statistics of these chaotic interactions, are universal and computable.

FM4B.6 • 15:00
Elegant Laguerre-Gaussian beams as structured wavefields: light on self-healing, Alfonso I. Jaimes-Nájera[1], Jorge A. Ugalde-Ontiveros[1], Songjie Luo[2], Jixiong Pu[2], Sabino Chávez-Cerda[1]; [1]*INAOE, Mexico;* [2]*College of Information Science and Engineering, Huaqiao Univ., China.* We demonstrate that elegant Laguerre-Gaussian beams belong to the families of structured wavefields. As such, they also have the self-healing property that is explained on physical grounds as traveling waves that superposed conform these beams.

FM4B.7 • 15:15
Wigner Distribution Function of Airy Beam, Fengfei Wang[1], David Singh[1], Ping Yu[1], Guohai Situ[2]; [1]*Univ. of Missouri, USA;* [2]*Shanghai Inst. of Optics and Fine Mechanics, China.* We studied Wigner distribution function for finite-energy Airy beam in theory and experiment, and proposed that with a large truncating factor, Airy beam can be simplified for optical imaging based on phase-space method.

FM4C • General Information Acquisition, Processing and Display—Continued

FM4C.5 • 15:00
Lensless Object Detection and Positioning via Coherence Measurement, Hasan E. Kondakci[1], Andre Beckus[2], Ahmed El-Halawany[1], Nafiseh Mohammadian[1], George Atia[2], Ayman Abouraddy[1]; [1]*CREOL, Univ. of Central Florida, USA;* [2]*Electrical and Computer Engineering, Univ. of Central Florida, USA.* We measure the complex-coherence function of incoherent light scattered by a one-dimensional object in various configurations and determine the axial and transverse position of the object and its size by examining only the coherence function.

FM4C.6 • 15:15
Scene Reconstruction via Two-dimensional Complex Coherency Imaging, Ahmed Elhalawany[1], Andre Beckus[1], Hasan E. Kondakci[1], Nafiseh Mohammadian[1], George Atia[1], Ayman Abouraddy[1]; [1]*Univ. of Central Florida, USA.* The location of 1D objects is determined by numerically backpropagating the experimentally measured spatial coherence function. Partial coherent light and dynamical double slits generated by digital light processor are used in coherence measurement.

15:30–16:00 Coffee Break, *International Terrace, Terrace Level*

16:00–17:30 Workshop: Understanding Unconscious Bias, *Georgetown East, Concourse Level*

16:00–17:30 OSA Nonlinear Optics Technical Group Workshop & Networking Session, *Georgetown West, Concourse Level*

16:00–18:00 Evening with the Agencies & Reception, *Jefferson West, Concourse Level*

18:30–21:00 FiO + LS Awards Banquet, *International Ballroom Center, Terrace Level*

FiO

FM4D • Biomedical Optics in Scattering Media—Continued

FM4D.5 • 14:45 Invited

Towards Standardization of Clinical Biophotonic Device Technologies, T. Joshua Pfefer[1]; *[1]FDA Ctr Devices & Radiological Health, USA.* Standardized test methods are commonly used to facilitate development and clinical translation of medical imaging systems. Currently, efforts are underway in Biophotonics to establish consensus guidelines and develop objective, quantitative tests based on innovative phantoms.

FM4D.6 • 15:15

Polymer Metamaterial Fabrics for Personal Radiative Thermal Management, Seyed Hadi Zandavi[1], Yi Huang[1], George Ni[1], Richard Pang[2], Richard M. Osgood III[2], Preet Kamal[3], Amit Jain[3], Gang Chen[1], Svetlana V. Boriskina[1]; *[1]MIT, USA; [2]US Army Natick Soldier Research, Development, and Engineering Center, USA; [3]Shingora Textiles Limited, India.* We report on the design, fabrication and characterization of flexible polymer metamaterial fabrics that provide passive radiative cooling or heating by utilizing optical resonant effects in polymer microfibers with tailored sizes and composition.

FM4E • High-Dimension Quantum Systems and Simulation—Continued

FM4E.5 • 15:00

Two-Photon Joint Spectral Wave Function Measurement via Electro-Optic Spectral Shearing Interferometry, Alex O. Davis[1], Valérian Thiel[1], Brian J. Smith[1,2]; *[1]Oxford Univ. , UK; [2]Univ. of Oregon, USA.* We present a technique to completely characterize the joint spectral-temporal wave function of a photon pair at 830 nm center wavelength using spectral-shearing interferometry. Our fully self-referencing method applies spectral shear using an EOM.

FM4E.6 • 15:15

Full mode reconstruction of optical twin beams via photon-number-resolved measurement, Elizabeth Goldschmidt[1,2], Ivan Burenkov[2,3], Ankita Sharma[3], Thomas Gerrits[3], Georg Harder[4], Tim Bartley[4], Christine Silberhorn[4], Sergey Polyakov[3]; *[1]US Army Research Lab, USA; [2]Joint Quantum Inst., USA; [3]National Inst. of Standards and Technology, USA; [4]Univ. of Paderborn, Germany.* We present a method to reconstruct the mode structure of multimode conjugated optical fields using an experimentally measured joint photon-number probability distribution and demonstrate a reconstruction of a bright parametric down-conversion source.

LS

LM4F • X-Ray Science with Table Top and XFEL Lasers—Continued

LM4F.5 • 15:00

Holographic generation of high-harmonic vortex beams, Fanqi Kong[1,2], Chumei Zhang[1,2], Frédéric Bouchard[1], Zhengyan Li[1,2], Graham Brown[1,2], Donghyuk Ko[1,2], Thomas Hammond[1,2], Ladan Arissian[2], Robert Boyd[1,3], Ebrahim Karimi[1], Paul Corkum[1,2]; *[1]Univ. of Ottawa, Canada; [2]National Research Council of Canada , Canada; [3]Univ. of Rochester, USA.* We introduce a holographic method to manipulate the wavefront structures of extreme ultraviolet (XUV) beams. Based on this concept, we generate optical vortices with controllable orbital angular momentum (OAM) on high-order harmonics.

LM4F.6 • 15:15

An Instrument for Time-Resolved Photoelectron Spectroscopy at 87 MHz, Christopher Corder[1], Peng Zhao[1], Xinlong Li[1], Matthew D. Kershis[1], Amanda R. Muraca[1], Michael G. White[1], Thomas K. Allison[1]; *[1]Stony Brook Univ., USA.* We describe an instrument for high-repetition rate time-resolved XUV photoelectron spectroscopy, based on cavity-enhanced high-order harmonic generation. This system enables ultrafast surface photoemission studies without space-charge constraints.

15:30–16:00 Coffee Break, *International Terrace, Terrace Level*

16:00–17:30 Workshop: Understanding Unconscious Bias, *Georgetown East, Concourse Level*

16:00–17:30 OSA Nonlinear Optics Technical Group Workshop & Networking Session, *Georgetown West, Concourse Level*

16:00–18:00 Evening with the Agencies & Reception, *Jefferson West, Concourse Level*

18:30–21:00 FiO + LS Awards Banquet, *International Ballroom Center, Terrace Level*

07:00–17:30 Registration, *Concourse Foyer*

08:00–09:30 JTu1A • Joint Plenary Session, *International Ballroom Center, Terrace Level*

09:30–10:00 Exhibits and Coffee Break, *Science & Industry Showcase, Columbia, Terrace Level*

10:00–12:00 JTu2A • Science & Industry Showcase
Exhibits, Poster Session & E-Posters
Rapid-Fire Oral Presentations I in Theater
Columbia, Terrace Level

Science Showcase Theater

JOINT FiO + LS

10:00–11:00
JTu2A • Rapid-Fire Oral Presentations I

JTu2A.11 • 10:00 *RAPID*
Phosphor Screens for Laser Projection Systems, Takamasa Kohmoto[1], Masamichi Ohta[1], Ichiro Fujieda[1], Wataru Watanabe[1]; [1]*Ritsumeikan Univ., Japan.* High-resolution images can be displayed on a phosphor screen by projecting laser light. The screen can be made transparent and might be applicable for a head-up display and a volumetric 3d display.

JTu2A.12 • 10:05 *RAPID*
Novel Hard Mask Fabrication Method for Hybrid Plasmonic Waveguide and Metasurfaces, Sajid Choudhury[1], Volodymyr Zenin[2], Soham Saha[1], Vladimir Shalaev[1], Sergey I. Bozhevolnyi[2], Alexandra Boltasseva[1]; [1]*Purdue Univ., USA;* [2]*Univ. of Southern Denmark, Denmark.* A hybrid plasmonic waveguide fabrication technique has been developed and waveguides have been demonstrated. The developed technique can create similar hybrid waveguide structures and metasurfaces with transition metal nitrides and epitaxial silver.

JTu2A.25 • 10:10 *RAPID*
Switchable quarter wave plate using $Ge_2Sb_2Te_5$ metasurface, Chul Soo Choi[1], Jeong-geun Yun[1], Gun-yeal Lee[1], Sun-je Kim[1], Byoungho . Lee[1]; [1]*Seoul national Univ., South Korea.* $Ge_2Sb_2Te_5$ (GST) is in the spotlight as an ingredient of metasurface to achieve active feature. Here, we propose a novel method for active switching of polarization via the metasrufface composed of GST nanorods.

JTu2A.60 • 10:15 *RAPID*
Guided-Mode Resonance Biosensors: Quantifying the Binding of Neuropeptide Y to its Antibody, Kyu J. Lee[1], Robert Magnusson[1], Brett R. Wenner[2], Jeffery Allen[2], Monica S. Allen[2]; [1]*Univ. of Texas at Arlington , USA;* [2]*Air Force Research Lab, USA.* We apply the guided-mode resonance sensor principle to record peptide binding dynamics. In particular, we conveniently and expeditiously quantify anti-NPY binding to NeutrAvidin and then NPY binding to anti-NPY.

JTu2A.68 • 10:20 *RAPID*
2D Computational Modeling of Optical Trapping Effects on *Malaria*-infected Red Blood Cells, Joana S. Paiva[1,2], Rita S. R. Ribeiro[1,2], Pedro A. S. Jorge[1,2], Carla C. Rosa[1,2], A. Guerreiro[1,2], Joao P. S. Cunha[1,3]; [1]*INESC TEC - INESC Technology and Science, Portugal;* [2]*Astronomy and Physics Dept., Sciences Faculty of Univ. of Porto, Portugal;* [3]*Dept. of Electrical and Computer Engineering, Faculty of Engineering of Univ. of Porto, Portugal.* A computational method for optical fiber trapping of healthy and *Malaria*-infected blood cells characterization is proposed. A trapping force relation with the infection stage was found, which could trigger the development of a diagnostic sensor.

JTu2A.71 • 10:25 *RAPID*
Laser Induced Fluorescence in combination with Multivariate analysis classifies anti-malarial herbal plants, Charles L. Amuah[1]; [1]*Univ. of Cape Coast, Ghana.* Laser-induced fluorescence in combination with multivariate analysis as a simple, rapid and non-destructive method for classifying anti-malarial herbal plants is presented. A suitable alternative method that enhances safety and objectivity.

JTu2A.72 • 10:30 *RAPID*
Characterization and discrimination of basal cell carcinoma and normal human skin tissues using resonance Raman spectroscopy, Cheng-hui Liu[1], Binlin Wu[3], Susie Boydston-White[2], Hugh Beckman[1], Vidyasagar Sriramoju[1], Laura Sordillo[1], Chunyuan Zhang[1], Jason Smith[3], Lin Zhang[1], Lingyan Shi[4], Robert R. Alfano[1]; [1]*CUNY City College, USA;* [2]*CUNY, USA;* [3]*Southern Connecticut State Univ., USA;* [4]*Columbia Univ., USA.* Resonance Raman spectroscopy is used for rapid detection of skin BCC cancer. The cross-validated classification accuracy is achieved to be as high as 98% using nonnegative matrix factorization along with support vector machine statistical method.

JTu2A.84 • 10:35 *RAPID*
Mechanical properties of cellular nucleus characterized by Brillouin flow cytometry, Jitao Zhang[1], Xuefei Nou[1], Hanyoup Kim[2], Giuliano Scarcelli[1]; [1]*Univ. of Maryland at College Park, USA;* [2]*Canon U.S. Life Sciences, Inc., USA.* We developed a label-free flow cytometry platform to characterize the nuclear mechanics based on Brillouin microscopy, which is an all-optical technique so that can measure the stiffness of the nucleus in a non-contact, non-invasive manner.

JTu2A.91 • 10:40 *RAPID*
Utilizing Machine Learning for Smart Starting Guesses for Phase Retrieval, Scott Paine[1], James Fienup[1]; [1]*Univ. of Rochester, USA.* Traditional wavefront-sensing phase retrieval problems with large amounts of wavefront error often do not converge without a good starting point. We use machine learning in an attempt to produce better starting guesses for these problems.

JTu2A.92 • 10:45 *RAPID*
Building Scalable Integrated Silicon Photonics Reservoirs for Signal Processing, Andrew Katumba[1], Matthias Freiberger[2], Jelle Heyvaert[1], Joni Dambre[2], Peter Bienstman[1]; [1]*Dept. of Information Technology, Gent Univ. - imec, Belgium;* [2]*Dept. of Electronics and Information Systems, Gent Univ., Belgium.* Photonic reservoir computing is a novel bio-inspired paradigm for signal processing. We discuss how it can be scaled up by injecting multiple copies of the input and by using multi-mode rather than single-mode components.

JTu2A.105 • 10:50 *RAPID*
Automatic calibration of Projector and DDHOE based IP displays, Jackin Boaz Jessie[1], Lode Jorissen[2], Ryutaro Oi[1], Koki Wakunami[1], Yasuyuki ichihashi[1], Makoto Okui[1], Philippe Bekaert[2], Kenji Yamamoto[1]; [1]*National Inst. of Communications Tec, Japan;* [2]*Expertise Center for Digital Media, Hasselt Univ.-tUL, Belgium.* A calibration technique for integral photography(IP) based 3D display that uses a commercial projector and digitally designed holographic optical element (DDHOE), is reported. This method requires less number of input images for calibration.

10:00–12:00
JTu2A • Joint Poster Session I

JTu2A.1 *E-Poster*
Angle-Resolved Measurement of Photoluminescence Spectra for Illumination and Display Applications, Masamichi Ohta[1]; Ichiro Fujieda[1]; *[1]Ritsumeikan Univ., Japan.* Photoluminescence spectra from a laser-driven phosphor layer vary with the emission angle. This phenomenon is attributed to uneven absorption of the laser light and self-absorption of the emitted photons within the phosphor layer.

JTu2A.2 *E-Poster*
Holographic Microscope Slide for Single Beam Off-Axis Digital Holography Microscopy, Biagio Mandracchia[1], Vittorio Bianco[1], Melania Paturzo[1], Pietro Ferraro[1]; *[1]Inst. for Applied Sciences and Intelligent Systems, Italian National Research Council, Italy.* We designed, realized, and tested a pocket module that allows performing off-axis Digital Holography microscopy with no need for an interferometer setup. To this purpose, a commercial plastic chip is engineered for the scope.

JTu2A.3 *E-Poster*
3-D Printed Spatial Domain Multiplexer, Syed H. Murshid[1], Nasir Hariri[1], Greg Lovell[1], Engine Eyceyurt[1], Rayan Enaya[1]; *[1]Florida Inst. of Technology, USA.* This paper presents the capability of using a 3D printing technology in manufacturing a platform that will improve fixation and stability which provide more control over the current SDM system.

JTu2A.4 *E-Poster*
Deep learning on OCT images of skin cancer, Dmitry Raupov[1], Oleg Myakinin[1], Ivan Bratchenko[1], Valery Zakharov[1]; *[1]Samara National Research Univ. , Russia.* A deep learning with neural nets for diagnostics of skin tumors on OCT images is investigated. The convolutional neural network is used to solve the task of tumor recognition.

JTu2A.5 *E-Poster*
Transmission of Polarization-Entangled Photons Through Brain Tissue, Enrique J. Galvez[1,2], Behzad Khajavi[1,3], Lingyan Shi[4,2], Jhonny Castrillon[1,5], Robert R. Alfano[2]; *[1]Colgate Univ., USA; [2]Physics, City College of New York, USA; [3]Physics and Astronomy, Florida Atlantic Univ., USA; [4]Chemistry, Columbia Univ., USA; [5]Fisica, Universidad de Antioquia, Colombia.* We characterize the entanglement after one of two polarization-entangled photons travels through a soft-matter scattering medium: brain tissue. We consider tissue samples of distinct thickness, water content, type, and healthy or affected by disease.

JTu2A.6 *E-Poster*
Design of a Steerable, Configurable Detection, Adaptive Optics Scanning Laser Ophthalmoscope with Integrated Fixation and Stimulation, Stephen A. Burns[1], Alberto de Castro[1,2], Lucie Sawides[1,2], Ting Luo[1], Kaitlyn Sapoznik[1]; *[1]Indiana Univ., USA; [2]Physics, Univ. of Murcia, Spain.* We present an AOSLO with steering that allows imaging 30 degrees, with minimal distortion. A spatial light modulator in the confocal plane provides detection specificty. An integrated display subsystem allows measuring functional responses.

JTu2A.7 *E-Poster*
Exploiting Speckle Decorrelation Rate To Decouple Singly Scattered Light Reflected from A Scattering Surface, Aparna Viswanath[1], Prasanna Rangarajan[1], Indranil Sinharoy[1], Muralidhar M. Balaji[1], Marc Christensen[1], Duncan MacFarlane[1]; *[1]Southern Methodist Univ., USA.* Angular dependence of surface/sub-surface scattering from rough reflecting sample is examined, as evidenced in objective speckle patterns acquired at standoff, to decouple the single and multiply-scattered light using Principal-Component -Analysis.

JTu2A.8 *E-Poster*
Computational ghost imaging under Gaussian distributed sparse speckles, Yong Yue[1], Bin Luo[2], Junhui Li[3], Dongyue Yang[1], Guohua Wu[1], Longfei Yin[1], Hong Guo[3]; *[1]School of Electronic Engineering, Beijing Univ. of Posts and Telecommunications, China; [2]State Key Lab of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, China; [3]School of Electronics Engineering and Computer Science, Peking Univ., China.* Computational ghost imaging under Gaussian distribution sparse speckles (GSGI) with spatial light modulator(SLM) is proposed and demonstrated. At a price of more measurements, GSGI outperformances its counterpart under traditional random speckles.

JTu2A.9 *E-Poster*
Normally Transparent Liquid-Crystal Smart Glass for Augmented Reality Head-Up Displays, Chun-Wei Chen[1], Tsung-Jui Ho[1], Iam Choon Khoo[1]; *[1]Pennsylvania State Univ., USA.* We report a translucency-tunable cholesteric liquid crystal window, of which the transparent state is the only stable state upon removal of electric fields. The relaxation from the scattering to clear state takes only 100's ms.

JTu2A.10
Identification of optimum transforms for evaluating perceptual image quality scores using objective metrics, Quanzeng Wang[1], Nitin Suresh[1]; *[1]Food and Drug Administration, USA.* Regression models for conversion of objective quality metrics to perceptual scores are identified. These models depend on the distortion type present in the image, and an ensemble of metrics is best suited for overall evaluation.

JTu2A.11
Phosphor Screens for Laser Projection Systems, Takamasa Kohmoto[1], Masamichi Ohta[1], Ichiro Fujieda[1], Wataru Watanabe[1]; *[1]Ritsumeikan Univ., Japan.* High-resolution images can be displayed on a phosphor screen by projecting laser light. The screen can be made transparent and might be applicable for a head-up display and a volumetric 3d display.

JTu2A.12
Novel Hard Mask Fabrication Method for Hybrid Plasmonic Waveguide and Metasurfaces, Sajid Choudhury[1], Volodymyr Zenin[2], Soham Saha[1], Vladimir Shalaev[1], Sergey I. Bozhevolnyi[2], Alexandra Boltasseva[1]; *[1]Purdue Univ., USA; [2]Univ. of Southern Denmark, Denmark.* A hybrid plasmonic waveguide fabrication technique has been developed and waveguides have been demonstrated. The developed technique can create similar hybrid waveguide structures and metasurfaces with transition metal nitrides and epitaxial silver.

JTu2A.13
Analysis of Double Slot Hybrid Plasmonic Ring Resonator with different dielectric materials in Nanoslots, Lokendra Singh[1], Santosh Kumar[1]; *[1]DIT Univ., India, India.* This paper presents the analysis of double slot hybrid plasmonic ring resonator structure by varying the dielectric materials in ring nanoslots using finite element method (FEM). It enhances the sensitivity of the refractive-index sensor.

JTu2A.14
Photonic Bandgap Effect in Mie Scattering of Bragg Fibers, Zeba Naqvi[1], Tsing-Hua Her[1]; *[1]Univ of North Carolina at Charlotte, USA.* Anomalous suppression and enhancement in scattering of optical fibers coated with Bragg layers is observed. A scattering angle diagram is introduced to explain the anomalous features and are attributed to photonic bandgap of Bragg layers.

JTu2A.15
Research of Solid-state Laser Based on Pre-polymerization PMMA Polymer Doped with Laser Dye, Zhigang Zhou[1,2], Rongwei Fan[1,2], Zhaodong Chen[1,2], Xinrui Xu[1,2], Tao Jia[1,2], Deying Chen[1,2]; *[1]Inst. of Optical-Electronics, National Key Lab of Tunable Lasers, China; [2]Harbin Inst. of Technology, China.*
This article gave a brief research about solid-state dye laser based on PMMA polymer doped with different laser dye through pre-polymerization method, and showed good fluorescence and laser characteristics in experimental research.

JTu2A.16
Two-photon absorption lithography for nanofabrication of 3D X-Ray compound refractive lenses, Ksenia Abrashitova[4], Alexandr Petrov[1,4], Vladimir Bessonov[4], Kokareva Natalia[4], Kirill Safronov[4], Alexandr Barannikov[1], Petr Ershov[1], Nataliya Klimova[1], Ivan Lyatun[1], Vyacheslav Yunkin[2], Maxim Polikarpov[1], Irina Snigireva[3], Andrey Fedyanin[4], Anatoly Snigirev[1]; *[1]Immanuel Kant Baltic Federal Univ., Russia; [2]Inst. of Microelectronics Technology RAS, Russia; [3]European Synchrotron Radiation Facility, France; [4]Lomonosov Moscow State Univ., Russia.* The present work proves that X-Ray compound refractive nano-lens can be produced through two-photon polymerization lithography. It was tested successfully at the X-ray microfocus Lab source and a focal spot of 5 μm was measured.

JTu2A.17
Surface-energy-driven growth and optical modulation of ZnO hexagonal microtube optical cavities, Hongxing Dong[1]; *[1]Shanghai Inst. of Optics and Fine Mechanics, China.* A distinct "split and recoalescence" growth mechanism of tubular ZnO micro/nanostructures is observed. Optical resonant modes of such microtube optical cavities were directly observed experimentally.

JTu2A.18
Integrated Gradient-Index Planar Optofluidic Polymer Waveguide, Juan E. Villegas[1], Mutasem A. ODEH[1], Marcus S. Dahlem[1]; *[1]Masdar Inst., United Arab Emirates.* We propose a microfluidic channel with a rectangular cross-section, built on a polydimethylsiloxane substrate that also acts as a waveguide through a controlled gradient refractive index profile, fabricated by a modified soft-lithography technique.

JTu2A.19
2-Beam action spectroscopies: A new class of methods for the measurement of the effective order of nonlinear absorption, Nikos Liaros[1], Zuleykhan Tomova[1], Sandra A. Gutierrez Razo[1], Samuel R. Cohen[1], John T. Fourkas[1]; *[1]Chemistry and Biochemistry, Univ. of Maryland at College Park, USA.* We introduce a new class of methods, based on excitation with two independent beams, for determining the order of effective nonlinearity in different materials. We discuss representative examples of 2-beam action spectroscopies and their applications

JTu2A.20
Fabrication of Anti-reflection Microstructures on ZnSe Single Crystal by Using Femtosecond Laser Pulses, Mikhail K. Tarabrin[1,2], Andrey Bushunov[1], Vladimir A. Lazarev[1], Valerii E. Karasik[1], Vladimir I. Kozlovsky[2], Dmitriy Sviridov[2], Yuriy Korostelin[2,3], Mikhail P. Frolov[2], Yan K. Skasyrsky[2]; *[1]Bauman Moscow State Technical Univ., Russia; [2]P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia; [3]Moscow Inst. of Physics and Technology, Russia.* We report the demonstration of zinc selenide single crystal reflectivity reduction in a spectral range of 3.5 to 15 μm up to 3% by using femtosecond laser pulses for microstructure formation without any etching technique.

JTu2A • Joint Poster Session I—Continued

JTu2A.21
Real Time Sulfur Particles Analysis in Diesel Using Instrumentation Methods based on Spectrometry, Eduardo Perez[1,2]; [1]*DICIS, Mexico;* [2]*Electronics, Univ. of Guanajuato, Mexico.* Sulfur contamination has been a problem since the begging in oil refinery methods. This paper proposes the application of a monochromatic wavelength fluorescence (MWDXRF) technique to identify and reduce the sulfur particles contained in Diesel.

JTu2A.22
Flexible Tunable Liquid Crystal Platform in Terahertz Region, Abubaker M. Tareki[1], Robert G. Lindquist[1], Emin Gulduren[1]; [1]*Univ. of Alabama in Huntsville, USA.* We investigated an engineered flexible material platform to actively modulate terahertz waves in phase and amplitude using stratified layers of patterned gold, Teflon and liquid crystals. Both simulation and experimental results will be provided.

JTu2A.23
Applications of Software Defined Radio to heterodyne optoelectronics, Lucas M. Riobo[1,2], Francisco E. Veiras[1,2], María T. Garea[1], Patricio A. Sorichetti[1]; [1]*Universidad de Buenos Aires , Argentina;* [2]*CONICET, Argentina.* This paper describes a real time detection system for heterodyne optoelectronics using a Software Defined Radio (SDR) receiver. The performance of the system is demonstrated in an application on displacement measuring interferometry (DMI).

JTu2A.24
Holistic Performance-Cost Metric for Post Moore Era, Shuai Sun[1], Vikram Narayana[1], Armin Mehrabian[1], Ruoyu Zhang[1], Tarek El-Ghazawi[1], Volker J. Sorger[1]; [1]*George Washington Univ., USA.* Here we demonstrated the first holistic metric which includes all critical performance and cost variables that accurately evaluates the overall abilities of post Moore's law computing machines and matches with all historical data.

JTu2A.25
Switchable quarter wave plate using $Ge_2Sb_2Te_5$ metasurface, Chul Soo Choi[1], Jeong-geun Yun[1], Gun-yeal Lee[1], Sun-je Kim[1], Byoungho . Lee[1]; [1]*Seoul national Univ., South Korea.* $Ge_2Sb_2Te_5$ (GST) is in the spotlight as an ingredient of metasurface to achieve active feature. Here, we propose a novel method for active switching of polarization via the metasruface composed of GST nanorods.

JTu2A.26
Greatly extended depth of field for microscopic imaging, Zengzhuo Li[1], Guoqiang Li[1]; [1]*The Ohio State Univ., USA.* Based on wavefront-coding technique, a custom transmissive phase plate can extend the depth of field (DoF) of a microscope by more than 13 times with diffraction-limited resolution in comparison with the conventional microscope.

JTu2A.27
Design of reversible TR gate using pockel's effect in lithium -niobate based Mach-Zehnder interferometers, Chanderkanta Chauhan[1], Santosh Kumar[1]; [1]*DIT Univ., India, India.* In this paper, design of reversible TR gate using lithium- niobate based Mach-Zehnder interferometer is proposed. The results are verified using beam propagation method and MATLAB simulations.

JTu2A.28
Optical flat comb source generation based on a cascade of two stage mach-zehnder modulator, Abir Hraghi[1]; [1]*Engring School of Communication of Tunis, Tunisia.* A novel technique to generate an optical flat comb source is presented experimentally demonstrated. the transmission of 137.5Gbps(11*11.5Gbps) QPSK-OFDM-UDWDM signal is experimentally illustratted over 25km and 100km SSMF link using direct detection.

JTu2A.29
Fiber optical current sensor based on tapered Terfenol-D composite, Suha Lasassmeh[1], Edward Lynch[1], Chiu T. Law[1]; [1]*Univ. of Wisconsin Milwaukee, USA.* This paper presents an optical current sensor which is based on introducing non-uniform period onto a fiber Bragg Grating (FBG) by embedded it in a magnetostrictive composite with tapering shape.

JTu2A.30
Automated phase-shifting in a cube beam splitter interferometer, Uriel Rivera-Ortega[1]; [1]*Strategic Planning and Technology Management, Universidad Popular Autónoma del Estado de Puebla, Mexico.* It is presented a low-cost and fully automated process for phase-shifting interferometry by continuously changing the input voltage of a laser diode under the scheme of a common-path cube beam splitter interferometer

JTu2A.31
Optical Cloaking Using Afocal System, Pavan D. Vadapalli[1], Sourabh Roy[1]; [1]*Dept. of Physics, National Inst. of Technology Warangal, India.* Using paraxial approximations an optical cloaking device is designed and is simulated using CODE – V. The aberrations in the system are within allowed limits. MTF of the device is more than 50% at 30 cycles/mm of spatial frequency.

JTu2A.32
Detection of damage in Oil and Gas Pipelines using FBG Sensor, Vaishali Kothari[1], Santosh Kumar[1]; [1]*DIT Univ., India, India.* The idea of a Fiber Bragg grating (FBG) sensor has been proposed for detecting damage in pipeline structure based on acoustic emission and their output has been simulated using MATLAB.

JTu2A.33
Suppressing 1.06-mm spontaneous emission of Neodymium by using a tellurite all-solid photonic bandgap fiber, Hoang Tuan Tong[1], Demichi Daisuke[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*Toyota Technological Inst., Japan.* We demonstrate a suppression of the 1.06-μm emission which corresponds to the $^4F_{3/2} \rightarrow {}^4I_{11/2}$ transition of Nd^{3+} ion doped in a tellurite all-solid photonic bandgap fiber by employing the light-guiding properties of its photonic bandgap structure.

JTu2A.34
Color Beam Combiners and Splitters, Nikolai I. Petrov[1], Maxim Khromov[1], Angela Storozheva[1], Yuri Sokolov[1]; [1]*Scientific Research Center of Unique Instrumentation of the Russian Academy of Sciences, Russia.* Beam combiners and splitters based on the frustrated total internal reflection, diffraction and refraction effects of light beams are considered. New high efficiency prismatic beam combiner consisting of uniform material is proposed.

JTu2A.35
Super-Resolution Imaging in Optical Waveguide, Nikolai I. Petrov[1]; [1]*Scientific Research Center of Unique Instrumentation of the Russian Academy of Sciences, Russia.* Remote focusing of light via mode interference in optical waveguide is demonstrated using exact solutions. The possibility of super-resolution image transfer through the graded-index optical waveguide due to the large-scale revival effect is shown.

JTu2A.36
Fiber-based Optical Thermocouples for In-Situ Temperature Sensing in Extreme Environments, Benjamin R. Anderson[1], Steven Livers[1], Ray Gunawidjaja[1], Hergen Eilers[1]; [1]*Washington State Univ., USA.* We develop an optical thermocouple for use in extreme environments by depositing a Dy:YAG film on a sapphire fiber using pulsed laser deposition. Temperature sensing is achieved by way of two-color photoluminescence thermometry.

JTu2A.37
Efficient 1550 nm Diffractive Log-Polar Element Based Orbital Angular Momentum Mode-division Multiplexing, Wenzhe Li[1], Keith Miller[1], Indumathi Srimathi[1], Yuan Li[1], Kaitlyn Morgan[1], Eric G. Johnson[1]; [1]*Clemson Univ., USA.* Diffractive log-polar orbital angular momentum elements have been designed and fabricated for 1550 nm. Mode-division multiplexing has been experimentally demonstrated. The power efficiency of the two log-polar elements are 84% and 81%, respectively.

JTu2A.38
Random Micro-Lens Arrays: Effects of Coherence and Polarization, Nikolai I. Petrov[1], Galina N. Petrova[1]; [1]*Scientific Research Center of Unique Instrumentation of the Russian Academy of Sciences, Russia.* Influence of light coherence on the intensity distribution of diffracted beam by random microlens arrays is investigated. Significant influence of wave-front curvature and polarization of incident beam on the reflectance and transmittance is shown.

JTu2A.39
Non-destructive optical loss characterization using designed scattering features, David Lombardo[1], Imad Agha[1], Andrew Sarangan[1]; [1]*Univ. of Dayton, USA.* We develop and demonstrate a new, non-destructive technique for measuring optical material losses. This technique takes advantage of induced scattering by designed photoresist features to measure the optical power in thin film waveguides.

JTu2A.40
Generation of vector Bessel beams by using phase elements based on the Jacobi-Anger expansion, Gabriel Mellado-Villaseñor[1], Dilia Aguirre-Olivas[2], Ulises Ruiz[1], Victor Arrizón[1]; [1]*Óptica, Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico;* [2]*Instituto de Fisiología Celular-Neurociencias, Universidad Nacional Autónoma de México, Mexico.* We generate vector Bessel beams (VBBs) of arbitrary order by using a diffraction phase element. The phase transmittance of this element is based on the Jacobi-Anger identity. Results of the VBB generation are shown through numerical simulations.

JTu2A.41
Holographic Screens with Controlled Scattering Indicatrix, Nikolai I. Petrov[1]; [1]*Scientific Research Center of Unique Instrumentation of the Russian Academy of Sciences, Russia.* Optical layers with controllable scattering indicatrices are considered. The influence of light source coherence, roughness height and correlation length of the surface roughness on the scattering angle is investigated.

JTu2A.42
Telescope windows: development of a novel pixellated optical system, Cyril Bourgenot[2], Johannes K. Courtial[1], Euan Cowie[1], John Girkin[2], Gordon Love[2], David Robertson[2], Laura Young[2]; [1]*Univ. of Glasgow, UK;* [2]*Dept. of Physics, Durham Univ., UK.* We describe progress towards building arrays of small telescopes called telescope windows. The telescopes act as pixels of a light-ray-direction-changing window. Applications include improved medical low-vision aids.

JTu2A.43
Wavefront analysis of Aberrated Laguerre-Gaussian Beam , Chittur S. Narayanamurthy[1]; [1]*Indian Inst. of Space Sci & Tech, India.* Wavefront analysis of an aberrated Laguerre-Gaussian beam generated using LC-SLM and after passing through a Pseudo Random Phase Plate(PRPP) is carried out using Shack Hartmann wavefront sensor and Zernike polynomials.

JTu2A • Joint Poster Session I—Continued

JTu2A.44
Description of Pairs of Skew Lenses as a Single Lens, Jakub Bělín[1], Stephen Oxburgh[1], Tomáš Tyc[2], Johannes K. Courtial[1]; *[1]Univ. of Glasgow, UK; [2]Inst. of Theoretical Physics and Astrophysics, Masaryk Univ., Czech Republic.* We describe pairs of skew ideal thin lenses as a single thin lens with non-coinciding, non-parallel, principal planes. This description facilitates the understanding of structures of skew lenses such as the ideal-lens cloak.

JTu2A.45
Ideal-Lens Cloak and Omnidirectional Lens, Johannes K. Courtial[1], Tomáš Tyc[2], Jakub Bělín[1], Stephen Oxburgh[1], Euan Cowie[1], Chris D. White[3]; *[1]Univ. of Glasgow, UK; [2]Inst. of Theoretical Physics and Astrophysics, Masaryk Univ., Czech Republic; [3]Centre for Research in String Theory, Queen Mary Univ. of London, UK.* We present a structure of ideal thin lenses that acts as an omnidirectional transformation-optics cloak and an omnidirectional lens. We present the design principles, and discuss experimental realisability and potential applications.

JTu2A.46
Beam Quality Deterioration Due to Angular Dispersion of Optical Elements, Sergiy Mokhov[1]; *[1]Univ. of Central Florida, CREOL, USA.* The deterioration of M^2 from unity due to angular dispersion for non-monochromatic Gaussian beam is found analytically. It depends on beam size and meansquare variation of optical element angular dispersion averaged with beam spectral distribution.

JTu2A.47
Electronic frequency divider as a tool for phase/frequency noise analysis, Dipenkumar Barot[1], Lingze Duan[1]; *[1]Univ. of Alabama in Huntsville, USA.* We demonstrate experimentally that the electronic frequency divider can be used as a simple tool for measuring phase/frequency modulation noise in the beat note and also provide theoretical explanation for that.

JTu2A.48
Detecting of spectrometric information in a diffraction grating spectral device, Artur Paraskun[1], Vasily Kazakov[1], Oleg Moskaletz[1]; *[1]St. Petersburg State Univ. of Aerospace Instrumentation, Russia.* The detecting process of spectrometric information via CCD structures in diffraction spectral device is considered. Mathematical relationships between photocurrent in each element of CCD and incident spectrum of optical radiation is obtained.

JTu2A.49
Exploring Lens Geometry for Superlensing in an Electrostatic Pendry Lens, Elizabeth Keys[1], Sergei Mistyuk[1], Christopher Keys[1], Gary Shoemaker[1]; *[1]California State Univ., Sacramento, USA.* In superlensing, the methods of manufacturing complicated lens designs can be cost-prohibitive. Motivated by unpublished results in 2007, a changeable electrostatic Pendry lens was designed and the effects of geometry are being pursued.

JTu2A.50
Chebyshev Freeform Microlens Array Homogenizer for Excimer Laser Beam Shaping, Yuhua Jin[1], Ali Hassan[1], Yijian Jiang[1]; *[1]Beijing Univ. of Technology, China.* A novel design technique of microlens beam homogenizer for excimer lasers is presented. As a new approach by applying Chebyshev freeform surface microlens array, the homogenizer can yield superior beam shaping results than conventional method.

JTu2A.51
U Shaped Fiber-Optic pH Sensor Using Sol-gel Coating Over TiO2, Akhilesh K. Pathak[1], Vinod k. Singh[1]; *[1]IIT(ISM), India.* A wide range U shaped fiber optic pH sensor utilizing titanium dioxide (TiO2) layer with sol-gel coating, has been fabricated and demonstrated in this paper. A high sensitivity of 0.37 dBm/pH is observed with fast response time of 14s.

JTu2A.52
Catching Robot Hand System in Dynamic Depth Variation with a Rotating Variable Focusing Unit, Kenichi Murakami[2], Lihui Wang[2], Tomohiko Hayakawa[2], Taku Senoo[1], Masatoshi Ishikawa[2,1]; *[1]Dept. of Information Physics and Computing, Univ. of Tokyo, Japan; [2]Dept. of Creative Informatics, Univ. of Tokyo, Japan.* We proposed a catching robot hand system that extended the focal length of the original optics unit by adding rotating adjustment transparent plates, and succeeded the catching task with the adaptive optics in dynamic scene.

JTu2A.53
Calculation of the impulse response of PIN and MUTC photodetectors using the drift-diffusion equations, Seyed Ehsan Jamali Mahabadi[1], Curtis R. Menyuk[1]; *[1]Univ. of Maryland, Baltimore County, USA.* We calculate the impulse response of high-current PIN and MUTC photodetectors using the drift-diffusion equations, avoiding computationally-expensive Monte Carlo simulations. We calculate the shot noise limit and cut-off frequency of the devices.

JTu2A.54
Parametric Studies on Wide Field of View Imaging Systems with Curved Image Sensors, Gil Ju Lee[1], Young Min Song[1]; *[1]GIST, South Korea.* We present simple optical systems composed of curved image sensors and different lens geometries reducing the complexity of the optical system while capturing optical performances such as wide field of view.

JTu2A.55
Optical Fiber Loops and Helices: Tools for Integrated Photonic Devices Characterization and Microfluidic Manipulations, Yundong Ren[1]; *[1]Worcester Polytechnic Inst., USA.* We fabricated two special geometry tapered fibers, tapered fiber loops and helices. And demonstrated their applications in nanophotonics and microfluidics.

JTu2A.56
Nanocomposites of plasmon nanoparticles with dyes and biological objects, Valentyn Smyntyna[1], Valentyna Skobeeva[2], Nikolay Malushin[2], Vladimir Tkachenko[2], Vadim Ulyanov[3], Mariya Makarova[3]; *[1]Dept. of Physics, Odessa National I. I. Mechnikov Univ., Ukraine; [2]Research Inst. of Physics, Odessa National I. I. Mechnikov Univ., Ukraine; [3]Odessa National Medical Univ., Ukraine.* The optical properties of heterogeneous systems, including Ag nanoparticles and dye were studied. The effect of Ag nanoparticles influence on molecular structuring of methylene blue dye and on luminescence of dye, on immunomodulating blood cells.

JTu2A.57
Extreme light confinement based on plasmonic nanopost arrays for super-localization microscopy, HK Lee[1], Donghyun Kim[1]; *[1]Yonsei Univ., South Korea.* Near-field distribution produced by plasmonic nanopost arrays was measured and compared with finite difference time domain simulations. The possibility of plasmonic nanopost arrays for applications in super-localization microscopy was explored.

JTu2A.58
Long Range Capturing and Delivery of Water Dispersed Nanoparticles for High Resolution Detection, Francesco Tantussi[1], Gabriele Messina[1], Laura Lovato[1], Rosario Capozza[1], Michele Dipalo[1], Francesco De Angelis[1]; *[1]Istituto Italiano di Tecnologia, Italy.* The generation and the following collapse of a gas bubble in water is a highly efficient technique for capturing, trapping and delivering water dispersed nanoscale elements in a specific area of a substrate.

JTu2A.59
Fiber Bragg Grating based Temperature Sensor for Biomedical applications, Vaishali Kothari[1], Amna Bedi[1], Santosh Kumar[1]; *[1]DIT Univ., India, India.* In this paper, measurement of temperature for biomedical instruments like medical drugs, heat liquids or to clean medical equipment using Fiber Bragg grating (FBG) sensors has been given. The results have been simulated using MATLAB.

JTu2A.60
Guided-Mode Resonance Biosensors: Quantifying the Binding of Neuropeptide Y to its Antibody, Kyu J. Lee[1], Robert Magnusson[1], Brett R. Wenner[2], Jeffery Allen[2], Monica S. Allen[2]; *[1]Univ. of Texas at Arlington , USA; [2]Air Force Research Lab, USA.* We apply the guided-mode resonance sensor principle to record peptide binding dynamics. In particular, we conveniently and expeditiously quantify anti-NPY binding to NeutrAvidin and then NPY binding to anti-NPY.

JTu2A.61
Photo-bio modulatory response of platelets to low power laser - A pilot study, Bharath Rathnakar[1], Namita Bhyravbhatla[1], Subhash Chandra[1], Bola Sadashiva Satish Rao[1], Krishna Kishore Mahato[1]; *[1]Manipal Univ., India.* Platelets isolated were treated with varying fluences (0.5, 1 and 2 J/cm^2) of low power laser (830 nm). Mitochondrial membrane potential (MMP) of platelets were assessed through flow cytometry using Tetramethylrhodamine, Methyl Ester (TMRM).

JTu2A.62
Nonlinear Photoacoustic Studies of Cu_2O nanoparticles for Photonic and Biomedical Applications, Vijayakumar Sadasivan Nair[1], Chandra S. Yelleswarapu[1]; *[1]Univ. of Massachusetts Boston, USA.* We synthesized Cu_2O nanoparticles and performed structural, nonlinear optical characterization. Grain size of the nanoparticles was found to be 21 nm with a band gap of 2.32eV. Z-scan studies depicts reverse saturable absorption type behavior.

JTu2A.63
Styryl BODIPY Derivatives as Contrast Agents for In Vivo Photoacoustic Imaging, Maryam Hatamimoslehabadi[1], Stephanie Bellinger[1], Jonathan Rochford[1], Chandra S. Yelleswarapu[1]; *[1]Univ. of Massachusetts Boston, USA.* We report synthesis and characterization of BODIPY inspired molecular systems as photoacoustic contrast agents. Chemical modification of pristine BODIPY provided amplified photoacoustic response in the NIR biologically transparent region.

JTu2A.64
Design of a Spectrometer for Frequency Domain Optical Coherence Tomography Working at 1325 nm, Athira G[1], Naren Mekala[1], Nitin Chandrachoodan[1], Ashish Mishra[1], Anil Prabhakar[1], Shanti Bhattacharya[1]; *[1]indian Inst. of Technology Madras, India.* For an FDOCT system imaging depth, axial resolution and sensitivity roll-off depend on the characteristics of its detector which is a spectrometer. Optical and electronic design considerations of a spectrometer for a 1325nm FDOCT system are presented.

JTu2A.65
Diethyl Ether Sensor using Double Nanoslot Hybrid Plasmonic Waveguide, Lokendra Singh[1], Amna Bedi[1], Santosh Kumar[1]; *[1]DIT Univ., India, India.* The diethyl ether can be easily detected using double nanoslot hybrid plasmonic waveguide based sensor. The sensitivity can be achieved up to 27.67π (nm/RIU) at the wavelength of 1550nm.

JTu2A • Joint Poster Session I—Continued

JTu2A.66
Optical Properties Distribution in Nanobiophotonics Theranostic Applications, Felix Fanjul-Velez[1], Jose L. Arce-Diego[1]; [1]*Universidad de Cantabria, Spain*. Theranostic biomedical optical techniques can add nanoparticles to increase contrast in diagnosis, or to potentiate treatment effect. Specific optical properties of the nanoparticles involved may greatly influence the efficiency of these techniques.

JTu2A.67
An Isogeometric solution to the forward problem of Optical Tomographic reconstruction, Vahid Bateni[1], Robert West[1]; [1]*Virginia Tech, USA*. Optical tomography (OT) is a powerful tool for diagnosis. We applied Isogeometric Analysis (IGA), a novel numerical method, to the forward problem. IGA shows more accurate and efficient results compared to Finite Element Method.

JTu2A.68
2D Computational Modeling of Optical Trapping Effects on *Malaria*-infected Red Blood Cells, Joana S. Paiva[1,2], Rita S. R. Ribeiro[1,2], Pedro A. S. Jorge[1,2], Carla C. Rosa[1,2], A. Guerreiro[1,2], Joao P. S. Cunha[1,3]; [1]*INESC TEC - INESC Technology and Science, Portugal;* [2]*Astronomy and Physics Dept., Univ. of Porto, Portugal;* [3]*Dept. of Electrical and Computer Engineering, Univ. of Porto, Portugal*. A computational method for optical fiber trapping of healthy and *Malaria*-infected blood cells characterization is proposed. A trapping force relation with the infection stage was found, which could trigger the development of a diagnostic sensor.

JTu2A.69
Design Considerations in Decreasing the Cost of Adaptive Optics Retinal Imaging, Ann E. Elsner[1,2], Matthew S. Muller[2], Joel A. Papay[1], Edmund Arthur[1], Stephen A. Burns[1]; [1]*Indiana Univ., USA;* [2]*Aeon Imaging, USA*. Cost, size, and complexity inhibit the use of adaptive optics retinal imaging. Designing an imager with only sufficient resolution for key features provides visualization and quantification of biomarkers not seen with wide field techniques.

JTu2A.70
PPPIX-based Photodynamic Therapy Monitoring by Fluorescence Patterns, Felix Fanjul-Velez[1], José Luis Arce-Diego[1]; [1]*Univ. of Cantabria, Spain*. Photodynamic Therapy provides highly specific tumor destruction. Treatment efficiency depends on the photodynamic process. Fluorescence patterns emitted by the photosensitizer contribute to treatment dosimetry guidelines and recurrence avoidance.

JTu2A.71
Laser Induced Fluorescence in combination with Multivariate analysis classifies anti-malarial herbal plants, Charles L. Amuah[1]; [1]*Univ. of Cape Coast, Ghana*. Laser-induced fluorescence in combination with multivariate analysis as a simple, rapid and non-destructive method for classifying anti-malarial herbal plants is presented. A suitable alternative method that enhances safety and objectivity.

JTu2A.72
Characterization and discrimination of basal cell carcinoma and normal human skin tissues using resonance Raman spectroscopy, Cheng-hui Liu[1], Binlin Wu[3], Susie Boydston-White[2], Hugh Beckman[1], Vidyasagar Sriramoju[1], Laura Sordillo[1], Chunyuan Zhang[1], Jason Smith[3], Lin Zhang[1], Lingyan Shi[4], Robert R. Alfano[1]; [1]*CUNY City College, USA;* [2]*CUNY, USA;* [3]*Southern Connecticut State Univ., USA;* [4]*Columbia Univ., USA*. Resonance Raman spectroscopy is used for rapid detection of skin BCC cancer. The cross-validated classification accuracy is achieved to be as high as 98% using nonnegative matrix factorization along with support vector machine statistical method.

JTu2A.73
Multimodal Method of Virtual Biopsy for Skin Cancer Diagnosis, Oleg Myakinin[1], Ivan Bratchenko[1], Valery Zakharov[1]; [1]*Samara National Research Univ., Russia*. In this paper we present a multimodal method of virtual (optical) biopsy for the diagnosis of skin oncological neoplasms. The results of diagnostic accuracy (75%-95%), applications as well as further directions of the method development are shown.

JTu2A.74
Multiple analyze on 3D-OCT images of skin cancer, Dmitry Raupov[1], Oleg Myakinin[1], Ivan Bratchenko[1], Julia Khristoforova[1], Valery Zakharov[1], Alexander Khramov[1]; [1]*Samara National Research Univ., Russia*. A computer method for diagnostics of skin tumors on OCT images based on textural, morphological, geometrical, spectral and other features is proposed. The method is designed for 2D and 3D images.

JTu2A.75
Performance Testing of a Mobile-Phone-Based Near-Infrared Fluorescence Imaging System, Pejhman Ghassemi[1], Bohan Wang[2], Jianting Wang[1], Quanzeng Wang[1], Yu Chen[2], T. Joshua Pfefer[1]; [1]*US Food and Drug Administration, USA;* [2]*Univ. of Maryland , USA*. This study explores the potential for fluorescence imaging with an NIR-enabled mobile phone. Measurements of tissue phantoms and an *ex vivo* rodent model provide quantitative and qualitative insights into performance relative to a CCD system.

JTu2A.76
Optimization for measurement of diffusion correlation spectroscopy: experiment study, Zeren Li[1], Detian Wang[1], Liguo Zhu[1], Peng Gao[1], Qixian Peng[1], Jianheng Zhao[1]; [1]*China Academy of Engineering Physics, China*. We present how the optical intensity and optode's separation affect the DCS measurement.

JTu2A.77
Skin Redox Potential Inspection Based on Ubiquinone Using Multispectral and Fluorescence Analysis, Elvira O. Timofeeva[1], Elena Gorbunova[1], Aleksandr Chertov[1]; [1]*ITMO Univ., Russia*. This research is dedicated to investigate optical properties of ubuquinone and find the way to apply the results to clinical diagnostics of the redox potential.

JTu2A.78
Optical characterization of polymeric nanocapsules interaction with the cell membrane and in vivo analysis, Yana V. Tarakanchikova[1,2], Tatyana Avsievich[1], Evgeny Zherebtsov[3,1], Seppo Vainio[1], Igor Meglinski[1], Alexey Popov[1]; [1]*Oulu Univ., Finland;* [2]*Remotely Controlled Theranostics Systems, Saratov State Utiversity, Russia;* [3]*Aston Inst. of Photonic Technologies, Aston Univ., UK*. Polymeric nanocapsules was studied with respect to intracellular drug delivery applications. In this paper, we review diffraction phase microscopy (DPM), an effective quantitative phase microscopy tool which was used for determination cells structure.

JTu2A.79
Fiber-shifting endomicroscopy for enhanced resolution imaging, Khushi Vyas[1], Michael Hughes[1,2], Guang-Zhong Yang[1]; [1]*Imperial College London, UK;* [2]*Univ. of Kent, UK*. We introduce a miniaturized two-axis, fiber-shifting endomicroscope in which a super-resolution image is restored from multiple pixelation limited images by scanning the fiber-bundle behind a fixed micro-lens, giving a 2-fold resolution improvement.

JTu2A.80
Three-Stage Blood Plasma Photodynamic Drug Delivery & Activation Device, Abdullah J. Zakariya[1]; [1]*Ministry of Interior Kuwait, Kuwait*. A three stage integrated optical microfluidic drug delivery and activation device consists of a monolithic selectively intermixed QW LED structure emitting three wavelengths of 805nm, 787nm and 772nm to allow a single step photodynamic operation.

JTu2A.81
2D Fourier Fractal Analysis of Skin Tumor with Spectral Domain Optical Coherence Tomography, Wei Gao[1], Jing Jin[1], Dmitry Raupov[2], Oleg Myakinin[2], Yulia Khristoforova[2], Ivan Bratchenko[2], Valery Zakharov[2]; [1]*Ningbo Univ. of Technology, China;* [2]*Dept. of Laser and Biotechnical System, Samara National Research Univ. , Russia*. The 2D Fourier fractal analysis (FFA) was utilized in OCT images for automatically categorizing the basal cell carcinomas, melanomas and pigment nevi.

JTu2A.82
Quantitative X-ray ultra-small angle scattering retrieval with structured illumination for microvessel characterization, ziling wu[1], Yunhui Zhu[1], Xiaolong Li[1]; [1]*Electrical and Computer Engineering, Virginia Tech, USA*. A structured illumination based X-ray ultra-small angle scattering imaging resolves the orientation-dependent differential cross-section from a single shot, enabling texture analysis for microvessels with a large field of view.

JTu2A.83
Computational Analysis of Swallowing Mechanics in an Aging Rodent Model, Heidi Kletzien[1], Nadine P. Connor[1]; [1]*Univ. of Wisconsin - Madison, USA*. Novel methodology was developed to computationally analyze swallowing mechanics in a rodent model using multivariate morphometric analysis of skeletal and muscular landmarks during vidofluoroscopy. With aging, biomechanics of the swallow are altered.

JTu2A.84
Mechanical properties of cellular nucleus characterized by Brillouin flow cytometry, Jitao Zhang[1], Xuefei Nou[1], Hanyoup Kim[2], Giuliano Scarcelli[1]; [1]*Univ. of Maryland at College Park, USA;* [2]*Canon U.S. Life Sciences, Inc., USA*. We developed a label-free flow cytometry platform to characterize the nuclear mechanics based on Brillouin microscopy, which is an all-optical technique so that can measure the stiffness of the nucleus in a non-contact, non-invasive manner.

JTu2A.85
Non-scanning gonioreflectometer for rapid multi-angle spectrum measurement, Szu-Yu Chen[1], Hong Ling Chen[1]; [1]*National Central Univ., Taiwan*. A non-scanning measuring system for multi-angle spectrum was introduced to fit for rapid dynamics measurement. Using an objective to transform the angular information into spatial domain, spectra within -60°~60° can be measured with one snap.

JTu2A.86
Exceptional Point Engineered Multifunctional Glass Slide for Microscopic Thermal Mapping, Han Zhao[1], Zhaowei Chen[2], Ruogang Zhao[2], Liang Feng[1]; [1]*Dept. of Electrical Engineering, SUNY Buffalo, USA;* [2]*Dept. of Biomedical Engineering, SUNY Buffalo, USA*. We demonstrate a thermal sensitive glass slide with enhanced sensitivity by exploiting an optical exceptional point. The devised glass slide expands its functionality to cost-efficient thermal mapping under a conventional microscope system.

JTu2A • Joint Poster Session I—Continued

JTu2A.87
Real-time confocal fluorescence lifetime imaging microscopy (FLIM) based on the analog mean-delay (AMD) method, Young Jae Won[1], Seungrag Lee[1]; *[1]Osong Medical Innovation Foundation, South Korea.* We demonstrated GPU accelerated real-time confocal fluorescence lifetime imaging microscopy (FLIM) based on the analog mean-delay (AMD) method. The frame rate of our system was demonstrated to be 13 fps for a 200 × 200 pixel image.

JTu2A.88
Second-Harmonic Generation Microscopy Imaging of Corneal Superstructure, Chen Y. Dong[1]; *[1]National Taiwan Univ., Taiwan.* Optical clarity and mechanical strength are properties of cornea that are dictated by the collagen superstructure. We used second hamronic generation microscopy to characterize and study chicken cornea model in thee-dimensions.

JTu2A.89
Label-free cell membrane detection by Raman spectroscopy using biocompatible gold nanostructure microscale arrays on a ferroelectric template, Rusul M. Al-Shammari[1,2], Nebras Alattar[1], Michele Manzo[3], Katia Gallo[3], Brian Rodriguez[1,2], James Ricejam[1,2]; *[1]School of Physics, Univ. college Dublin, Ireland; [2]Conway Inst. of Biomolecular and Biomedical Research, Univ. college Dublin, Ireland; [3]Applied Physics, KTH, Sweden.* A biocompatible ferroelectric template, patterned with gold nanoparticles by photodeposition, is used here to enable SERS monitoring of the cell membrane of osteoblast-like cells.

JTu2A.90
Seeing Through Fog: Polarized Monte Carlo Light Propagation through Turbid Atmosphere, Brett H. Hokr[1], Jonathan Farmer[2], Christopher Persons[3], Robert DeSilva[2], James Kirkland[2], Greg Finney[3], Kirk Fuller[4]; *[1]US Army Space and Missile Defense Comman, USA; [2]Eikon Research, Inc., USA; [3]Ierus Technologies, Inc., USA; [4]Earth System Science Center, Univ. of Alabama in Huntsville, USA.* The ability to see through turbid media has many applications ranging from driving in fog to imaging the brain. Here we develop a Monte Carlo light transport simulation capable of simulating polarized light transport through fog.

JTu2A.91
Utilizing Machine Learning for Smart Starting Guesses for Phase Retrieval, Scott Paine[1], James Fienup[1]; *[1]Univ. of Rochester, USA.* Traditional wavefront-sensing phase retrieval problems with large amounts of wavefront error often do not converge without a good starting point. We use machine learning in an attempt to produce better starting guesses for these problems.

JTu2A.92
Building Scalable Integrated Silicon Photonics Reservoirs for Signal Processing, Andrew Katumba[1], Matthias Freiberger[2], Jelle Heyvaert[1], Joni Dambre[2], Peter Bienstman[1]; *[1]Dept. of Information Technology, Gent Univ. - imec, Belgium; [2]Dept. of Electronics and Information Systems, Gent Univ., Belgium.* Photonic reservoir computing is a novel bio-inspired paradigm for signal processing. We discuss how it can be scaled up by injecting multiple copies of the input and by using multi-mode rather than single-mode components.

JTu2A.93
Single pixel non-imaging object saliency detection by means of Fourier spectrum acquisition, Hui C. Chen[1], Jian H. Shi[1], Xia l. Liu[1], Gui H. Zeng[1]; *[1]Shanghai Jiao Tong Univ., China.* We propose and experimentally demonstrate object saliency detection by means of Fourier spectrum acquisition can realize single pixel non-imaging object saliency detection. This technique can be applied to saliency detection and recognition of image.

JTu2A.94
Volumetric Light-field Encryption at the Microscopic Scale, Changliang Guo[1], Haoyu Li[1], Inbarasan Muniraj[2], Bryce Schroeder[1], John Sheridan[2], Shu Jia[1]; *[1]Stony Brook Univ., USA; [2]School of Electrical, Electronic Engineering, Univ. College Dublin, Ireland.* A light-field based method allowing the optical encryption of three-dimensional (3D) volumetric information at the microscopic scale is reported, in which it paves the way for biomedical applications in processing and securing data.

JTu2A.95
PSF Engineering for Sensor Protection, Jacob H. Wirth[1], Abbie Watnik[2], Grover Swartzlander[1]; *[1]Rochester Inst. of Technology, USA; [2]Naval Research Lab, USA.* An imaging system is designed to protect sensors from laser radiation. A Spatial Light Modulator is used to engineer a new point spread function with low peak intensity while sharp images are recovered in post-processing.

JTu2A.96
Multiple-image Authentication based on Random Sparse Encoding of Optical Discrete Cosine Transform, Ayman Alfalou[1], Qu Wang[1], Christian Brosseau[1]; *[1]ISEN-Brest, France.* In our proposal, a synthetic ciphertext is constructed and the security level of this scheme is improved greatly because the decryption result generated from correct decryption keys is a noise-like image without plaintext visually revealed.

JTu2A.97
Augmented Reality Based Real-Time Data Visualization Concept for Ultra-Efficient Car Prototype, Peter Wozniak[1,2], Oliver Vauderwange[1,2], Nicolas Javahiraly[2], Dan Curticapean[1]; *[1]Offenburg Univ., Germany; [2]Univ. of Strasbourg / ICube, France.* For an ultra-efficient car-engineering project, we aim to utilize AR technology for the driver and engineering team. A real-time monitoring of the car's operational parameters is crucial for best possible fuel efficiency and overall performance.

JTu2A.98
Calibration between a 3D camera and an aerial screen without relative change of object size, Shusei Ito[2], Nao Kurokawa[2], Hirotsugu Yamamoto[2,1]; *[1]JST, ACCEL, Japan; [2]Utsunomiya Univ., Japan.* The purpose of this paper is to propose a calibration method of a 3D camera and an aerial information screen. Our proposed method features direct input in the real space and a short calibration time.

JTu2A.99
Radiation Modes of Surface Plasmons in SnO_2 Thin Films, Viktor S. Grinevych[1], L. M. Filevska[1], Valentyn Smyntyna[1], S. P. Rudenko[2], M. A. Stetsenko[2], L. S. Maksimenko[2], Boris Serdega[2]; *[1]Odessa National I.I.Mechnikov Univ., Ukraine; [2]V.E.Lashkarev Inst. of Semiconductor Physics, National Academy of Sciences of Ukraine, Ukraine.* SP radiation modes, responsible for structure-dependent energy loss, are studied by MPS in SnO_2 films depending on production technology. Amplitude decrease *r(l)* is associated with precursor concentration increase in films production initial solution.

JTu2A.100
Digital image encryption using chaotic logistic mapping, Francisca A. Canales[1], Roman Hurtado Perez[1], Martin Hernandez-Romo[1]; *[1]Optica, Universidad Politécnica de Tulancingo, Mexico.* The protection against unauthorized access is essential. The proposed method of digital processing of encrypted images decreases the correlation between adjacent pixels, increasing entropy, using secret key and chaotic encryption.

JTu2A.101
Active underwater polarization imaging technology, Kui Yang[1], Pingli Han[1], Fei Liu[1], XiaoPeng Shao[1]; *[1]Xidian Univ., China.* This study attempts to recover high-quality underwater images through the PSF of degraded images and the polarimetric technology. This experiment employs extracted slant-edge to estimate the PSF and then the recovery of image is achievable.

JTu2A.102
FRFT-based method for estimating parameters of optical fiber connectors, Ming-Feng Lu[1], Jinmin J. Wu[1], Kun Xiong[1], Zhen Guo[1], Jian Xu[1], Chenchen Ji[1], Feng Zhang[1], Ran Tao[1], Zhi-Chun Zhao[1]; *[1]Beijing Inst. of Technology, China.* This paper proposes a fractional Fourier method to analyze a single closed interferogram of the connector end-face. When shadowed or discontinuous areas exist, higher accuracy is obtained in comparison with 5-step phase shifting interferometry.

JTu2A.103
High space-bandwidth product compressive lensless holography with efficient block-wise model, Hua Zhang[1], Liangcai Cao[1], Wenhui Zhang[1], Hao Zhang[1], Guofan Jin[1]; *[1]Tsinghua Univ., China.* The applications of compressive holography are limited by its long processing time due to huge global searching space. A block-wise model is developed with multiple sub-holograms to reduce reconstructed time by fifty times.

JTu2A.104
Vehicle Extraction from UAV Data, Tingting Zhou[1], Lingjia Gu[1], Ruizhi Ren[1], Qiong Cao[1]; *[1]Jilin Univ., China.* For the purpose of vehicles dynamic management of the parking lot, a color image segmentation algorithm is used to extract static vehicles and a Gaussian mixture model is used to extract dynamic vehicles.

JTu2A.105
Automatic calibration of Projector and DDHOE based IP displays, Jackin Boaz Jessie[1], Lode Jorissen[2], Ryutaro Oi[1], Koki Wakunami[1], Yasuyuki ichihashi[1], Makoto Okui[1], Philippe Bekaert[2], Kenji Yamamoto[1]; *[1]National Inst. of Communications Tec, Japan; [2]Expertise Center for Digital Media, Hasselt Univ.-tUL, Belgium.* A calibration technique for integral photography(IP) based 3D display that uses a commercial projector and digitally designed holographic optical element (DDHOE), is reported. This method requires less number of input images for calibration.

JTu2A.106
Babinet Principle for Partially Coherent Fields, Mahed Batarseh[1], Sergey Sukhov[1], Roxana Rezvani Naraghi[1,2], Heath E. Gemar[1], Alexandru Tamasan[3], Aristide Dogariu[1]; *[1]CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA; [2]Dept. of Physics, Univ. of Central Florida, USA; [3]Dept. of Mathematics, Univ. of Central Florida, USA.* Babinet theorem (BT) in an electromagnetic diffraction theory relates single-point quantities, intensities or field amplitudes, generated by complementary sources. We demonstrated BT for two-point quantity, the spatial coherence function of the field.

JTu2A.107
Integral Imaging Multi-View 3D Display, Nikolai I. Petrov[1], Yuri Sokolov[1], Maxim Khromov[1], Angela Storozheva[1]; *[1]Scientific Research Center of Unique Instrumentation of the Russian Academy of Sciences, Russia.* Multiview 3D display system consisting of the modules of capturing three-dimensional objects, image processing and display screen is developed. Multi-projector system with four projectors is designed and 3D images on 30-inch screen are demonstrated.

JTu2A • Joint Poster Session I—Continued

JTu2A.108
UMapβ: A Semi-automatic Image Analysis Assistant Bridging the Gap between Experimentalists and Image Analysis Specialists, Jeffrey La[1], Briana Mason[1], Tiffany Donaldson[1], Chandra S. Yelleswarapu[1]; [1]*Univ. of Massachusetts Boston, USA*. Quantitative biological analysis traditionally relies on labor intensive manual methods and newer fully automated methods are often inflexible and unfeasible to implement. We propose UMapβ, our semi-automated graphical user interface, as a solution.

JTu2A.109
Phase modulation based optical asymmetric image encryption, Areeba Fatima[1], Naveen K. Nishchal[1]; [1]*Indian Inst. of Technology, Patna, India*. This work proposes an optical asymmetric cryptosystem. Information of the input image is encoded in the phase of the circular components of an optical beam. Simulation results have been produced to substantiate the proposed scheme.

JTu2A.110
Building detection from high-resolution remotely sensed images, Qiong Cao[1], Lingjia Gu[1], Ruizhi Ren[1]; [1]*Jilin Univ., China*. The commercial high-resolution satellite images became available, which provides more potential for automatic and accurate building detection. So Building extraction currently is important in the application of remote sensing imagery.

JTu2A.111
Fast Implementation of Fractional Fourier Analysis of Quadratic Phase Interferogram, Feng Zhang[1], Ming-Feng Lu[1], Zhi-hai Zhuo[2], Jinmin J. Wu[1], Cui-ling Qi[1]; [1]*Beijing Inst. of Technology, China;* [2]*Beijing Information Science and Technology Univ., China*. An image block linear superpose method is proposed for fast implementation of Fractional Fourier analysis of quadratic phase interferogram, its performance, verifying the feasibility of the method, is assessed by analyzing Newton's rings images.

JTu2A.112
Statistics of Wave inside Random Media with Lévy Disorder, Xujun Ma[1], Victor Gopar[2], Azriel Genack[1]; [1]*CUNY Graduate Center and Queens College, USA;* [2]*Departamento de Fisica Teorica and BIFI, Universidad de Zaragoza, Spain*. We explored the anomalous localization of waves inside random media with Lévy disorder. The average of intensity and its logarithm exhibit a power law fall-off, which implies that the LDOS falls within the medium.

JTu2A.113
Reducing Cybersickness: The Role of Wearing Comfort and Ease of Use, Kai Israel[1], Christopher Zerres[1], Dieter K. Tscheulin[2]; [1]*Dept. of Media and Information, Univ. of Applied Sciences Offenburg, Germany;* [2]*Dept. of Business Administration, Univ. of Freiburg, Germany*. The paper focuses on how wearing comfort and ease of use of smartphone-based headmounted displays can minimize the occurrence of cybersickness.

JTu2A.114
Integrating Technology to Supplement Classroom Teaching of Optics, Sumit Ghosh[1]; [1]*School of Optics, India*. A teaching-learning process which concentrates on a collaborative methodology with simultaneous integration of technology has been developed to teach the basic principles of optics to students hailing from under-privileged schools.

JTu2A.115
New Perspectives in Color Vision using Spectroscopy and Nanotechnology: Application to Media Photonics, Oliver Vauderwange[1,2], Peter Wozniak[1,2], Nicolas Javahiraly[2], Dan Curticapean[1]; [1]*Offenburg Univ., Germany;* [2]*Univ. of Strasbourg / ICube, France*. This paper summarizes the basic ideas of the actual research work, based on the question, how quantum dots changes the possibilities of color rendering, with the focus on the human visual perception.

JTu2A.116
Peripheral Monochromatic Aberrations in Young Adult Caucasian and East Asians, Uchechukwu L. Osuagwu[1], Noel A. Brennan[2], Marwan Suheimat[1], David A. Atchison[1]; [1]*Optometry & Vision Science, Queensland Univ. of Technology, Australia;* [2]*Johnson & Johnson Vision Care, Inc., Jacksonville, FL, USA*. We determined variations in peripheral aberration across the visual field. Caucasians and East Asians had similar relative peripheral myopia but vertical coma and spherical aberration coefficients were more negative in Caucasians than in East Asians.

JTu2A.117
Fine Tuning of Reflective Colors by Introducing Porosity in Ultra-thin Lossy Films, Youngjin Yoo[1], Young Min Song[1]; [1]*Gwangju Inst. of Science and Technology, South Korea*. We demonstrate a fine tuning of reflective colors by porosity (P_r) in ultra-thin lossy films by oblique angle deposition (OAD). The effect of P_r with an optical resonance-shift is shown by calculation and experimental results.

JTu2A.118
Ultra-large Mode Field Diameter of Outer Fibers of Rod Photoreceptor Cells, Ziming Meng[1], Anhui Liang[1]; [1]*Guangdong Univ. of Technology, China*. In this paper, we theoretically calculate the MFD of outer fibers of rod photoreceptor cells.

11:45–12:45 Meet OSA's Journal Editors, *Science Showcase Theater, Columbia, Terrace Level*

12:00–13:00 Pizza Lunch, *Science & Industry Showcase, Columbia, Terrace Level*

13:00–13:30 Coffee Break, *Science & Industry Showcase, Columbia, Terrace Level*

Science Showcase Theater

JOINT FiO + LS

13:00–14:00
JTu3A • Rapid-Fire Oral Presentations II

JTu3A.12 • 13:00 *RAPID*
Temporal measurement of the wave-breaking flash in a laser plasma accelerator, Bo Miao[1], Jared Wahlstrand[1], Linus Feder[1], Andy Goers[1], George Hine[1], Fatholah Salehi[1], Daniel C. Woodbury[1], Howard Milchberg[1]; *[1]Inst. for Research in Electronics and Applied Physics, Univ. of Maryland, College Park, USA.* Wave-breaking injection of electrons in a laser plasma accelerator generates intense broadband ($\Delta\lambda \approx 300$ nm) radiation flash. We study its spectral coherence and measure its pulse length (~50 fs) with single-shot supercontinuum spectral interferometry.

JTu3A.35 • 13:05 *RAPID*
Enhanced optical nonlinearities in ultra-silicon-rich photonic crystal waveguides, Ezgi Sahin[1,3], Kelvin J. Ooi[1], George F. R. Chen[1], Doris K. T. Ng[2], Ching Eng Png[3], Dawn T. H. Tan[1]; *[1]Photonics Devices and Systems Group, Engineering Product Development, Singapore Univ. of Technology and Design, Singapore; [2]Data Storage Inst., A*STAR, Singapore; [3]Dept. of Electronics and Photonics, Inst. of High Performance Computing, A*STAR, Singapore.* Photonic crystal waveguides (PhCWs) are realized on ultra-silicon-rich nitride platform which possesses negligible nonlinear losses. An effective nonlinear parameter of $1.97\times10^{4}(\mathrm{Wm})^{-1}$ is estimated from self-phase modulation on PhCW of length 96.6 μm.

JTu3A.42 • 13:10 *RAPID*
Velocity-selective Saturated Spectroscopy with a Train of Ultra-short Pulses and a Diode Laser, Alexis Carlos G. Wong[1], Alexandre Almeida[1], Natalia R. de Melo[2], Sandra S. Vianna[1]; *[1]UFPE, Brazil; [2]Escola politécnica, UPE, Brazil.* A mode-locked 1 GHz femtosecond laser together with a diode laser is used to perform coherent spectroscopy of the D_2 rubidium line. The results are well described using the Bloch equations in the frequency domain picture.

JTu3A.61 • 13:15 *RAPID*
Nonlinear Optical Properties of Chalcogenopyrylium-Terminated Heptamethine Dyes in Multiple Polymer Hosts, Taylor G. Allen[1], Yulia Getmanenko[1,2], Hyeongue Kim[1], Joel M. Hales[1], Bhupinder Sandhu[2], Marina S. Fonari[2], Kyrill Y. Suponitsky[2,3], Yadong Zhang[1], Jonathan D. Matichak[1], Victor N. Khrustalev[2,4], Tatiana Timofeeva[2], Stephen Barlow[1], San-Hui Chi[1], Joseph W. Perry[1], Seth Marder[1]; *[1]Georgia Inst. of Technology, USA; [2]Biology and Chemistry, New Mexico Highlands Univ., USA; [3]A. N. Nesmeyanov Inst. of Organoelement Compounds, Russian Academy of Sciences, Russia; [4]Peoples' Friendship Univ. of Russia, Russia.* Z-scan and linear loss measurements on polymethine-polymer blends with varied chalcogens and hosts confirm polymethine aggregation as the primary interaction influencing solid-state NLO properties for ultrafast all-optical signal-processing.

JTu3A.75 • 13:20 *RAPID*
Tunable Cavity Fiber-Optic Fabry-Perot Magnetometer Based on Fiber-Cantilever Beam-Deflection, Somarpita Pradhan[1], Samik Saha[1], Partha Roy Chaudhuri[1]; *[1]Indian Inst. of Technology Kharagpur, India.* We devised a tunable cavity fiber Fabry-Perot magnetometer using deflection of cobalt-doped nickel ferrite coated optical fiber cantilever. Sensitivity is improved by introducing a silver coated fiber-mirror in the developed configuration.

JTu3A.81 • 13:25 *RAPID*
Diffusive Dynamics and Signature of Phase Singularities in Gain/Loss Assisted Disordered Optical Waveguide Lattices, Somnath Ghosh[1], Ravi K Varshney[3], Bishnu P. Pal[2]; *[1]Indian Inst. of Technology Jodhpur, India; [2]MEC Hyderbad, India; [3]Indian Inst. of Technology Delhi, India.* Co-existence and interplay between mesoscopic light dynamics with singular optics in spatially disordered waveguide lattices is reported. Disorder induced singular behavior and diffusive wave propagation are quantitatively analyzed.

JTu3A.85 • 13:30 *RAPID*
Generation of optical vector beams using a single spatial light modulator, Benjamin Perez-Garcia[1], Carlos Lopez-Mariscal[2], Raul I. Hernandez-Aranda[1], Julio C. Gutiérrez-Vega[1]; *[1]Tecnologico de Monterrey, Mexico; [2]Underwater Photonics, Mexico.* We present an optical scheme to produce vector beams. Our realization features control over the local polarization state of the transverse coordinates. As an example, we investigate the generation of cylindrical vector vortex beams.

JTu3A.100 • 13:35 *RAPID*
Three waveguide direction coupler based polarization splitter under stimulated Raman adiabatic passage, Pragati Aashna[1]; *[1]Indian Inst. of Technology, Delhi, India.* We propose the design of a polarization splitter based on stimulated Raman adiabatic passage (STIRAP) mechanism in a three waveguide directional coupler.

JTu3A.104 • 13:40 *RAPID*
Gain-Clamping for an Externally-Incident Field Passing through a Laser Cavity, Ali Kazemi Jahromi[1], Alexander Cerjan[2], A. Douglas Stone[3], Ayman Abouraddy[1]; *[1]Univ. of Central Florida, CREOL, USA; [2]Applied Physics, Stanford Univ., USA; [3]Applied Physics, Yale Univ., USA.* Behavior of a self-oscillating cavity probed with an externally incident field has been the subject of controversy for decades. We address this issue by designing an experiment, and verify it with state-state ab-initio laser theory.

JTu3A.105 • 13:45 *RAPID*
Efficient Lasing on Alkali Atomic D_2 Lines Utilizing Spin-Polarized Alkali Vapor, Andrey Mironov[1], J. G. Eden[1]; *[1]Univ of Illinois at Urbana-Champaign, USA.* We report a novel method for significantly improving the efficiency of alkali atomic lasers. By pumping alkali-rare gas atomic pairs with a circularly polarized optical field, an increase in the efficiency of >50% has been demonstrated.

JTu3A.113 • 13:50 *RAPID*
Studies on nonlocal plasmonic resonances: analytical and numerical approaches, Milan Burda[1], Pavel Kwiecien[1], Ivan Richter[1], Jan Fiala[1]; *[1]Czech Technical Univ. in Prague, Czech Republic.* Both (quasi)analytical and numerical approaches describing the complexity of nonlocal interactions at nanoscaled plasmonic structures are investigated, in comparison with the standard linear response approximation.

13:00–15:00
JTu3A • Joint Poster Session II

JTu3A.1 *E-Poster*
Laser driven droplets generation and their optical delivery using a tapered hollow optical fiber for liquids with a wide range of refractive indices, Hyeonwoo Lee[1], Jinwon Yoo[1], Jihyun Hwang[1], Wonhyoung Ryu[2], Kyunghwan Oh[1]; *[1]Inst. of Physics and Applied Physics, Yonsei Univ., South Korea; [2]Dept. of Mechanical Engineering, Yonsei Univ., South Korea.* Liquids of a wide range of refractive indices were atomized by a guided IR laser along a tapered hollow optical fiber with a nanometer hole. Liquid droplet delivery by the light field was also experimentally investigated.

JTu3A.2 *E-Poster*
Test Methods for Assessing Plasmonic Nanoparticle Photodamage: Spectral Evaluation of Nanosphere Reshaping, Andrew M. Fales[1], William C. Vogt[1], T. Joshua Pfefer[1], Ilko Ilev[1]; *[1]CDRH, FDA, USA.* There is a current lack of standardized test methods for evaluating pulsed laser-nanoparticle interaction damage thresholds. Photothermally-induced reshaping of 20-100 nm diameter gold nanospheres was characterized, and damage thresholds determined.

JTu3A.3 *E-Poster*
Growth and characterization of niobate laser crystals, Shoujun Ding[1,2]; *[1]USTC, China; [2]Chinese Academy of Sciences, China.* In this work, the growth and characterization of a series of Nd-doped niobate laser crystals have been reviewed, including Nd:$YNbO_4$, Nd:$GdNbO_4$ and Nd:$GdYNbO_4$. The excellent laser properties make them to be used in many fields.

JTu3A.4 *E-Poster*
Axial plane optical microscopy for particle manipulation with Weber accelerating beams, Sha An[1,2], Tong Peng[1], Guoxia Han[1], Zhangxiang Huang[1], Meirong Wang[3], Baoli Yao[1], Peng Zhang[1]; *[1]State Key Lab of Transient Optics and Photonics, Xi'an Inst. of Optics and Precision Mechanics of Chinese Academy Sciences, China; [2]Univ. of Chinese Academy Sciences, China; [3]School of Science, Northwestern Polytechnical Univ., China.* We directly observe the optical particle manipulation with Weber accelerating beams by the axial plane optical microscopy (APOM). Optically trapped particles moving along parabolic trajectories are successfully monitored by the APOM.

JTu3A.5 *E-Poster*
Measurement of Kerr Coefficient in Large Bandgap Solids at Mid-IR Wavelengths, Sina Zahedpour Anaraki[1], Jared K. Wahlstrand[2], Howard Milchberg[1]; *[1]Univ. of Maryland at College Park, USA; [2]National Inst. of Standards and Technology , USA.* We measure the Kerr coefficients for widely used solids in mid-IR applications. To our knowledge, this is the first direct absolute measurement for pump wavelengths longer than 800 nm. We observed insignificant dispersion in the measured n_2 values.

JTu3A.6 *E-Poster*
Pulse Train Generation in Fiber Lasers with Tunable Repetition Rate, Dmitry Korobko[1], Andrei Fotiadi[1,2], Sergey G. Moiseev[1], Igor O. Zolotovskii[1]; *[1]Ulyanovsk State Univ, Russia; [2]Univ. of Mons, Belgium.* Simple approach was applied to analyze behavior of the harmonically mode-locked fiber laser with adjustable Mach-Zehnder interferometer. The model describes key features of the laser outputs at different repetition rates tuned over a whole GHz range.

JTu3A.7 *E-Poster*
Diffractals from regular polygon Sierpinski gaskets, Sean M. Nomoto[1], Reeta Vyas[1], Surendra Singh[1]; *[1]Univ. of Arkansas, USA.* Fraunhofer diffraction of a collimated Gaussian beam by fractal screens with regular polygon Sierpinski gaskets up to fifth iteration was studied experimentally for 3–9 sided polygons and compared to theoretical results.

JTu3A.8 *E-Poster*
Laser cooling investigation of a single-mode Yb-doped ZBLAN optical fiber, Esmaeil Mobini[1], Mostafa Peysokhan[1], Behnam Abaie[1], Arash Mafi[1]; *[1]Univ. of New Mexico, USA.* A theoretical study on laser cooling of a single-mode Yb3+:ZBLAN fiber is presented. Strategies to maximize the cooling efficiency are highlighted. The cooling scales quadratically with the core and inversely with the cladding radius

JTu3A.9 *E-Poster*
Dynamic control of laser-induced flow-focused microjets., Jan Krizek[1], Paul Delrot[1], Christophe Moser[1]; *[1]École Polytechnique Fédérale de Lausanne, Switzerland.* Laser-based actuation of liquid microjet relies on precise localisation of the optical focus with respect to the liquid/air meniscus. We show the meniscus position control by synchronisation of laser pulses with a dynamic settling of its position.

JTu3A.10 *E-Poster*
Reconfiguring structured light beams using nonlinear metasurfaces, Yun Xu[1], Jingbo Sun[1], Jesse Frantz[2], Mikhail Shalaev[1], Jason D. Myers[2], Robel Y. Bekele[4], Alexander Tsukernik[3], Jasbinder S. Sanghera[2], Natalia M. Litchinitser[1]; *[1]Univ. at Buffalo SUNY, USA; [2]US Naval Research Lab, USA; [3]Univ. of Toronto, Canada; [4]Univ. Research Foundation, USA.* We show a nonlinear metasurface made of nanostructured chalcogenide glass. We combined on- and off-resonance nanostructures to realize reconfigurable structured light that switches between Hermit-Gaussian and vortex shape depending on its intensity.

JTu3A.11
Atmospheric Propagation Model and affecting on laser beam propagation via Free Space, Hussein T. Khamees[1]; *[1]Electronic and Communication Engineering, Cankaya Univ., Turkey.* In this article, a laser source (He-Ne) laser with maximum output power (2.95 mW) was used to study and analyze laser beam when the laser propagates through the atmosphere. Atmosphere layer, also the spot diameter of the laser beam can be measured.

JTu3A.12
Temporal measurement of the wave-breaking flash in a laser plasma accelerator, Bo Miao[1], Jared Wahlstrand[1], Linus Feder[1], Andy Goers[1], George Hine[1], Fatholah Salehi[1], Daniel C. Woodbury[1], Howard Milchberg[1]; *[1]Inst. for Research in Electronics and Applied Physics, Univ. of Maryland, College Park, USA.* Wave-breaking injection of electrons in a laser plasma accelerator generates intense broadband (Δλ≈300 nm) radiation flash. We study its spectral coherence and measure its pulse length (~50 fs) with single-shot supercontinuum spectral interferometry.

JTu3A.13
Analysis of Modulation Instability in Free-carrier Driven Microring Resonator Based Kerr Frequency Comb, Raktim Haldar[1], Arkadev Roy[1], Partha Mondal[1], Vishwatosh Mishra[1], Shailendra K. Varshney[1]; *[1]Indian Inst. of Technology Kharagpur, India.* Analytical and numerical studies on the dynamics of modulation-instability and Kerr-comb in free-carrier driven microring resonators are reported through Lugiato-Lefever equation in presence of multi-photon, free-carrier absorptions and dispersions.

JTu3A.14
Dark Solitons and Cnoidal Waves in Microresonators with Normal Dispersion, Zhen Qi[1], Giuseppe D'Aguanno[2], Curtis Menyuk[1]; *[1]Univ. of Maryland Baltimore County, USA; [2]Univ. of Texas at Austin, USA.* We study dark solitons and cnoidal waves in microresonators with normal dispersion. In the lossless case, we obtain analytical expressions for solitons and cnoidal waves. When loss is present, we discuss accessibility of cnoidal waves.

JTu3A.15
All-Fiber Passively Mode-Locked Ring Laser Based on Normal Dispersion Active Tm-Doped Fiber, Vasilii S. Voropaev[1], Alexander Donodin[1,2], Vladimir A. Lazarev[1], Mikhail K. Tarabrin[1,2], Valerii E. Karasik[1], Alexander A. Krylov[3]; *[1]Science and Education Center for Photonics and IR-Technology, Bauman Moscow State Technical Univ., Russia; [2]Frequency Standards Lab, P.~N.~Lebedev Physical Inst. of the Russian Academy of Sciences, Russia; [3]Fiber Optics Research Center of the Russian Academy of Sciences, Russia.* We demonstrate the generation of stable 210 fs pulses with 26 nm spectral width at a central wavelength of 1940 nm with 150 mW average output power and 11 MHz repetition rate.

JTu3A.16
High Harmonics Source for Probing Ultrafast Optical Demagnetization in Multilayer Films, Katherine K. Légaré[1], Vincent Cardin[1], Tadas Balciunas[2], François Légaré[1]; *[1]INRS, Centre EMT, Canada; [2]Inst. of Photonics, Vienna Univ. of Technology, Austria.* We generate harmonics in neon, reaching the cobalt M-edge absorption resonance. A pump-probe scheme then allows us to retrieve demagnetization curves by observing resonant X-ray magnetic scattering on a multilayer cobalt/platinum sample.

JTu3A.17
Low-power consumption dual-comb spectroscopy based on a battery-powered, free-running dual-comb laser system, Jie Chen[1], Siyao Yin[1], Xin Zhao[1], Ruliu Wang[1], Yingling Pan[1], Jiansheng Liu[1], Zheng Zheng[1,2]; *[1]School of Electronic and Information Engineering, Beihang Univ. , China; [2]Collaborative Innovation Center of Geospatial Technology, China.* Dual-comb spectroscopy is demonstrated with an energy-efficient free-running fiber laser and the amplifiers. Avoiding feedback control electronics, the dual-comb source consumes only a few watts and runs on a mobile power pack for cell phones.

JTu3A.18
Generation of circularly polarized high-order harmonics in solids driven by single-color infrared pulses, Nicolai Klemke[1,2], Giuseppe Di Sciacca[1], Yudong Yang[1,2], Giulio M. Rossi[1,2], Roland E. Mainz[1,2], Nicolas Tancogne-Dejean[3,4], Angel Rubio[3,4], Franz X. Kärtner[1,2], Oliver Mücke[1,5]; *[1]Center for Free-Electron Laser Science CFEL, Deutsches Elektronen-Synchrotron DESY, Germany; [2]Physics Dept., Univ. of Hamburg, Germany; [3]Max Planck Inst. for the Structure and Dynamics of Matter, Germany; [4]European Theoretical Spectroscopy Facility (ETSF), Germany; [5]The Hamburg Center for Ultrafast Imaging, Germany.* Intraband and interband dynamics generating high-order harmonics in solids exhibit qualitatively different responses to driver-pulse ellipticity. TDDFT simulations and experiments demonstrate circularly polarized harmonics from single-color pulses.

JTu3A.19
Rapid Frequency Comb Spectroscopy from 4.4 μm to 4.7 μm using a Virtually Imaged Phased Array, Adam J. Fleisher[1]; *[1]NIST, USA.* Rapid, precise, and sensitive multiplexed measurements of N_2O were performed using a mid-infrared frequency comb and virtually imaged phased array spectrometer. Multiplexed images covering >35 cm^{-1} were recorded in 500 μs.

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JTu3A.20
Broadband Cavity-enhanced Precision Molecular Spectroscopy using Electro-optic Frequency Combs, Adam J. Fleisher[1], David Long[1], Joseph Hodges[1]; *[1]NIST, USA*. We extend the tunable bandwidth of electro-optic frequency comb spectroscopy to >2 THz around λ = 1.6 μm using an external cavity diode laser and report precision spectroscopy of CO_2, H_2O, and N_2O.

JTu3A.21
Topological properties of graphene on a nanowire superlattice subjected to ultrafast circular pulses, Hamed Koochaki Kelardeh[1,2], Vadym Apalkov[1,2], Mark Stockman[1,2]; *[1]Georgia State Univ., USA; [2]Center for Nano-Optics, USA*. We manifest the topological nature of graphene without a magnetic field. Graphene under a few-cycle circularly polarized optical field and coupled to a nanowire superlattice allows for observing the Berry phase in the excitation distribution.

JTu3A.22
Synchronous All-Optical Buffer-cum-Logic Gates In Dual-Pump Kerr Microring Resonators, Arkadev Roy[1], Raktim Haldar[1], Shailendra K. Varshney[1]; *[1]Indian Inst. of Technology Kharagpur, India*. We report robust and synchronous all-optical buffer in dual-pumped microring resonators by leveraging temporal cavity solitons. The proposed scheme can also be employed to carryout logical operations.

JTu3A.23
Topological phase transitions in the photonic spin Hall effect, Wilton Kort-Kamp[1]; *[1]Los Alamos National Lab, USA*. We unveil topological phase transitions in the spin Hall effect of light in the graphene family materials and show that spinoptics provides a unprecedented pathway to investigate spintronics and valleytronics in two-dimensional semiconductors.

JTu3A.24
Implications of Self-Steepening on Temporal Tweezing of Light in Optical Buffer Applications, Arkadev Roy[1], Raktim Haldar[1], Shailendra K. Varshney[1]; *[1]Indian Inst. of Technology Kharagpur, India*. We numerically explore the impact of self-steepening on temporal tweezing of light while manipulating temporal cavity solitons. Differences observed in transient and steady state behavior establishes the importance of self-steeping in this regard.

JTu3A.25
Light Emission Enhancement of 2D Materials in Monomer vs. Dimer Nanoantennae, Mohammad H. Tahersima[1], Muhammad Danang Birowosuto[2], Zhizhen Ma[1], William C. Coley[3], Michael Valentin[3], Sahar Naghibi Alvillar[3], Cesare Soci[2], Ludwig Bartels[3], Volker J. Sorger[1]; *[1]The George Washington Univ., USA; [2]Nanyang Technological Univ., Singapore; [3]Univ. of California Riverside, USA*. We show that the emission enhancement from a TMD emitter- monomer antenna cavity system rivals that of dimers at much reduced lithographic effort.

JTu3A.26
High-NA Aberration-Corrected Raman Analysis of Femtosecond Bessel Beam Modification in Diamond, Brian K. Canfield[1], Lloyd M. Davis[1]; *[1]Univ. of Tennessee Space Inst., USA*. We report femtosecond Bessel beam laser processing of diamond with high-NA aberration-corrected Raman analysis in order to create improved arrays of micron diameter columnar graphitized electrodes for use in advanced high-energy particle detectors.

JTu3A.27
Detection of Janus Au-SiO_2 Nanoparticles with a Photothermal Technique, Maryam Zahedian[1], Yan Yu[1], Bogdan Dragnea[1]; *[1]Indiana Univ. Bloomington, USA*. In this study, we explore the optical properties of Janus Au-SiO_2 Nanoparticles that consist of silica deposited on a partial surface of Au nanospheres with the aid of photothermal microscopy.

JTu3A.28
Laser Induced Fluorescence Spectroscopy in Dysprosium Atomic Vapor, Jhonatha Ricardo[2,1], Jonas Jakutis Neto[2], José W. Neri[2], Patricia Bueno[2,1], Marcelo G. Destro[2]; *[1]Instituto Tecnológico da Aeronáutica ITA, Brazil; [2]Photonics, Instituto de Estudos Avançados, Brazil*. This paper presents the observation of the isotopes ^{162}Dy, ^{163}Dy and ^{164}Dy of the dysprosium optical transition 0→16717.79 cm^{-1} .The high-resolution spectra were obtained through the laser induced fluorescence technique in atomic vapor.

JTu3A.29
Observation of Third Harmonic Enhancement Due to Tunneling at a Metal-Insulator-Metal Junction, Mallik Mohd Raihan Hussain[1], Zhengning Gao[2], Domenico de Ceglia[3], Maria Vinceti[4], Andrew Sarangan[1], Imad Agha[1], Michael Scalora[5], Parag Banergee[2,6], Joseph W. Haus[1]; *[1]Dept. of Electro-Optics and Photonics, Univ. of Dayton, USA; [2]Inst. of Materials Science and Engineering, Washington Univ., USA; [3]AEgis Technologies Group Inc., USA; [4]Dept. of Information Engineering, Univ. of Brescia, Italy; [5]Charles M. Bowden Research Lab, US Army AMRDEC, USA; [6]Dept. of Mechanical Engineering & Materials Science, Washington Univ., USA*. We experimentally observed an enhancement of the third harmonic (TH) signal at Au/Al_2O_3/Au interfaces. The TH signal behavior with surface coverage qualitatively resembles the quantum tunneling predictions.

JTu3A.30
Enhancement of Electromagnetically-Induced Focusing by a Microwave Field, Onkar N. Verma[1], Sourabh Roy[1]; *[1]Dept. of Physics, National Inst. of Technology Warangal, India*. We have theoretically studied the effect of a microwave field on electromagnetically-induced focusing of a weak probe beam due to spatial variations of control beam in an electromagnetically-induced transparency medium.

JTu3A.31
Mid-Infrared Pump-Probe Measurements of Carrier Dynamics in Black Phosphorus, Yigit Aytac[1], Martin Mittendorff[1], Thomas E. Murphy[1]; *[1]Univ. of Maryland, USA*. Time-resolved transmission measurements are employed to probe the carrier dynamics in black phosphorus. Measurements at mid-IR wavelengths near the bandgap show saturable absorption attributed to Pauli blocking and a fluence-dependent recombination.

JTu3A.32
Application of adiabatic following to three specific three-sate quantum system, Wei Huang[1], Bruce Shore[2], Andon Rangelov[3], Elica Kyoseva[2]; *[1]Singapore Univ. of Technology and D, Singapore; [2]retire, USA; [3]Sofia Univ., James Bourchier, Bulgaria*. We propose an adiabatic following for a Vee, a Ladder and a Lambda quantum system. We illustrate different possibilities for population transfer in these multi-level quantum systems.

JTu3A.33
Optical and electrical control of valley polarized exciton polaritons in 2D materials, Zheng Sun[1], Biswanath Chakraborty[2], Jie Gu[1], Vinod M. Menon[1]; *[1]City Univ. of New York, USA; [2]City College of New York, USA*. We report the observation of optical and electrical-control of microcavity polaritons in 2D WS2 embedded in microcavity. Optical control of polariton states show their distinct valley origin and the electrical control shows the spectral tuning.

JTu3A.34
The effect of Laser Induced Periodic Surface Structures on Wear and Friction Coefficient, Hasnaa Meliani[2,1], Mohamed Assoul[2], Michaël Fontaine[3], Guy Monteil[3], Vahan Malkhasyan[1]; *[1]Femto-st, France; [2]Univ. Bourgogne Franche-Comté, France; [3]ENSMM, France*. The influence of laser surface texturing on tribological properties of stainless steel was studied. Linear Reciprocating Tribometer (LRT) was used to observe evolution of friction coefficient and wear versus number of cycles performed.

JTu3A.35
Enhanced optical nonlinearities in ultra-silicon-rich photonic crystal waveguides, Ezgi Sahin[1,3], Kelvin J. Ooi[1], George F. R. Chen[1], Doris K. T. Ng[2], Ching Eng Png[3], Dawn T. H. Tan[1]; *[1]Photonics Devices and Systems Group, Engineering Product Development, Singapore Univ. of Technology and Design, Singapore; [2]Data Storage Inst., A*STAR, Singapore; [3]Dept. of Electronics and Photonics, Inst. of High Performance Computing, A*STAR, Singapore*. Photonic crystal waveguides (PhCWs) are realized on ultra-silicon-rich nitride platform which possesses negligible nonlinear losses. An effective nonlinear parameter of $1.97\times10^4(Wm)^{-1}$ is estimated from self-phase modulation on PhCW of length 96.6 μm.

JTu3A.36
Strong-Field Ionization Modified by Optical and Quantum Interferences, David B. Foote[1], Yingda Lin[1], Kevin Lehr[1], Zhenqian Jian[1], Wendell T. Hill[1], Jean Marcel N. Djiokap[2], Liang-Wen Pi[2], Anthony F. Starace[2]; *[1]Univ. of Maryland, USA; [2]Univ. of Nebraska, USA*. We measure Xe^+ and electron yields after ionization from twin-peaked pulses. The ionization spectra show periodic modulation indicating interference. Small features of the pulse substantially change the optical interference and ion/electron yields.

JTu3A.37
Withdrawn.

JTu3A.38
Inherent Limitations in Mid-Wave and Long-Wave-IR Upconversion Detector, Ajanta Barh[1], Yu-Pei Tseng[1], Christian Pedersen[1], Peter Tidemand-Lichtenberg[1]; *[1]Technical Univ. of Denmark (DTU), Denmark*. Inherent limitations in terms of optical losses, selection of nonlinear crystal(s), detection efficiency and pumping conditions in mid-wave (3-5 μm) and long-wave (8-12 μm) infrared frequency upconversion modules are investigated in this paper.

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JTu3A.39
Bragg-induced Rabi Oscillations in Periodic Photonic Structures With $\mathcal{PT}$ Symmetry, Paulo A. Brandão[1], Solange B. Cavalcanti[1]; *[1]Instituto de Física, Universidade Federal de Alagoas, Brazil.* We study optical Rabi-like oscillations between a pair of resonant Bragg modes in a linear $\mathcal{PT}$ symmetric periodic photonic structure by analytically solving the paraxial wave equation.

JTu3A.40
Aberrated Soliton Forming at Femtosecond Pulse Propagation in Cubic Nonlinear Medium with Inhomogeneous Refraction Index, V. A. Trofimov[1], Alexei A. Kalinovich[1], Irina G. Zakharova[1]; *[1]M. V. Lomonosov Moscow State Univ., Russia.* We demonstrate a possibility of the formation of a new soliton type, named as chirped or aberrated soliton. Such solitons arise at optical pulse propagation in a nonlinear layered structure situated in a cubic nonlinear medium.

JTu3A.41
Femtosecond Laser-induced Dual Periodic Structures on Ni, Hyun Uk Lim[1,4], Jeongjin Kang[1], Chunlei Guo[2,3], Taek Yong Hwang[1]; *[1]Molds & Dies R&D group, Korea Inst. of Industrial Technology, South Korea; [2]The Inst. of Optics, Univ. of Rochester, USA; [3]The Guo China-US Photonics Lab, Changchun Inst. of Optics, Fine Mechanics, and Physics, China; [4]Mechanical Engineering, Dankook Univ., South Korea.* Under femtosecond laser pulse irradiation at off normal incidence, we create nanostructure-covered laser-induced dual periodic surface structures on Ni. Mechanisms of the structure formation will be discussed in this work.

JTu3A.42
Velocity-selective Saturated Spectroscopy with a Train of Ultra-short Pulses and a Diode Laser, Alexis Carlos G. Wong[1], Alexandre Almeida[1], Natalia R. de Melo[2], Sandra S. Vianna[1]; *[1]UFPE, Brazil; [2]Escola politécnica, UPE, Brazil.* A mode-locked 1 GHz femtosecond laser together with a diode laser is used to perform coherent spectroscopy of the D_2 rubidium line. The results are well described using the Bloch equations in the frequency domain picture.

JTu3A.43
Preliminary Investigation On Selective Laser Melting Of 17-4PH Steel Using High laser Powers Of up to 1500W, Nkutwane Washington Makoana[1,2], Heinrich Moller[1], Danie Louw[1], Igor Yadroitsev[2]; *[1]Council for Scientific and Industrial Research, South Africa; [2]Mechanical Engineering, Central Univ. of Technology, South Africa.* High laser powers of up to 1500W were used to additively manufacture 17-4PH samples. Porosity was measured using the image analysis technique, and all samples are fairly dense with a maximum of 0.42 percent porosity.

JTu3A.44
Liquid Crystal Elastomers (LCEs) Dynamics in Response to Visible Light Illumination, Vahideh Abdolazimi[1], Adam Fontecchio[2,3]; *[1]Electrical and Computer Engineering, Drexel Univ., USA; [2]Vice Dean, Graduate College, Drexel Univ., USA; [3]Professor of Electrical and Computer Engineering, Drexel Univ., USA.* Liquid crystal elastomers are elastic materials that deform by illumination. The LCE film dynamics under different visible light frequencies is simulated. The results illustrate rapid deformations at higher frequencies with greater resultant forces.

JTu3A.45
Bound Electron Nonlinearity Beyond the Ionization Threshold, Jared K. Wahlstrand[1,2], Sina Zahedpour[2], Howard Milchberg[2]; *[1]NIST, USA; [2]Univ. of Maryland, USA.* We measure the residual bound electron nonlinear polarizability well above the ionization threshold in a range of gases, and find that it scales approximately linearly with laser intensity.

JTu3A.46
Low Jitter Measurement of Laser Linewidth using Brillouin Induced Self-Heterodyne Method., Arpita Sinha Roy[1]; *[1]IIT Kanpur, India.* We mathematically analyse and experimentally measure the linewidth of a DFB laser using Brillouin induced self-heterodyne method. We show that Brillouin induced self-heterodyne method reduces the jitter effect as compared to self-heterodyne method.

JTu3A.47
Ultrafast carrier dynamics in wide bandgap semiconductor materials, Roderick B. Davidson[2], Adam D. Dunkelberger[1], Ioannis Chatzakis[2], Brad Pate[1], Joshua Caldwell[1], Jeffrey Owrutsky[1]; *[1]Naval Research Lab, USA; [2] National Research Council, USA.* Free-carrier relaxation dynamics in several unique wide bandgap materials is characterized by pump-probe spectroscopy. Lifetimes are observed from ten to hundreds of picoseconds in aluminum nitride, polymorphic diamond, and hexagonal boron nitride.

JTu3A.48
X-ray Photoelectron Spectroscopy Analysis of Surface Segregation in Bimetallic Nanoalloy, Justyna Piwowar[1], Adam Lewera[1]; *[1]Faculty of Chemistry, Univ. of Warsaw, Poland.* The surface composition of a heterogeneous catalyst determines its properties. This presentation will demonstrate that X-ray Photoelectron Spectroscopy innovative analysis in an efficient way of studying surface segregation.

JTu3A.49
Metal-enhanced lasing from zinc-doped GaAs nanowires, Fatemesadat Mohammadi[1], Mykhaylo Lysevych[2], Hoe Tan[2], Chennupati Jagadish[2], Hans Peter Wagner[1]; *[1]Dept. of Physics, Univ. of Cincinnati, USA; [2]Dept. of Electronic Materials Engineering, Research school of Physics and Engineering, Australia.* We observe enhanced optically excited lasing and decreased lasing threshold in Zn doped GaAs laid on gold and silver films. The enhancement is attributed to energy transfer between the stimulated emission in the NWs and surface plasmons in the metal.

JTu3A.50
Significant Enhancement of Magneto-Optical Rotation in a Low-Light Resonant Tripod System, Eric Y. Zhu[1], Feng Zhou[1], Edward W. Hagley[2], Lu Deng[1]; *[1]Quantum Measurement Division, National Inst. of Standards and Technology, USA; [2]Sensor Science Division, National Inst. of Standards and Technology, USA.* The magneto-optical rotation experienced by a resonant probe field in an ambient-temperature atomic vapor is enhanced more than ten-fold when a secondary low-intensity optical field is introduced, forming an atomic tripod system.

JTu3A.51
Linear and Nonlinear Optical Properties of Organic Cavity Polaritons in the Ultrastrong Regime, Bin Liu[1], Michael Crescimanno[2], Kenneth Singer[1]; *[1]Case Western Reserve Univ., USA; [2]Youngstown State Univ., USA.* We demonstrate coupling between two ultrastrong exciton-photon coupled low-Q organic microcavities at room temperature. We also experimentally observe cavity-polariton enhanced third harmonic generation in single exciton-photon coupled microcavities.

JTu3A.52
Analytical Expression for Z-scan Curves in Solely Refractive Nonlocal Thick Media, Roman Torres[1], M. Maribel Méndez Otero[1], M. Luis Arroyo Carrasco[1], E. Reynoso Lara[1], M. David Iturbe Castillo[2]; *[1]BUAP, Mexico; [2]Optics, INAOE, Mexico.* Z-scan curves in thick nonlinear nonlocal media are analytically calculated by considering the sample as a stack of thin slices without coupling of nonlinearities between them. Obtained results are compared with previously reported in literature.

JTu3A.53
Polarization Properties of White-Light Continuum due to a Single Femtosecond Filament in YVO_4 Crystal, Chinmoy Biswas[1], Maruthi M. Brundavanam[1]; *[1]Indian Inst. of Technology Kharagpur, India.* Polarization properties of white-light continuum due to a single femtosecond filament inside a YVO_4 crystal are investigated at different input laser powers. The results show the depolarization of the white-light continuum at high powers.

JTu3A.54
Conical third-harmonic generation in a 2D periodically-poled crystal, XinYuan Fang[1], Yong Zhang[1]; *[1]Nanjing Univ., China.* We have experimentally demonstrated conical third-harmonic generation in a two dimensional periodically poled $LiTaO_3$ crystal, which was attributed to cascaded quasi-phase-matching processes assisted by scattering fundamental waves in the crystal.

JTu3A.55
Chemical vapor sensing in photonic crystal slabs, Yonghao Liu[1], Priyanka Biswas[1], Weidong Zhou[1], Yuze Sun[1]; *[1]Univ. of Texas at Arlington, USA.* We report here chemical vapor sensing in free-space coupled defect-free photonic crystal slabs. It shows a quality factor of 6,890 and a sensitivity of 1.76×10^{-2} pm/ppm for hexane, with a detection limit of 57 ppm.

JTu3A.56
Nonlinear Pulse Compressor on Silicon Slot Hybrid Optical Waveguide, Nishit Malviya[1], Vishnu Priye[1]; *[1]IIT (ISM) Dhanbad, India.* Theoretical investigation of pulse compression in slot optical waveguide based on nonlinear organic material PTS is presented. Results depict compression of pulse from 1ps to 0.59ps in propagation range of 20 cm at 1550 nm

JTu3A.57
A Dynamical Perspective on Noise in Passively Modelocked Lasers, Curtis Menyuk[1], Shaokang Wang[1], Thomas Carruthers[1]; *[1]Univ. of Maryland, Baltimore County, USA.* We show how to use dynamical methods to calculate the impact of noise on the timing jitter and power spectral density of passively modelocked lasers without using computationally expensive Monte Carlo simulations.

JTu3A.58
Realization of S-type and N-type Hysteresis Loops at Femtosecond Laser Pulse Action in Semiconductor, V. A. Trofimov[1], Mariya M. Loginova[1], Vladimir A. Egorenkov[1]; *[1]M. V. Lomonosov Moscow State Univ., Russia.* Using computer simulation, we showed a possibility of simultaneous existence of S- type and N-type hysteresis loops at femtosecond pulse interaction with a semiconductor.

JTu3A.59
Nonlinear self-channeling of laser pulses through distributed atmospheric turbulence, Michael H. Helle[1], Gregory DiComo[1], John Palastro[1], Joseph Penano[1], Jennifer Elle[2], Andreas Schmitt-Sody[2]; *[1]Naval Research Lab, USA; [2]U.S. Air Force Research Lab, USA.* We present experimental evidence of a new propagation paradigm where a laser pulse, near the self-focusing power of air with a spot size smaller than the coherence diameter of turbulence, self-channels over hundreds of meters.

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JTu3A.60
Experimental Study on the Relationship Between the Polarizability and Non-Linear Refractive Index in Hydrocarbons, Sebastian Vergara Palacio[1], Carlos A. Rodriguez Ortiz[2,1], Raul E. Jimenez Mejia[1], Rodrigo Acuna Herrera[1], Carlos Andres Alvarez Ocampo[1,2]; *[1]Escuela de Fisica, Universidad Nacional de Colombia-Medellin, Colombia; [2]Ciencias Basicas, Universidad de Medellin, Colombia.* Theoretical and experimental characterization of non-linear refractive index of Hydrocarbons dyes is presented by using the free electron model. An empirical linear relationship between nonlinear and linear refractive index was found.

JTu3A.61
Nonlinear Optical Properties of Chalcogenopyrylium-Terminated Heptamethine Dyes in Multiple Polymer Hosts, Taylor G. Allen[1], Yulia Getmanenko[1,2], Hyeongue Kim[1], Joel M. Hales[1], Bhupinder Sandhu[2], Marina S. Fonari[2], Kyrill Y. Suponitsky[2,3], Yadong Zhang[1], Jonathan D. Matichak[1], Victor N. Khrustalev[2,4], Tatiana Timofeeva[2], Stephen Barlow[1], San-Hui Chi[1], Joseph W. Perry[1], Seth Marder[1]; *[1]Georgia Inst. of Technology, USA; [2]Biology and Chemistry, New Mexico Highlands Univ., USA; [3]A. N. Nesmeyanov Inst. of Organoelement Compounds, Russian Academy of Sciences, Russia; [4]Peoples' Friendship Univ. of Russia, Russia.* Z-scan and linear loss measurements on polymethine-polymer blends with varied chalcogens and hosts confirm polymethine aggregation as the primary interaction influencing solid-state NLO properties for ultrafast all-optical signal-processing.

JTu3A.62
Simple Diagnostics of Femtosecond Pulses by the Use of Nanosecond Oscilloscope, Karapet Manukyan[1], Minas Sukiasyan[1,2], Hrach Toneyan[1,2], Aram Zeytunyan[3], Levon Mouradian[1,2]; *[1]Yerevan State Univ., Armenia; [2]CANDLE Synchrotron Research Inst., Armenia; [3]Technology and Applications Center, Newport Corporation, USA.* We determine the duration of femtosecond pulses by coupling them into a passive fiber, generating the nanosecond duration nonlinear-dispersive similaritons and recording them by an oscilloscope. This diagnostics has real-time performance.

JTu3A.63
Withdrawn.

JTu3A.64
Airy Wavepackets Accelerating Only in the Spatio-Temporal Domain, Hasan E. Kondakci[1], Ayman Abouraddy[1]; *[1]CREOL, Univ. of Central Florida, USA.* We experimentally demonstrate Airy wavepackets accelerating only in the spatio-temporal domain of the localized pulse produced via a two-dimensional pulse shaper. When observed with a slow detector, the Airy wavepacket does not accelerate.

JTu3A.65
Single-shot, Axially Resolved Measurements of Femtosecond Filament Energy Deposition over 10 Meter Scales, Ilia Larkin[1], Eric Rosenthal[1], Nihal Jhajj[1], Howard Milchberg[1]; *[1]Univ. of Maryland, USA.* The axial energy deposition profile of an extended femtosecond filament is captured in a single shot over a >10 m propagation distance by an array of synchronized microphones.

JTu3A.66
Frequency downshifting of perturbed dissipative solitons: A variational approach, Ambaresh Sahoo[1], Samudra Roy[1], Govind P. Agrawal[2]; *[1]Indian Inst. of Technology Kharagpur, India; [2]The Inst. of Optics, Univ. of Rochester, USA.* We develop a variational approach to study the Raman-induced frequency downshift of dissipative solitons whose evolution is governed by a complex Ginzburg-Landau equation. We derive a set of coupled differential equations that explain the dynamics.

JTu3A.67
High Order Harmonic Generation in ZnSe Driven by 3 µm Parametric Laser Source at High Repetition Rate, Giedre M. Archipovaite[1], Stéphane Petit[1], Jean-Christophe Delagnes[1], Eric Cormier[1]; *[1]CELIA, France.* We present an ultrashort high-power 3µm laser source based on optical parametric amplification. The source provides a promising tool for strong field experiments in solids and high-order harmonics have been generated in ZnSe.

JTu3A.68
Highly Sensitive Ammonia Gas Detection with a Silica Toroid Microcavity Packaged in a Box, Taku Okamura[1], Misako Kobayashi[1], Shun Fujii[1], Takasumi Tanabe[1]; *[1]Keio Univ., Japan.* We demonstrate highly sensitive and practical ammonia gas (NH_3) detection with a packaged silica toroid microcavity. We report our experimental results and achieve a detection sensitivity of 0.43 nm/ppm.

JTu3A.69
Narrowband Tunable Thz Generation in Orientation Patterned Gallium Phosphide, Patrick Tekavec[1], Vladimir Kozlov[1], Peter Schunemann[2]; *[1]Microtech Instruments, USA; [2]BAE Systems, USA.* We demonstrate tunable, narrowband THz generation by optical rectification of a femtosecond pulse in orientation patterned Gallium Phosphide. Center frequencies from 0.9 – 3.8 THz with average power up to 15 µW were obtained.

JTu3A.70
Spectral Broadening of a High Average Power Yb:KGW Laser, John E. Beetar[1], Shima Gholam-Mirzaei[1], Sean Buczek[1], Steven Solis[1], Michael Chini[1]; *[1]UCF, USA.* Broadening and compression efficiency of high average power NIR pulses from a Yb:KGW laser amplifier, undergoing self-phase modulation in a series of thin fused silica plates, is investigated through spatial characterization of spectrum and power.

JTu3A.71
Efficient Production of Picosecond 9-11 µm Pulses by Parametric Three Wave Mixing in GaSe, Eric C. Welch[1], Sergei Tochitsky[1], Chandrashekhar Joshi[1]; *[1]Electrical Engineering, UCLA, USA.* Generation of picosecond, 5 µJ, 10 µm pulses by parametric three wave mixing in GaSe is demonstrated. Two new methods are explored in which the nonlinear interaction is seeded by either the signal or idler waves.

JTu3A.72
Geometric parametric instability of femtosecond pulses in graded-index multimode fiber, Uğur Tegin[1,2], Bülend Ortaç[1,2]; *[1]Inst. of Materials Science and Nanotechnology, Bilkent Universitesi, Turkey; [2]National Nanotechnology Research Center, Bilkent Univ., Turkey.* We experimentally study the spatio-temporal femtosecond pulse evolution in graded-index multimode fiber at normal dispersion regime. We report the first demonstration of geometric parametric instability with ultrashort pulses in the literature.

JTu3A.73
Withdrawn.

JTu3A.74
Broadband pulse generation from a low-power, carbon-nanotube mode-locked fiber laser, Ting Li[1], Guoqing Hu[1], Jie Chen[1], Zhi Qiao[1], Xin Zhao[1], Zheng Zheng[1,2]; *[1]School of Electronic and Information Engineering, Beihang Univ. , China; [2]Collaborative Innovation Center of Geospatial Technology, China.* Using a simple dispersion-managed ring cavity, 48-nm wide pulses are generated at a low intra-cavity pulse energy of 23 picojoules under small normal dispersion, facilitated by a polarization spectral filtering mechanism.

JTu3A.75
Tunable Cavity Fiber-Optic Fabry-Perot Magnetometer Based on Fiber-Cantilever Beam-Deflection, Somarpita Pradhan[1], Samik Saha[1], Partha Roy Chaudhuri[1]; *[1]Indian Inst. of Technology Kharagpur, India.* We devised a tunable cavity fiber Fabry-Perot magnetometer using deflection of cobalt-doped nickel ferrite coated optical fiber cantilever. Sensitivity is improved by introducing a silver coated fiber-mirror in the developed configuration

JTu3A.76
Coherent Combination and Self-similar Compression of Two RC Pulses with Different Pulse Widths, Ziyun Jian[1], Guangkuo Li[1], Qian Li[1]; *[1]Peking Univ., China.* Two raised cosine pulses with different initial pulse widths firstly coalesce into a single pulse and then experience self-similar compression.

JTu3A.77
The Impact of Laser Beam Polarization on Small-Scale Self-Focusing in Isotropic Crystals, Anton Kochetkov[1], Vlad Ginzburg[1], Maryana Kuz'mina[1], Efim Khazanov[1]; *[1]IAP RAS, Russia.* Direct measurements of spatial noise gain in a wave propagating in [001]-orientated BaF_2 were performed. Significant dependence of gain on the angle between the radiation polarization and the crystallographic axis predicted earlier was demonstrated.

JTu3A.78
Time-Evolving Single-Shot Imaging of Laser-Produced Plasmas by Spatial Division, Sarang Yeola[1], Donghoon Kuk[1], Ki-Yong Kim[1]; *[1]Univ. of Maryland at College Park, USA.* We have developed an ultrafast single-shot pump-probe technique which uses spatially- and temporally-separated multiple probe pulses to capture four frames of laser-induced plasmas at ~10 trillion frames per second (fps).

JTu3A.79
Interband absorption of topologically structured photon beams by semiconducting quantum dots, Maria Solyanik[1], Andrei Afanasev[1]; *[1]The George Washington Univ., USA.* Interaction of topological photon beams with semiconducting quantum dots is described in QED formalism. Absorption rates are calculated, and distinctive features arising due to the wavefront topology, such as modified selection rules, are discussed.

JTu3A.80
Withdrawn.

JTu3A.81
Diffusive Dynamics and Signature of Phase Singularities in Gain/Loss Assisted Disordered Optical Waveguide Lattices, Somnath Ghosh[1], Ravi K Varshney[3], Bishnu P. Pal[2]; *[1]Indian Inst. of Technology Jodhpur, India; [2]MEC Hyderbad, India; [3]Indian Inst. of Technology Delhi, India.* Co-existence and interplay between mesoscopic light dynamics with singular optics in spatially disordered waveguide lattices is reported. Disorder induced singular behavior and diffusive wave propagation are quantitatively analyzed.

JTu3A • Joint Poster Session II—Continued

JTu3A.82
Evolution of an Optical Vortex on the Morphology Sphere by Control of Fractional Charge of the Dislocation, Satyajit Maji[1], Maruthi M. Brundavanam[1]; [1]*Indian Inst. of Technology Kharagpur, India.* Evolution of the morphology parameters associated with the anisotropic vortex phases of generated non-canonical optical vortices is demonstrated in experiment and simulation by changing fractional charge of the dislocation and input beam curvature.

JTu3A.83
Optimization of a Birefringent Mask for Generating Optical Bottle Fields, Anthony Vella[2], Hippolyte Dourdent[1], Lukas Novotny[1], Miguel A. Alonso[2]; [1]*Photonics Lab, ETH Zürich, Switzerland;* [2]*The Inst. of Optics, Univ. of Rochester, USA.* We optimize the spatial variation of a birefringent mask, placed in a high-NA focusing system, to generate a bottle field with minimal volume. The optimal birefringence distribution is nearly identical to a stress-engineered optical element.

JTu3A.84
Confined bases: from paraxial to electromagnetic, Rodrigo Gutiérrez-Cuevas[1], Miguel A. Alonso[1]; [1]*Univ. of Rochester, USA.* We present novel discrete bases for optical fields with the distinct property of being confined. This delivers interesting properties like order-independent fits and simple description of fields with varying degrees of focusing.

JTu3A.85
Generation of optical vector beams using a single spatial light modulator, Benjamin Perez-Garcia[1], Carlos Lopez-Mariscal[2], Raul I. Hernandez-Aranda[1], Julio C. Gutiérrez-Vega[1]; [1]*Tecnologico de Monterrey, Mexico;* [2]*Underwater Photonics, Mexico.* We present an optical scheme to produce vector beams. Our realization features control over the local polarization state of the transverse coordinates. As an example, we investigate the generation of cylindrical vector vortex beams.

JTu3A.86
Transformation of Complex Spatial Coherence Function in Reflection from Random Media, Mahed Batarseh[1], Zhean Shen[1], Roxana Rezvani Naraghi[1,2], Heath E. Gemar[1], Sergey Sukhov[1], Aristide Dogariu[1]; [1]*CREOL, The College of Optics and Photonics, Univ. of Central Florida, USA;* [2]*Dept. of Physics, Univ. of Central Florida, USA.* We investigate both experimentally and numerically the transformation of the spatial coherence function (SCF) reflected from media with both surface and volume scattering, and demonstrate the conditions for the SCF survivability during scattering.

JTu3A.87
Azimuthal asymmetry in HE_{1x} modes analyzed, Antonio Astorino[1], Mario A. Usuga Castaneda[1], Stine M. Israelsen[1], Jesper Lægsgaard[1], Karsten Rottwitt[1]; [1]*DTU, Denmark.* An analytical study of higher-order modes in step-index fibers has been conducted with the aim of justifying the circular asymmetry experimentally observed in the intensity of higher-order Bessel-like modes.

JTu3A.88
White light beam shaping by volume holographic element, Sunil Vyas[1], Po-Hao Wang[1], Yuan Luo[1]; [1]*National Taiwan Univ., Taiwan.* Utilizing angle-wavelength coupling degeneracy of volume holograms, we experimentally demonstrate the generation of white light beam shapes corresponding to three different types of beams: Laguerre-Gaussian, Bessel-Gaussian and Airy-Gaussian beams.

JTu3A.89
Superfluidicity in an Optical Lattice with a PT Symmetric Defect, Lingxuan Zhang[1,2], Wenfu Zhang[2], Li Ge[1]; [1]*College of Staten Island, CUNY, USA;* [2]*Xi'an Inst. of Optics and Precision Mechanics, China.* We consider a nonlinear waveguide array with a PT symmetric defect at the center of a parabolic potential. The oscillations of a coherent state persist without dissipation, if its velocity is below a critical value.

JTu3A.90
Evolutionary Optimization of Nondiffracting Helicon Beams, Bryce Schroeder[1], Zhen H. Zhu[1], Changliang Guo[1], Shu Jia[1]; [1]*Stony Brook Univ., SUNY, USA.* We optimized helicon-like beams in a high resolution imaging sytem with an evolutionary algorithm, achieving a tight intensity profile while largely maintaining self-rotation and nondiffraction. The method promises wide applicability in beam design.

JTu3A.91
Polarization Singularities due to Unfolding of Fractional Vortex Beams in a Birefringent Crystal, Aswini K. Pattanayak[1], Satyajit Maji[1], Maruthi M. Brundavanam[1]; [1]*Indian Inst. Of Technology Kharagpur, India.* The evolution of polarization singularities due to unfolding of optical vortex beams with topological charges varying from 0 to 1 in fractional steps is investigated at the output of a birefringent crystal.

JTu3A.92
Effect of Astigmatism on Intensity Speckle Pattern, Abhijit Roy[1], Maruthi M. Brundavanam[1]; [1]*Indian Inst. of Technology Kharagpur, India.* Effect of astigmatism on intensity speckle pattern, generated using a ground glass plate, is investigated experimentally exploiting angular memory effect for different amounts of astigmatism introduced by rotating a lens at different angles.

JTu3A.93
A Second Harmonic Technique to Determine Metal-Induced-Gap-State Density, Mallik Mohd Raihan Hussain[1], Zhengning Gao[2], Domenico de Ceglia[3], Maria Vinceti[4], Andrew Sarangan[1], Imad Agha[1], Michael Scalora[5], Parag Banergee[2,6], Joseph W. Haus[1]; [1]*Dept. of Electro-Optics and Photonics, Univ. of Dayton, USA;* [2]*Inst. of Materials Science and Engineering, Washington Univ., USA;* [3]*AEgis Technologies Group Inc., USA;* [4]*Dept. of Information Engineering, Univ. of Brescia, Italy;* [5]*Charles M. Bowden Research Lab, US Army AMRDEC, USA;* [6]*Dept. of Mechanical Engineering & Materials Science, Washington Univ., USA.* We experimentally determine the metal-induced-gap-state (MIGS) density at Au/Al_2O_3 interfaces by applying a sensitive second harmonic generation (SHG) technique. We measure SHG efficiencies at these interfaces for Al_2O_3 films of nanometer thickness.

JTu3A.94
Appropriate field of illumination size for reflective ghost imaging concerning image quality, Lichen Zhang[1], Bin Luo[2], Guohua Wu[1], Junhui Li[3], Dongyue Yang[1], Longfei Yin[1], Hong Guo[3]; [1]*School of Electronic Engineering, Beijing Univ. of Posts and Telecommunications, China;* [2]*State Key Lab of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, China;* [3]*School of Electronics Engineering and Computer Science, Peking Univ., China.* For reflective ghost imaging, illumination field with the same size of the object provides the best image quality. Among other assessments, contrast-to-noise ratio (CNR) reflects the size effect best, and is more vulnerable to noise.

JTu3A.95
Radiation Pressure on a Transmissive Diffraction Grating, Ying-Ju Chu[1], Grover A. Swartzlander[1]; [1]*Rochester Inst. of Technology, USA.* Diffraction films afford advantages over reflective films for applications like solar sailing. Our torsion pendulum demonstrated radiation pressure on a thin transmissive Littrow grating. A significant tangential force was observed.

JTu3A.96
Nonlinear Interaction of Ultrafast Hollow Gaussian Beams, Amrit Chaitanya[1], Apurv Chaitanya Nellikka[2], J Banerji[2], Goutam K Samanta[2]; [1]*Pondicherry Univ., India;* [2]*Physical Research Lab, India.* We report on frequency-doubling of ultrafast hollow Gaussian beam (HGB) in the green with HGB order as high as six and power >250 mW. We observed doubling of the order of HGB in frequency-doubling process.

JTu3A.97
Withdrawn.

JTu3A.98
Frequency shift in three-photon resonant four-wave mixing due atom-field interaction, Natalia R. de Melo[1], Sandra S. Vianna[2]; [1]*Universidade de Pernambuco, Brazil;* [2]*Departamento de Física, Universidade Federal de Pernambuco, Brazil.* We investigate Frequency shift in three-photon resonant four-wave mixing in rubidium vapor. The results are consistent with theoretical model based on semiclassical Maxwell-Bloch equations considering the generated radiation field self-consistently.

JTu3A.99
Influence of silver concentration on the locality of nonlinear response in colloidal Ag nanocubes, Emma V. García Ramírez[1], Daysi Ramírez Martínez[1], Sergio sabinas Hernandez[1], Gabriela Díaz Guerrero[1], Alejandro Reyes esqueda[1]; [1]*Univ Nacional Autonoma de Mexico, Mexico.* Colloidal Ag nanocubes systems with particle sizes of 99 and 215 nm and different volume fraction were analyzed by Z-scan technique. Changes in the spatial nonlocality of their third order nonlinear response were observed.

JTu3A.100
Three waveguide direction coupler based polarization splitter under stimulated Raman adiabatic passage, Pragati Aashna[1]; [1]*Indian Inst. of Technology, Delhi, India.* We propose the design of a polarization splitter based on stimulated Raman adiabatic passage (STIRAP) mechanism in a three waveguide directional coupler.

JTu3A.101
Analysis of Markovian modes and their applications on holography, Carina Gutiérrez Ojeda[1], Patricia Martinez Vara[2], Gabriel Martinez Niconoff[1]; [1]*Instituto Nacional de Astrofísica Óptica, Mexico;* [2]*Engineering, BUAP, Mexico.* We have numerically generated Markovian optical fields of variable amplitude. By using such fields we describe the recording holographic and reconstruction processes. The model is generalized to a set of holographic structures.

JTu3A • Joint Poster Session II—Continued

JTu3A.102
Efficient Relativistic High-Order Harmonic Generation with Waveform-Engineered Driving Pulses, Matthew Edwards[1], Julia M. Mikhailova[1]; *[1]Princeton Univ., USA.* Multi-color synthesized waveforms generate relativistic high-order harmonics with far higher efficiencies than single-color driving pulses. Particle-in-cell simulations suggest an optimal waveform, providing an efficiency limit on the process.

JTu3A.103
Simultaneous emission of noise-like pulse and solitons from a fiber laser, Yazmin E. Bracamontes-Rodriguez[1], Olivier Pottiez[1], Hugo Ibarra[1], J. P. Lauterio-Cruz[1], Baldemar Ibarra-Escamilla[2], Evgeny Kuzin[2]; *[1]División de Fotónica, Centro de Investigaciones en Óptica, Mexico; [2]Óptica, INAOE, Mexico.*
Passively mode-locked fiber lasers (PML-FLs) are versatile sources for generating a broad variety of pulses. This work presents a PML-FL in an unusual hybrid regime, with simultaneous emission of NLP and solitons at different wavelengths.

JTu3A.104
Gain-Clamping for an Externally-Incident Field Passing through a Laser Cavity, Ali Kazemi Jahromi[1], Alexander Cerjan[2], A. Douglas Stone[3], Ayman Abouraddy[1]; *[1]Univ. of Central Florida, CREOL, USA; [2]Applied Physics, Stanford Univ., USA; [3]Applied Physics, Yale Univ., USA.* Behavior of a self-oscillating cavity probed with an externally incident field has been the subject of controversy for decades. We address this issue by designing an experiment, and verify it with state-state ab-initio laser theory.

JTu3A.105
Efficient Lasing on Alkali Atomic D_2 Lines Utilizing Spin-Polarized Alkali Vapor, Andrey Mironov[1], J. G. Eden[1]; *[1]Univ of Illinois at Urbana-Champaign, USA.* We report a novel method for significantly improving the efficiency of alkali atomic lasers. By pumping alkali-rare gas atomic pairs with a circularly polarized optical field, an increase in the efficiency of >50% has been demonstrated.

JTu3A.106
Minimizing heat generation by radiative cooling in a Ytterbium-doped silica fiber laser, Mostafa Peysokhan[1], Arash Mafi[1]; *[1]Univ. of New Mexico, USA.* We study thermal management and radiative cooling in a Ytterbium-doped silica fiber laser and design a specific fiber laser that minimizes the thermal load while maintaining an efficient power operation.

JTu3A.107
Theoretical Investigation of Blue-laser-diode-pumped High Efficiency CW Ti:sapphire Laser by High Intensity Pumping, Tomoki Kanetake[1]; *[1]Fukui Univ., Japan.* The efficiency of a blue laser-diode-pumped CW Ti:sapphire laser was investigated theoretically. The maximum optical-to-optical conversion efficiency was obtained to be 20.4% at a pump power of 14W, with a high cavity loss of 20%.

JTu3A.108
Theoretical Analysis of Efficiency in a Mode-locked Laser with an Intra-Cavity Highly Nonlinear Medium, Naoya Nakajima[1]; *[1]Fukui Univ., Japan.* We analyzed the optical-to-optical conversion efficiency of a mode-locked laser with an intra-cavity highly-nonlinear medium. Efficiency reduction was caused when the output spectrum are wider than the gain spectrum edge.

JTu3A.109
Research on LD Pumped Nd:$GdYTaO_4$ Quasi-three-level 928 nm Laser, Wentao Wu[1], XuDong Li[1], Renpeng Yan[1], Yufei Ma[1], Fang Peng[2], Qingli Zhang[2], Renqin Dou[2], Jing Gao[3]; *[1]National Key Lab of Tunable Laser Technology, Harbin Inst. of Technology, China; [2]The Key Lab of Photonic Devices and Materials, Anhui Inst. of Optics and Fine Mechanics, China; [3]Jiangsu Key Lab of Medical Optics, Suzhou Inst. of Biomedical Engineering and Technology, China.* We demonstrated a diode-pumped Nd:$Gd_{0.69}Y_{0.3}TaO_4$ quasi-three-level 928 nm laser. Output power of 87 mW at 928 nm was obtained in quasi-continuous-wave operation under 808 nm laser diode pumping.

JTu3A.110
Spectroscopy of Metastable Xenon Atoms in High Pressure Plasma Discharges, Carl R. Sanderson[1], Amanda Clark[2], Ian Gabalski[2], Paul J. Moran[3], Eric Guild[4], Jiande Han[5], Michael Heaven[5], Brett Hokr[2]; *[1]Systems Management and Production Center, Univ. of Alabama in Huntsville, USA; [2]High Energy Laser Division, US Army SMDC/ARSTRAT, USA; [3]Laser Technology Branch, Air Force Research Lab, USA; [4]Leidos Inc., USA; [5]Dept. of Chemistry, Emory Univ., USA.* Tunable diode laser absorption spectroscopy measurements of the metastable xenon population densities and spectral line broadening of the 904.545 nm transition in three high pressure plasma discharges are presented.

JTu3A.111
Variation in polarization profiles of Ince-Gaussian beams with eccentricity, Sean M. Nomoto[1], Reeta Vyas[1], Surendra Singh[1]; *[1]Univ. of Arkansas, USA.* Polarization intensity profiles for dominant and cross components of Ince-Gaussian beams for orders up to p = 5 and eccentricities 0.01, 0.2, 1.0, and 2.0 were observed. Experimental results agree with the theory.

JTu3A.112
Study on Features of a Diode-Pumped Alkali Laser: Temperature 3D-Distribution, Thermally-Induced Lens, and Ionization Processes, Guofei An[1], You Wang[1], Juhong Han[1], Wei Zhang[1], He Cai[1], Shunyan Wang[1], Kepeng Rong[1], Hang Yu[1], Hongyuan Wang[1]; *[1]Southwest Inst. of Technical Physics, China.* We develop a 3D-model to evaluate the kinetic processes and thermal features of a cesium-vapor laser. The 3D temperature distribution, effective focal length of a thermally-induced lens, and the influence of ionization processes are analyzed.

JTu3A.113
Studies on nonlocal plasmonic resonances: analytical and numerical approaches, Milan Burda[1], Pavel Kwiecien[1], Ivan Richter[1], Jan Fiala[1]; *[1]Czech Technical Univ. in Prague, Czech Republic.* Both (quasi)analytical and numerical approaches describing the complexity of nonlocal interactions at nanoscaled plasmonic structures are investigated, in comparison with the standard linear response approximation.

JTu3A.114
Vortex-antivortex wavefunction for superfluids in exciton-polariton laser, Alex Okulov[1]; *[1]Russian Academy of Sciences , Russia.* It is shown that interaction of exciton-polariton superfluid with structured light in laser microcavity leads to spontaneous formation of vortex-antivortex quantum states

JTu3A.115
Tamm plasmon polaritons in aperiodic metal deposited Bragg reflectors, Mukesh K. Shukla[1], Ritwick Das[1]; *[1]National Inst of Sci Education & Res., India.* We present existence of Tamm-plasmon-polariton (TPP) modes in one-dimensional quasi-crystals and deterministic aperiodic structures for normal incidence of broadband light. They exhibit similar propagation characteristics as conventional TPP modes.

JTu3A.116
Dynamic Ferroelectricity of Trojan Electrons on Hexagonal Face-Centered 3-Triangular Lattice, Matt . Kalinski[1]; *[1]Utah State Univ., USA.* We discover several types of the dynamic ferroelectric orders on the regular lattice consisting of three triangular lattices forming Hexagonal Face-Centered Lattice on which hydrogen atoms with coherently phase moving Trojan wavepackets are placed.

JTu3A.117
Spectroscopic & electrical investigations on Yb^{3+}/Er^{3+} co-doped $Ba_{0.5}Ca_{0.5}ZrO_3$ ceramics for application in sensing devices, PRASENJIT PRASAD SUKUL[1], Kaushal Kumar[1]; *[1]Applied Physics, Indian Inst. of Technology(ISM), India.* Yb^{3+}/Er^{3+} codoped $Ba_{0.5}Ca_{0.5}ZrO_3$ ceramics at different sintering temperature through solid state reaction route are prepared and photoluminescence properties of the ceramic were investigated.

JTu3A.118
Fluorescence Quantum Yield Measurements in Silver Nanoparticle-Rhodamine B Systems by Thermal Lens Spectroscopy, Luis Rodriguez[1], Marco Ferreira[1], Vincent Piscitelli[1]; *[1]Universidad Central de Venezuela, Venezuela, Bolivarian Republic of.* We studied the changes induced by silver nanoparticles, generated by laser ablation, in the quantum yield of Rhodamine B. The silver nanoparticles quenched the fluorescence of the Rhodamine B and depended on both concentrations.

15:00–16:30
FTu4A • Integrated Optics
Presider: Roger Helke; University of California, Santa Barbara, USA

FTu4A.1 • 15:00 Invited
Arbitrary and Self-configuring Optics – New Opportunities for Integrated Photonics, David A. B. Miller[1]; [1]*Stanford Univ., USA*. Recent understanding shows how to make universal linear components, beyond conventional optics. Fundamental consequences include new radiation laws. Practical integrated Mach-Zehnder meshes can be self-configured for arbitrary linear functions.

FTu4A.2 • 15:30
Lasing and Steering an integrated Vortex Laser, Babak Bahari[1], Felipe Valini[1], Thomas Lepetit[1], Ricardo Tellez-Limon[1], Junhee Park[1], Ashok Kodigala[1], Yeshaiahu Fainman[1], Boubacar Kante[1]; [1]*Univ. of California San Diego, USA*. We demonstrated theoretically and experimentally a Bound State in the Continuum Surface Emitting Laser that operates at room temperature and it can steer the beam with an angle depending on the topology of structure.

FTu4A.3 • 15:45
Graphene oxide integrated on-chip tunable waveguide polarizer, Subhabrata Ghosh[1], Debabrata Mandal[1], Amreesh Chandra[1], Shivakiran Bhaktha B. N.[1]; [1]*Indian Inst. of Technology Kharagpur, India*. We demonstrate tunable TE pass polarizer in graphene oxide (GO) coated SiO_2-HfO_2 channel waveguides fabricated by UV-photolithography. The tunability has been achieved by reduction of GO by controlled IR irradiation.

FTu4A.4 • 16:00
Flexible Visible Photonic Crystal Laser Cavity, Jie Zhou[1,2], Taojie Zhou[2], Jiagen Li[2], Kebo He[2], Qian Li[1], Zhaoyu Zhang[2]; [1]*Peking Univ., China;* [2]*Chinese Univ. of Hong Kong, China*. The authors propose a L3 defect photonic crystal nanolaser embedded in flexible medium for nanoscale strain detections. A theoretical optical strain sensitivity of ~4.5 nm or 3 nm per ε (1% strain) in the x-direction or y-direction is predicted.

FTu4A.5 • 16:15
Distributed Brillouin Scattering Measurement with Sub-mm Spatial Resolution, Atiyeh Zarifi[1,2], Birgit Stiller[1,2], Moritz Merklein[1,2], Khu Vu[3], Stephen J. Madden[3], Benjamin J. Eggleton[1,2]; [1]*Univ. of Sydney, Australia;* [2]*Australian Inst. for Nanoscale Science and Technology (AINST), Australia;* [3]*CUDOS, Laser Physics Centre, Australian National Univ., Australia*. We report a highly localized SBS response with 780 μm spatial resolution in an As2S3 photonic integrated waveguide. This approach is used to characterize the waveguide based on its acousto-optic properties.

15:00–16:30
FTu4B • Advanced Spectroscopy and New Approaches
Presider: Takashige Omatsu; Chiba University, Japan

FTu4B.1 • 15:00 Invited
Chemical Sensing From 3–13 μm Using Femtosecond Optical Parametric Oscillators, Derryck T. Reid[1]; [1]*Heriot-Watt Univ., UK*. Fourier-transform and dual-comb spectroscopy using MgO:PPLN and OPGaP femtosecond optical parametric oscillators is described in a variety of embodiments including stand-off identification of liquids and aerosols, and precision spectroscopy of gases.

FTu4B.2 • 15:30
Deep UV pulse shaping at 207 nm through Fourier-domain frequency upconversion, Philippe Lassonde[1], Bruno E. Schmidt[2], Guilmot Ernotte[1], Matteo Clerici[3], Roberto Morandotti[1], Heide Ibrahim[1], François Légaré[1]; [1]*INRS-emt, Canada;* [2]*Few-cycle inc., Canada;* [3]*School of Engineering, Univ. of Glascow, UK*. We demonstrate controlled amplitude and phase transfer of an ultrashort laser pulse through second-harmonic generation in the frequency domain. Sequential conversion allowed pulse shaping down to the deep UV at 207 nm.

FTu4B.3 • 15:45
Pulsed Light Sheets with Arbitrary Beam Profiles via Correlated Spatio-Temporal Spectrum, Hasan E. Kondakci[1], Ayman Abouraddy[1]; [1]*CREOL, Univ. of Central Florida, USA*. We experimentally demonstrate diffraction-free pulsed light sheets with arbitrary spatial profile at the pulse center by introducing tight correlations between the spatial and temporal degrees of freedom in hyperbolic form.

FTu4B.4 • 16:00
Advanced microscopy techniques for revealing molecular structure of starch granules, Nirmal Mazumder[1], Suchitta Umashankar[1], Bharath Ratnakar[1], Krishna Kishore Mahato[1], Fu-Jen Kao[2]; [1]*Dept. of Biophysics, School of Life Sciences, Manipal Univ., India;* [2]*Inst. of Biophotonics, National Yang Ming Univ. , Taiwan*. The molecular structure (crystalline and amorphous components) of potato starch was characterized using second harmonic generation (SHG) and coherent anti-Stoke Raman scattering (CARS) microscopy as well as scanning electron microscope (SEM).

FTu4B.5 • 16:15
Efficient visible frequency microcomb generation with 22% conversion efficiency, Xiang Guo[1], Chang-ling Zou[1], Hojoong Jung[1], Zheng Gong[1], Alexander Bruch[1], Liang Jiang[1], Hong X. Tang[1]; [1]*Yale Univ., USA*. We demonstrate an efficient visible frequency comb generation process in the aluminum nitride microring resonator. Up to 22% conversion efficiency from infrared pump to the visible comb is realized.

15:00–16:30
FTu4C • Display Technology for VR/AR Applications
Presider: Hong Hua; The University of Arizona, USA

FTu4C.1 • 15:00 Invited
Next Challenge for Augmented Reality as a Smart Display Technology, Hirokazu Kato[1]; [1]*Nara Inst. of Science and Technology, Japan*. Since the concept of Augmented Reality was proposed in the 1990's, that technology has evolved to reach a practical level. I will present its brief history and the challenges for further development in the future.

FTu4C.2 • 15:30 Invited
Head-mounted Holographic Display with Correct Depth-focusing for AR, Yuji Sakamoto[1]; [1]*Hokkaido Univ., Japan*. A compact and lightweight head-mounted holographic display based on computer-generated hologram for AR was developed. It shows 3D images at correct depth-focusing without fatigue by the depth difference with the gazing object.

FTu4C.3 • 16:00
Multi-SLM Holographic 3D Display of Real-world Holographic Data with Numerical Data Adaptation, Weronika Zaperty[1], Piotr L. Makowski[1], Tomasz Kozacki[1]; [1]*Warsaw Univ. of Technology, Poland*. We present color holographic imaging system, which data capture and reconstruction processes are characterized by different parameters. Necessary holographic content adaptation is performed numerically on the Fourier hologram basis.

FTu4C.4 • 16:15
Digital Degenerate Cavity Laser, Nir . Davidson[1], Chene Tradonsky[1], Ronen Chriki[1], Gilad Barach[1], Vishwa Pal[1], Asher Friesem[1]; [1]*Weizmann Inst. of Science, Israel*. A novel digital degenerate cavity laser allows computer controlled generation of arbitrary output intensity distributions, propagation invariance of the output distribution, and rapid all-optical solution of inverse scattering problems.

16:30-17:00 Environmental Sensing Technical Group Networking Event, *OSA Technical Group Booth, International Terrace, Terrace Level*

FiO

LS

15:00–16:30
FTu4D • Novel Phenomena in Photonic Devices

FTu4D.1 • 15:00 Invited
Ultra-sensitive Fiber Sensors using Structural Slow Light, Michel Digonnet[1]; [1]*Stanford Univ., USA*. Slow-light fiber Bragg gratings exhibit very narrow resonances that can be used to fabricate sensors with unprecedented resolutions. Their principles of operation and properties will be illustrated with strain, temperature, and acoustic sensors.

FTu4D.2 • 15:30
Material Loss Omits Nonlinearity in Optically Thick Materials, Boris Simkhovich[1], Guy Bartal[1]; [1]*Technion, Israel*. We show that Kerr-like nonlinearities may be omitted in lossy optically thick materials, resulting in underestimated Nonlinear effects. This indicates that Nonlinear characterization should be obtained in thin samples to avoid masking of the effect.

FTu4D.3 • 15:45
A new path to speckle by randomizing a vortex lattice, Argelia Balbuena Ortega[1], Santiago Lopez Huidobro[1], Freddy Jackson Poveda Cuevas[1], Laura Perez Garcia[1], Jorge Amin Seman Harutinian[1], Alejandro Vasquez Arzola[1], Karen Volke Sepulveda[1]; [1]*UNAM, Mexico*. In this work, we intend to establish a connection between the propagation of arrays of vortices, either ordered or random, and the emergence of speckle patterns. Experimental results are presented and compared with numerical simulations.

FTu4D.4 • 16:00
Self-Seeded Mid-Infrared Generation in Periodically-Poled Lithium Niobate Waveguides, Alexander Lind[1,2], Abijith S. Kowligy[1], Daniel D. Hickstein[1], David Carlson[1], Nima Nader[1], Henry Timmers[1], Erin Lamb[1], Gabe Ycas[1], Scott Papp[1], Scott Diddams[1,2]; [1]*National Inst. of Standards and Technology, USA;* [2]*Physics, Univ. of Colorado Boulder, USA*. We demonstrate a mid-infrared source, tunable from 4–5 μm, via cascaded $\chi^{(2)}$ supercontinuum generation and subsequent difference frequency generation (DFG) within a single lithium niobate waveguide.

FTu4D.5 • 16:15
Optical Isolation with Nonlinear Topological Photonics, Xin Zhou[1], You Wang[1], Daniel Leykam[1], Yidong Chong[1]; [1]*Nanyang Technological Univ., Singapore*. We present a theoretical study of optical isolation based on self-induced topological photonic edge states, occurring in nonlinear topological photonic structures such as 1D and 2D waveguide arrays and coupled-ring lattices.

15:00–16:30
FTu4E • Quantum Electronics in Automotive Sector
Presider: Thomas Gerrits; National Institute of Standards & Technology, USA

FTu4E.1 • 15:00
1060 nm HCG MEMS-VCSEL with 73 nm Tuning Range, Kevin T. Cook[1], Pengfei Qiao[1], Connie J. Chang-Hasnain[1]; [1]*Electrical Engineering and Computer Sciences, Univ. of California, Berkeley, USA*. We present a MEMS-actuated, high-contrast grating VCSEL operating at 1060 nm with a 73 nm tuning range. The tuning range ratio (Δλ/λ) of 6.9% is the highest for an electrically pumped laser, to the best of our knowledge.

FTu4E.2 • 15:15
Toward a Multi-Species Gas Sensor on a Chip, Afshin Shamsshooli[1], Chen Zhang[1], Yonghao Liu[1], Prithviraj Palit[1], Yuze A. Sun[1], Michael Vasilyev[1]; [1]*Univ. of Texas at Arlington, USA*. We demonstrate on-chip implementation of an optically accessible gas expansion chamber for a gas sensing system combining micro-gas-chromatography with optical spectroscopy. Acetylene traces are reliably detected in a 1-cm-long chamber.

FTu4E.3 • 15:30 Invited
Laser-based measurements of combustion engines– inside and outside., Paul Ewart[1], Ben Williams[1]; [1]*Univ. of Oxford, UK*. The development of linear and non-linear optical techniques for high precision measurements of combustion in internal combustion engines is described for applications in design of future fuels, increased engine efficiency and reduced emissions.

FTu4E.4 • 16:00 Invited
Automotive LiDAR: Challenges and Opportunities, Lute Maleki[1,2]; [1]*OEwaves Inc, USA;* [2]*Strobe, Inc., USA*. LiDAR is being used for development of autonomous vehicles. The current technology, however, does not meet the required performance for full autonomous operation. In this paper a demonstrated approach achieving this objective will be discussed.

15:00–16:30
LTu4F • High Harmonic Sources and Applications
Presider: Robert Baker; The Ohio State University, USA

LTu4F.1 • 15:00 Invited
New Generation Attosecond X-ray Light Sources, Zenghu Chang[1]; [1]*CREOL and Physics, Univ. of Central Florida, USA*. Isolated X-ray pulses as short as 53 as with photon energy reaching the carbon K-edge were generated by sub-cycle gating. The X-ray sources is driven by a carrier-envelope phase stable laser centered at 1.7 mm.

LTu4F.2 • 15:30
High-harmonic generation in solids using a mid-infrared sub-cycle pulse synthesizer, Kyung-Han Hong[1], Zhou Wang[2], Tobias Kroh[1,3], Hyunwook Park[2], Krogen Peter[1], Houkun Linag[1], Louis DiMauro[2], Franz X. Kärtner[1,3]; [1]*MIT, USA;* [2]*Physics, Ohio State Univ., USA;* [3]*CFEL, DESY, Germany.* We generate high harmonics in Si using a mid-infrared (2.5-9.0 μm) pulse synthesizer. Even and odd harmonics (19th order) with few-cycle pulses and near-continuous spectra with sub-cycle pulses, indicating an isolated harmonic emission, are observed.

LTu4F.3 • 15:45 Invited
Attosecond Dynamics without Dipole Approximation, Ursula Keller[1]; [1]*ETH Zurich, Switzerland*. To honor Louis DiMauro's 2017 APS Schawlow Prize we will review our recent work on ionization and rescattering in strong mid-infrared laser fields in the non-dipole regime over the full range of polarization ellipticity.

LTu4F.4 • 16:15
Electronic structure and ultrafast charge carrier dynamics of Zn clusters supported on a Si(100) surface, Mihai E. Vaida[1], Brett M. Marsh[2], Bethany Lamoureux[2], Stephen Leone[4,3]; [1]*Dept. of Physics, Univ. of Central Florida, USA;* [2]*Dept. of Chemistry, Univ. of California, USA;* [3]*Lawrence Berkeley National Lab, USA;* [4]*Dept.s of Chemistry and Physics, Univ. of California, USA*. Femtosecond XUV photoemission spectroscopy is employed to monitor the non-metal to metal transition in Zn clusters grown on p-Si(100) as well as the ultrafast charge migration, trapping, and recombination at the surface.

16:30-17:00 Environmental Sensing Technical Group Networking Event, *OSA Technical Group Booth, International Terrace, Terrace Level*

16:45–18:15
FTu5A • Pulse and Comb Sources

FTu5A.1 • 16:45 Invited

Soliton Microcomb Physics and Applications, Kerry Vahala[1]; [1]*Caltech, USA*. The physics of dissipative Kerr solitons in high-Q micro cavities is reviewed including discussion of Raman effects and counter-propagating soliton behavior.

FTu5A.2 • 17:15

Soliton Mitosis Across a Zero-Nonlinearity Wavelength in Photonic Crystal Fibers, Francisco Rodrigo Arteaga Sierra[1], Aku Antikainen[1], Govind P. Agrawal[1]; [1]*Univ. of Rochester, Mexico*. We show numerically the splitting of a single fundamental soliton into two copropagating solitons across the zero-nonlinearity wavelength through femtosecond pumping of a photonic crystal fiber with frequency-dependent nonlinearity.

FTu5A.3 • 17:30

Multispectral optical frequency comb based on microresonator Faraday instability, Shu-Wei Huang[1], Abhinav K. Vinod[1], Jinghui Yang[1], Mingbin Yu[2], Dim-Lee Kwong[2], Chee Wei Wong[1]; [1]*Univ. of California Los Angeles, USA;* [2]*Inst. of Microelectronics, Singapore*. We demonstrate a new type of microresonator frequency comb where the momentum conservation law is fulfilled by azimuthal modulation of the waveguide dispersion. The concept expands the parametric range in which Kerr comb is obtained.

FTu5A.4 • 17:45

Stability Evaluation of Passively Q-switched Erbium Doped Fiber Laser based on Double and Multi-Walled Carbon Nanotubes, A. Hadi Al-Janabi[1], Dunya Z. Mohammed[1]; [1]*Inst. of Laser for Postgraduate Studies, Iraq*. The stability of Q-switched erbium-doped fiber laser using double and multi -walled carbon nanotubes (DWCNTs and MWCNTs) saturable absorbers (SAs) has been investigated. DWCNTs SA showed better stability than MWCNTs SA at the proposed concentration.

FTu5A.5 • 18:00

Greatly Enhanced Absorption in Weakly-Doped Fibers through Coherent Perfect Absorption, Ali Kazemi Jahromi[1], Ayman Abouraddy[1]; [1]*Univ. of Central Florida, CREOL, USA*. We experimentally show that coherent perfect absorption is achievable in a few-centimeter-long moderately-doped fiber, and prove the CPA is best configuration to get a uniform absorption per unit length of the absorbing medium.

16:45–18:15
FTu5B • Advanced Imaging and Interactions with Materials

Presider: Sile Nic Chormaic; Okinawa Institute of Science & Technology, Japan

FTu5B.1 • 16:45 Invited

Dispersion mapping for tissue differentiation in optical coherence tomography, Frederique Vanholsbeeck[1,2]; [1]*Univ. of Auckland, New Zealand;* [2]*Dodd-Walls centre for photonics and quantum technologies, New Zealand*. We compare the techniques such as fractional Fourier transform or multiband OCT we have used to map chromatic dispersion in tissues using OCT dataset.

FTu5B.2 • 17:15

Systematic Refractive Index Control in DNA Solid Thin Films by DNA-Denaturation Process, Hayong H. Jeong[1], Bjorn Paulson[1], Seongjin Hong[1], Seunguk Cheon[1], Kyunghwan Oh[1]; [1]*Dept. of Physics in Yonsei Univ., South Korea*. Denaturation process to unchain double-strand (ds) DNAs into single-strand (ss) DNAs was experimentally found to systematically control the refractive index of spin-coated DNA thin solid films.

FTu5B.3 • 17:30

Two-Photon Polymerization of Biocompatible Hydrogels, Haibo Ding[1,2], Qiming Zhang[1], Zhongze Gu[2], Min Gu[1]; [1]*School of Science, RMIT Univ., Australia;* [2]*School of Biological and Medical Engineering, Southeast Univ., China*. We demonstrate a common UV photoinitiator with a two-photon absorption cross-section of 4.5 GM in the wavelength of 535 nm. Three-dimensional microstructured scaffolds could be achieved with two-photon polymerization of biocompatible hydrogels.

FTu5B.4 • 17:45

Visible spectrum luminescence of nanolayered erbium doped ZnO and TiO_2, Arslan Anjum[1], Elangovan Elamurugu[1], Jaime P. Viegas[1]; [1]*ECE - Masdar Inst., Khalifa Univ., United Arab Emirates*. Visible luminescence of erbium doped ZnO / TiO_2 thin films deposited by magnetron sputtering is presented. Through adjustment of deposition rates and layer thickness, doping concentration can be tailored with observable effect on photoluminescence.

FTu5B.5 • 18:00

Two-Photon Absorption Spectroscopy in $CuInS_2$ (Cis) Quantum Dots For Bio-Imaging, Gabriel Nagamine[1], Hunter McDaniel[2], Carlos Henrique Brito Cruz[1], Lázaro Padilha[1]; [1]*UNICAMP, Brazil;* [2]*UbiQD, USA*. We study two-photon absorption in $CuInS_2$ quantum dots. We show that the maximum two-photon absorption cross-section strongly dependents on quantum-confinement, and that the material is a promising candidate as label for multi-photon bio-imaging.

16:45–18:15
FTu5C • Real-time Optical Guidance of Cancer Therapy

Presider: David Busch; University of Pennsylvania Children's Hospital of Philadelphia, USA

FTu5C.1 • 16:45 Invited

Real-time quantitative optical imaging for surgery, Sylvain Gioux[1,2], Joseph Angelo[3]; [1]*Universite de Strasbourg, France;* [2]*Harvard Medical School, USA;* [3]*National Inst. of Standards and Technology, USA*. There currently exist no tools to effectively assist healthcare professionals during surgery. In this presentation we will review our efforts to provide real-time, wide-field & quantitative optical imaging for surgical applications.

FTu5C.2 • 17:15

Fast Multispectral Fluorescence Lifetime Rigid Endoscope for Screening of Skin Lesions, Ramon G. Rosa[1], Sebastião Pratavieira[1], Javier Jo[2], Cristina Kurachi[1]; [1]*Sao Carlos Inst. of Physics, Univ. of Sao Paulo, Brazil;* [2]*Dept. of Biomedical Engineering, Texas A&M Univ., USA*. The development of a fast multispectral fluorescence lifetime rigid endoscope for *in vivo* imaging is reported. Our preliminary results show the potential to identify precisely the borders of human skin lesions.

FTu5C.3 • 17:30

Quantitative characterization for identification of brain cancer surgical margin using resonance Raman spectroscopy, Yan Zhou[2], Cheng-hui Liu[1], Binlin Wu[3], Xinguang Yu[4], Gangge Cheng[2], Chunyuan Zhang[1], Robert R. Alfano[1]; [1]*CUNY City College, USA;* [2]*Air Force General Hospital, China;* [3]*Southern Connecticut State Univ., USA;* [4]*PLA General Hospital, China*. A new criterion was developed to characterize brain tissue using resonance Raman spectroscopy, by which, negative margins of cancer can be differentiated from normal tissues. This method may help a surgeon better decide surgical margins.

FTu5C.4 • 17:45

***In Vivo* Diagnostics of Malignant and Benign Tumors with Low-Cost Raman Spectrometer,** Julia Khristoforova[1], Ivan Bratchenko[1], Dmitry Artemyev[1], Oleg Myakinin[1], Alexandr Moryatov[2], Oleg Kaganov[2], Sergey Kozlov[2], Valery Zakharov[1]; [1]*Samara Univ., Russia;* [2]*Samara State Medical Univ., Russia*. A method for malignant skin tumors diagnostics based on the combination of Raman spectroscopy and autofluorescence analysis is proposed. Multivariate analysis of spectral data demonstrated 98.4% accuracy of malignant and benign tumors classification.

FTu5C.5 • 18:00

Second-harmonic Patterned Polarization-Analyzed Reflection Confocal Microscopy of Collagen, Chukwuemeka Okoro[1], Kimani Toussaint[1]; [1]*Univ. of Illinois Urbana-Champaign, USA*. Polarization analysis of images obtained by combining confocal microscopy with a second-harmonic mask permits traditional polarimetric metrics to be adapted to collagen imaging. This approach applies to any nonlinear scattering imaging technique.

16:30–16:45 Break

17:30–18:15 OSA Annual Business Meeting, *Kalorama, Lobby Level*

17:30–18:30 APS Division of Laser Science Annual Business Meeting, *Holmead East, Lobby Level*

18:30–20:30 FiO + LS Conference Reception, *International Ballroom Center, Terrace Level*

FiO | LS

16:45–18:15
FTu5D • Nanophotonic Systems
Presider: Yoshio Hayasaki; Utsunomiya University, Japan

FTu5D.1 • 16:45 Invited
3D Nanophotonic Systems for Biosensing and Integrated Photonics, Euan McLeod[1]; [1]*Univ. of Arizona, USA.* Three-dimensional nanophotonic systems assembled from soft materials such as liquids, polymers, and colloids can enable sensitive and high-throughput biosensing, as well as compact and efficient integrated photonics components.

FTu5D.2 • 17:15
Three-dimensional Direct Laser Writing of Neuron-inspired Structures, Haoyi Yu[1], Qiming Zhang [1], Zengji Yue [1], Min Gu[1]; [1]*RMIT Univ., Australia.* We propose the use of three-dimensional direct laser writing to create neuron-inspired structures. The experimental realization of neuron-inspired structures 10 times smaller than biological neurons is achieved using two-photon direct laser writing.

FTu5D.3 • 17:30
Concave Grating Enabled Compact Mid-IR Upconversion Spectrometer, Ajanta Barh[1], Peter Tidemand-Lichtenberg[1], Christian Pedersen[1]; [1]*Technical Univ. of Denmark (DTU), Denmark.* The paper demonstrates a wide-band (3.6 – 4.8 μm) compact mid-infrared grating spectrometer combining a nonlinear frequency upconversion process and a flat-field aberration corrected concave grating with overall system dimension of 25cm×50cm.

FTu5D.4 • 17:45
Low loss 19-cell hollow core photonic bandgap fiber as transmission medium for mode division multiplexed system, Olena Muliar[1], Mario Usuga Castaneda[1], Karsten Rottwitt[1], Jesper Lægsgaard[1]; [1]*Technical Univ. of Denmark, Denmark.* We investigated and simulated the modal content of 19-cell hollow core photonic bandgap fiber (19-cell HC PBGF) with anti-resonant elements and low loss region for the fundamental mode around 1550nm.

FTu5D.5 • 18:00
Broadband metasurface for chiral phase control, Gun-Yeal Lee[1], Jangwoon Sung[1], Byoungho . Lee[1]; [1]*Seoul National Univ., South Korea.* We report a novel metasurface that controls the spatial phase distributions of light and switches them by using chirality of incident light, which can be applied to chiral imaging and chiral control of optical beams.

16:45–18:15
FTu5E • Quantum Measurement and Sensors
Presider: Lute Maleki; OEwaves Inc, USA

FTu5E.1 • 16:45 Invited
New detectors and advanced electronics for quantum-based technologies, Rik van Gorsel[1]; [1]*Boston Electronics Corp., USA.* No Abstract Provided

FTu5E.2 • 17:15
Quantum Metrology in the Joint Measurement of Multiple Parameters Encoded in Non-Commuting Observables with SU(1,1) Interferometer, Yuhong Liu[1], Jiamin Li[1], Xiaoying Li[1], Zhe-Yu . Ou[2], Syed M. Assad[3]; [1]*Tianjin Univ., China;* [2]*Indiana Univ.-Purdue Univ. Indianapolis, USA;* [3]*The Australian National Univ., Australia.* Joint measurement of phase and amplitude modulations on a probe field is performed with an SU(1,1) interferometer. Signal-to-noise ratios in the joint measurement simultaneously beat the classical limit by 1dB.

FTu5E.3 • 17:30
Quantum position measurement of a shadow: beating the classical limit, Ermes Toninelli[1], Matthew P. Edgar[1], Paul-Antoine Moreau[1], Graham M. Gibson[1], Giles D. Hammond[1], Miles J. Padgett[1]; [1]*School of Physics & Astronomy, Univ. of Glasgow, UK.* The precision with which the position of a shadow can be measured is classically limited by shot-noise. We achieve sub-shot-noise position sensitivity by jointly detecting correlated photons with a simple split-detector scheme.

FTu5E.4 • 17:45 Invited
High-efficiency Superconducting Detectors and Their Applications in Quantum Optics, Thomas Gerrits[1]; [1]*NIST, USA.* High efficiency single-photon detection resides at the heart of many quantum information applications. Our efforts towards high efficiency, fast single photon detectors, and their range of applications and impacts in quantum optics will be discussed.

16:45–18:15
LTu5F • Applications of Ultrafast X-rays
Presider: Mihai Vaida; University of Central Florida, USA

LTu5F.1 • 16:45 Invited
Probing Electron Delocalization with Femtosecond X-ray Spectroscopy, Munira Khalil[1]; [1]*Univ. of Washington, USA.* Uisng femtosecond X-ray spectroscopy and multidimensional vibrational-electronic spectroscopies we will probe the electronic delocalization and vibronic coupling in a mixed valence transition metal complex dissolved in water.

LTu5F.2 • 17:15
Nonlinear optical signals and spectroscopy with quantum light and in microcavitites, Shaul Mukamel[1], Konstantin Dorfman[1], Markus Kowalewski[1], Kochise Bennett[1], Frank Schlawin[1]; [1]*Univ. of California Irvine, USA.* Nonlinear optical signals induced by quantized light fields and entangled photon pairs are presented. Different signals, and photon counting setups are discussed and illustrated for molecular model systems.

LTu5F.3 • 17:30 Invited
Femtosecond Time-resolved X-ray Absorption Spectroscopy of Liquids Using the SPring-8 Angstrom Compact Free-Electron Laser (SACLA, Kazuhiko Misawa[1,2]; [1]*Dept of Applied Physics, Tokyo Univ of Agriculture and Technology, Japan;* [2]*Inst. of Global Innovation Research, Tokyo Univ of Agriculture and Technology, Japan.* We present time-resolved X-ray absorption spectroscopy of ammonium iron(III) oxalate trihydrate and anatase TiO_2 nanoparticles in aqueous solutions using an X-ray free electron laser in combination with a synchronized ultraviolet femtosecond laser.

LTu5F.4 • 18:00
Achieving Surface Sensitivity in Ultrafast XUV Spectroscopy: $M_{2,3}$-edge Reflection-Absorption of Transition Metal Oxides, Robert Baker[1], Anthony Cirri[1], Jakub Husek[1], Somnath Biswas[1]; [1]*Chemistry & Biochemistry, The Ohio State Univ., USA.* We have developed near grazing angle XUV reflection-absorption (RA) spectroscopy to study ultrafast carrier dynamics at surfaces and provide a general method for interpreting XUV RA spectra that quantitatively accounts for surface morphology.

16:30–16:45 Break

17:30–18:15 OSA Annual Business Meeting, *Kalorama, Lobby Level*

17:30–18:30 APS Division of Laser Science Annual Business Meeting, *Holmead East, Lobby Level*

18:30–20:30 FiO + LS Conference Reception, *International Ballroom Center, Terrace Level*

07:30–17:30 Registration, *Concourse Foyer*

08:00–08:45 FW1A • Visionary Speaker: Evelyn Hu, *International Ballroom West*
FW1B • Visionary Speaker: Wilhelm Kaenders, *International Ballroom East*
LW1C • Visionary Speaker: James K. Thompson, *Jefferson East*

08:45–09:00 Break

09:00–10:00
FW2A • Quantum Communications

FW2A.1 • 09:00
Simultaneous high-contrast switching and high-efficiency routing for spontaneous emission, He Hao[1], Juanjuan Ren[1], Xue k. Duan[1], Iam Choon Khoo[2], Guowei Lu[1], Ying Gu[1], Qihuang Gong[1]; *[1]Peking Univ., China; [2]Pennsylvania state Univ., USA.* We theoretically demonstrated a high contrast switching of spontaneous emissionas well as high efficient routing photons enabled by liquid crystal tuned gap surface plasmons.

FW2A.2 • 09:15
Lattice Dislocation in a Photonic Weak Topological Insulator with a Synthetic Frequency Dimension, Qian Lin[1], Xiaoqi Sun[1], Meng Xiao[1], Shanhui Fan[1]; *[1]Stanford Univ., USA.* We propose realization of photonic 3D topological insulator in a 2D ring array with a synthetic dimension, and show that with dynamic modulating we can create a screw dislocation that supports protected one-way state localized on the dislocation.

FW2A.3 • 09:30 Invited
New Color Centers in Diamond for Long Distance Quantum Communication, Nathalie de Leon[1]; *[1]Princeton Univ., USA.* We have developed new methods to stabilize SiV^0 in diamond, and observe T_1 approaching 1 minute at 4K, and >90% of its emission into its zero phonon line, making it a promising single atom quantum memory.

09:00–10:00
FW2B • Trapping and Shaping of Light
Presider: Carlos Lopez-Mariscal; Underwater Photonics, Mexico

FW2B.1 • 09:00
Nonlinearity-induced spectral lattice with optically tunable long-range complex hopping, Bryn Bell[1], Kai Wang[2], Alexander S. Solntsev[2], Dragomir N. Neshev[2], Andrey A. Sukhorukov[2], Benjamin Eggleton[1]; *[1]Centre for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS), School of Physics, Univ. of Sydney, Australia; [2]Nonlinear Physics Centre, Research School of Physics and Engineering, The Australian National Univ., Australia.* We suggest and realize quantum walks on a spectral photonic lattice with optically tunable long-range and complex hopping facilitated by nonlinear interactions, enabling asymmetric frequency shaping and Talbot effect with arbitrary periodicity.

FW2B.2 • 09:15
Direct generation of tunable optical vortex dipole beams using a Gaussian beam pumped optical parametric oscillator, Varun Sharma[1,2], Aadhi A[1], Goutam K Samanta[1]; *[1]PRL Ahmedabad, India; [2]Physics, IIT Gandhinagar, India.* We report on tunable optical vortex dipole source based on an optical parametric oscillator (OPO) pumped with Gaussian beam. Pumped in the green, the source produces vortex dipole tunable across the wavelength range 968-1181 nm.

FW2B.3 • 09:30 Invited
Advanced Optical Trapping of Ultracold Atoms for Studying Superfluid Transport and Turbulence, Tyler W. Neely[1,2], Guillaume Gauthier[1,2], Stuart Szgeti[1,2], Thomas Bell[1,2], Mark Baker[1], Matthew J. Davis[1], Halina . Rubinsztein-Dunlop[1,2]; *[1]Univ. of Queensland, Australia; [2]ARC Centre of Excellence for Engineered Quantum Systems, Univ. of Queensland, Australia.* We utilise direct-imaging of a digital micromirror device to create binary and optimised optical potentials for the trapping and manipulation of atomic Bose-Einstein condensates. Studies of a superfluid circuit and quantum turbulence are described.

09:00–10:00
FW2C • Optics in Computing and Imaging
Presider: Jae-Hyeung Park; Inha Univ., South Korea

FW2C.1 • 09:00 Invited
Deep Learning Optical Devices and Architectures, Kelvin H. Wagner[1]; *[1]Univ. of Colorado Boulder, USA.* A rectifying linear unit implemented as a bidiectional switch along with convolutional layers using lenslet arrays and thick Fourier holograms allows the implemention of Deep Neural Networks in a self-aligning multilayer optical neural network.

FW2C.2 • 09:30
Fused phase image obtained from frequency comb profilometer and optical interferometer, Yoshio Hayasaki[1], Quang D. Pham[1]; *[1]Utsunomiya Univ., Japan.* Phase images obtained in the radio frequency and optical frequency ranges, whose difference was about 4×10^5, were combined on the basis of a pattern matching method.

FW2C.3 • 09:45
Quantitative Phase Imaging by Evanescent Wave Microscopy, biagio mandracchia[1], Melania Paturzo[1], Pietro Ferraro[1]; *[1]Inst. for Applied Sciences and Intelligent Systems, Italian National Research Council, Italy.* Here we show the versatility of Digital Holography Microscopy for the development of innovative systems for quantitative phase imaging of Total Internal Reflection.

10:00–10:30 Coffee Break, *Science & Industry Showcase, Columbia, Terrace Level*

10:00–12:00 JW3A • Science & Industry Showcase
Exhibits, Poster Session & E-Posters
Rapid-Fire Oral Presentations III in Theater
Columbia, Terrace Level

07:30–17:30 Registration, *Concourse Foyer*

08:00–08:45 FW1A • Visionary Speaker: Evelyn Hu, *International Ballroom West*
FW1B • Visionary Speaker: Wilhelm Kaenders, *International Ballroom East*
LW1C • Visionary Speaker: James K. Thompson, *Jefferson East*

08:45–09:00 Break

09:00–10:00
FW2D • Advocacy Session
Science Policy talk by Rush Holt, CEO of AAAS and former U.S. member of Congress

At a time when there are widespread concerns about the place of science in our society and government, we should consider: What is the obligation of a scientist, engineer, or technologist to policymakers? Sometimes, we simply disparage the ill-founded pronouncements of politicians, decisions producing inadequate funding for research, or regulations hampering research, when instead we might ask what we can do to help avoid such short-sighted actions.

09:00–10:00
FW2E • Precision Measurement Using Laser-Atom Interactions
Presider: Virginia Lorenz; University of Illinois, USA

FW2E.1 • 09:00
Sub-nano-Tesla, Shield-less, Field Compensation-Free Optical Wave Mixing Magnetometry for Bio-magnetism, Lu Deng[1], Yvonne L. Li[2], Feng Zhou[1,3], Eric Y. Zhu[1], Edward W. Hagley[1]; *[1]NIST, USA; [2]Dept. of Medical Oncology, Dana-Farber Cancer Inst., Harvard Medical School, USA; [3]Dept. of Physics, Huazhong Univ. of Science and Technology, China*. We report an optical wave-mixing-enhanced Zeeman-coherence atomic magnetometry scheme that results in sub-nT magnetic field detection at human-body temperatures without magnetic field shielding, zero-field compensation, or RF-modulation spectroscopy.

FW2E.2 • 09:15
Multiaxis, Single-Laser Atom Interferometer for Inertial Sensing, Xuejian Wu[1], Jordan Dudley[1], Fei Zi[1,2], Holger Müller[1]; *[1]Univ. of California, Berkeley, USA; [2]Zhejiang Univ., China*. We demonstrate a multiaxis atom interferometer based on a pyramidal magneto-optical trap and one diode laser. Being simple and capable of multiaxis operation, our atomic sensor opens up applications in geodesy, geology, or inertial navigation.

FW2E.3 • 09:30 Invited
Precision Inertial Measurements with Cold Atom Interferometers, Remi Geiger[1], Bess Fang[1], Denis Savoie[1], Matteo Altorio[1], Nicolas Mielec[1], almazbek imanaliev[1], romain karcher[1], Carlos Garrido Alzar[1], Sébastien Merlet[1], Franck Pereira Dos Santos[1], Arnaud Landragin[1]; *[1]LNE-SYRTE, Observatoire de Paris, PSL Research Univ., CNRS, Sorbonne Universités, UPMC Univ. Paris 06, France*. This talk will describe the principle of cold atom interferometers and review some recent results in the field of precision inertial measurements. It will present different applications in basic science and related to industrial developments.

09:00–10:00
LW2F • Nanophotonics II
Presider: Gary Wiederrecht; Argonne National Lab, USA

LW2F.1 • 09:00 Invited
Plasmon-empowered Single-photon Sources, Sergey I. Bozhevolnyi[1]; *[1]Univ. of Southern Denmark, Denmark*. Coupling of quantum emitters to localized and propagating surface plasmons is considered from the viewpoint of enhancing spontaneous emission rates, revealing advantages of plasmon-based configurations as compared to purely dielectric structures.

LW2F.2 • 09:30
High-repetition-rate, Nanosecond, Self-Q-switched Cr,Nd:YAG Microchip Laser for Stable Vortex Beam, Jun Dong[1], Hongsen He[1]; *[1]Xiamen Univ., China*. Stable vortex beams have been generated in a self-Q-switched Cr,Nd:YAG microchip laser with the pulse width of 8.5 ns and repetition rate of 113 kHz. The lasing threshold for optical vortex is just 1.2 W.

LW2F.3 • 09:45
Optically indcued alignement of gold nanorods and dichroism in plasmonic nanosuspesnions, Pepito Bustos Alvaro[1], Trevor Kelly[1], Yu-xuan Ren[1], HUIZHONG Xu[1], Zhigang Chen[1,2]; *[1]San Francisco State Univ., USA; [2]Nankai Univ, China*. We demonstrate soliton-mediated, polarization-dependent alignment of gold nanorods in colloidal suspensions. We discuss orientation-enhanced dichroism due to disorder-to-order transition of nanorods resulting from the torque exerted by soliton beam.

10:00–10:30 Coffee Break, *Science & Industry Showcase, Columbia, Terrace Level*

10:00–12:00 JW3A • Science & Industry Showcase
Exhibits, Poster Session & E-Posters
Rapid-Fire Oral Presentations III in Theater
Columbia, Terrace Level

Science Showcase Theater

JOINT FiO + LS

10:00–11:00
JW3A • Rapid-Fire Oral Presentations III

JW3A.19 • 10:00 *RAPID*
Nonlinear Coupled Mode Equations for Kerr Comb Generation in Coupled Microcavity System, Shun Fujii[1], Yusuke Okabe[1], Takumi Kato[1], Ryo Suzuki[1], Atsuhiro Hori[1], Takasumi Tanabe[1]; [1]*Keio Univ., Japan.* We performed a rigorous numerical simulation of Kerr comb generation with nonlinear coupled mode equations including mode coupling between two different mode families. The calculated results agree well with experimental results.

JW3A.20 • 10:05 *RAPID*
Controllable photon quantum state generation in multimode optical fibers, Hamed Pourbeyram[1], Arash Mafi[1]; [1]*Univ. of New Mexico, USA.* We present the multimode optical fiber as a robust and practical platform to manipulate and control the quantum state of light using various linear and nonlinear mechanisms.

JW3A.34 • 10:10 *RAPID*
Temporal Amplitude & Phase: Algorithmic Reconstruction via Time-domain Interferometry (TeAPARTI), Joseph H. Munns[2,1], Sang Park[1], Benjamin Brecht[1], Ian A. Walmsley[1]; [1]*Univ. of Oxford, UK;* [2]*Imperial College London, UK.* We introduce a novel protocol for the complex characterisation of nanosecond duration pulses -- TeAPARTI -- and apply it to different test pulses. In all cases, the reconstructed intensity and phase profiles agree very well with the target pulses.

JW3A.35 • 10:15 *RAPID*
Influence of Counterpropagating Light on Phase Matching in Second Harmonic Generation, Amy L. Lytle[1], Thomas Lehman-Borer[1], Etienne Gagnon[1]; [1]*Franklin & Marshall College, USA.* Experimental and numerical results verify the influence of counterpropagating light on phase matching of SHG, enhancing conversion efficiency by up to 20%, toward understanding and implementation of an all-optical method for quasi-phase matching.

JW3A.75 • 10:20 *RAPID*
Differential Polarisation-sensitive Photodetectors Design Utilising Plasmonic Metasurfaces, Evgeniy Panchenko[1], Jasper J. Cadusch[1], Timothy D. James[1], Lukas Wesemann[1], Ann Roberts[1]; [1]*The Univ. of Melbourne, Australia.* We propose and demonstrate a CMOS compatible plasmonic antenna-based differential photodetector. Our design permits using differential detection techniques in telecommunication systems potentially significantly increasing the data transmission rate.

JW3A.76 • 10:25 *RAPID*
Bio-sensing with asymmetric THz metasurfaces, Joshua Burrow[1], Thomas Searles[2], Imad Agha[1,3], Jay Mathews[3,1]; [1]*Electro-Optics and Photonics, Univ. of Dayton, USA;* [2]*Physics & Astronomy, Howard Univ., USA;* [3]*Physics, Univ. of Dayton, USA.* We demonstrate an asymmetric 4-gap square ring resonator terahertz (THz) metasurface as an ultra-sensitive biological sensor. Polarization-insensitive modes due to asymmetry exhibit low minimal detectable concentration of bovine serum albumin.

JW3A.77 • 10:30 *RAPID*
Plasmonic Filter Arrays for Infrared Spectral Reconstruction, Benjamin Craig[1], Kenneth B. Crozier[1]; [1]*Univ. of Melbourne, Australia.* We experimentally demonstrate an array of plasmonic infrared transmission filters. We show, by simulations that include noise, reconstruction of the spectra of infared light sources from measurements of the energy transmitted through each filter.

JW3A.80 • 10:35 *RAPID*
Planar Optics with High Numerical Apertures at Visible Wavelengths, Wei-Ting Chen[1], Alexander Zhu[1], Mohammadreza Khorasaninejad[1], Zhujun Shi[1], Federico Capasso[1]; [1]*Harvard Univ., USA.* We report high numerical aperture planar optics using metasurfaces. Meta-axicons and immersion meta-lenses with numerical apertures up to 1.1 are demonstrated; they can generate wavelength-independent Bessel beams and diffraction-limited focal spots.

10:00–12:00
JW3A • Joint Poster Session III

JW3A.1 *E-Poster*
Colossal Bunching in Nanodiamond Cathodoluminescence, Matthew A. Feldman[1,2], Roderick Davidson[1,2], Jordan Hachtel[1,2], Eugene Dumitrescu[2], Raphael Pooser[2], Anming Hu[3], Denzel Bridges[3], Phil Evans[2], Richard Haglund[1], Benjamin Lawrie[2]; *[1]Dept. of Physics and Astronomy, Vanderbilt Univ., USA; [2]Oak Ridge National Lab, USA; [3]Dept. of Mechanical, Aerospace and Biomedical Engineering, Univ. of Tennessee, USA*. Photon bunching with g(2)(0)>30 was observed in cathodoluminescence from nanodiamond particles coupled to Ag surface-plasmon polaritons. Comparisons with the photon bunching of diamond nanoparticles point to Ag-plasmon-mediated decoherence processes.

JW3A.2 *E-Poster*
Photonic transport in disordered multiqubit non-chiral waveguide QED., Imran M. Mirza[1]; *[1]Univ. of Michigan , USA*. We study photon transport in one-dimensional waveguide side coupled to a position disordered multiqubit array. Particularly, we show how emitter-waveguide coupling influences the formation of localized photonic states under varying disorder strength.

JW3A.3 *E-Poster*
Quantum tomography with all-dielectric metasurfaces, Kai Wang[1], Sergey S. Kruk[1], Lei Xu[1,2], Matthew Parry[1], Hung-Pin Chung[1,3], James Titchener[1], Ivan Kravchenko[4], Yen-Hung Chen[3], Alexander S. Solntsev[1], Yuri S. Kivshar[1], Dragomir N. Neshev[1], Andrey A. Sukhorukov[1]; *[1]Nonlinear Physics Centre, Research School of Physics and Engineering, The Australian National Univ., Australia; [2]The MOE Key Lab of Weak Light Nonlinear Photonics, School of Physics and TEDA Applied Physics Inst., Nankai Univ., China; [3]Dept. of Optics and Photonics, National Central Univ., Taiwan; [4]Center for Nanophase Materials Sciences, Oak Ridge National Lab, USA*. We suggest and realize experimentally dielectric metasurfaces with high transmission efficiency for quantum multi-photon tomography, allowing for full reconstruction of pure or mixed quantum polarization states across a broad bandwidth.

JW3A.5 *E-Poster*
Frequency comb manipulation by photonic gauge potentials, Chengzhi Qin[1], Bing Wang[1], Peixiang Lu[1]; *[1]Huazhong Univ of Science and Technology, China*. We experimentally demonstrate photonic gauge potential in frequency dimension based on electro-optic phase modulators. The gauge potentials can be used to manipulate frequency comb evolution, leading to spectral shift and bandwidth expansion.

JW3A.6 *E-Poster*
Ultrafast Insulator-Metal Transition in Strained Vanadium Dioxide Films, Ryan J. Suess[1], Nicholas S. Bingham[2], Kristin Charipar[3], Heungsoo Kim[3], Scott Mathews[3], Alberto Pique[3], Nicholas Charipar[3]; *[1]Nova Research, Inc., U.S. Naval Research Lab, USA; [2]National Research Council Research Associate, U.S. Naval Research Lab, USA; [3]U.S. Naval Research Lab, USA*. Strained VO_2 films are characterized by optoelectronic autocorrelation measurements that reveal a material response of 400 fs. This suggests the insulator-metal transition in strained VO_2 can be activated by electronic, rather than thermal, means.

JW3A.7 *E-Poster*
Single Peaked Optical Ramsey Interference with Repeated Query Interrogation, Zachary Warren[1], Renu Tripathi[1], Gour S. Pati[1]; *[1]Delaware State Univ., USA*. In this paper, we have proposed a repeated query technique as a new interrogation method for acquiring Ramsey interference fringes with enhanced central fringe and suppressed side fringes.

JW3A.9 *E-Poster*
Broadband Near Infrared Supercontinuum for Z-Scan Nonlinear Spectrometer, Natalia Múnera[2,1], Peng Zhao[2], Rodrigo Acuna Herrera[1], David J. Hagan[2], Eric W. Van Stryland[2]; *[1]Escuela de Fisica, Universidad Nacional de Colombia Medellin, Colombia; [2]CREOL, Univ. Of Central Florida, USA*. High-spectral-irradiance infrared supercontinuum with fundamental gaussian spatial profile was generated in Krypton gases. We demonstrate its usefulness for Z-scan nonlinear spectroscopy in the 800-1600nm spectral range using GaAs and CS_2.

JW3A.10 *E-Poster*
Plasmonic sensing beyond the shot noise limit, Ashok Kumar[1], Mohammadjavad Dowran[1], Benjamin Lawrie[2], Raphael Pooser[2], Alberto Marino[1]; *[1]Univ. of Oklahoma, USA; [2]Oak Ridge National Lab, USA*. We demonstrate a sensitivity enhancement of plasmonic sensors by a factor of 1.6 beyond the shot noise limit using quantum states of light. Our results show the potential to enhance the sensitivity of real-life devices.

JW3A.4
Spectrally Multiplexed Upconversion Single-Photon Detection with C-band Pump and Signal Wavelengths, Michael L. Silver[1], Vesselin Velev[1], Carsten Langrock[2], Martin Fejer[2], Prem Kumar[1], Gregory Kanter[1]; *[1]Northwestern Univ., USA; [2]Stanford Univ., USA*. We demonstrate low noise, spectrally multiplexed, upconversion single-photon detection using a waveguide with multiple phase-matching peaks. Two signal wavelengths are upconverted using two distinct pump wavelengths, all in the 1550-nm band.

JW3A.8
Strong suppression of forward or backward Mie scattering by using partial coherence, Taco D. Visser[1], yangyundou wang[2], Hugo Schouten[1]; *[1]Vrije Universiteit, Amsterdam, Netherlands; [2]NPU, China*. The intensity of forward- or backward Mie scattering can be suppressed several orders of magnitude by tuning the coherence length of a J_0 Bessel correlated field.

JW3A.11
Large Purcell Enhancement with Efficient One-dimensional Collection via Coupled Nanowire-nanorod System, Xue k. Duan[1], Juanjuan Ren[1], Fan Zhang[1], He Hao[1], Guowei Lu[1,2], Ying Gu[1,2], Qihuang Gong[1,2]; *[1]State Key Lab for Mesoscopic Physics, Collaborative Innovation Center of Quantum Matter, Dept. of Physics, Peking Univ., China; [2]Collaborative Innovation Center of Extreme Optics, Shanxi Univ., China*. Spontaneous emission is enhanced by thousands of times based on excitation of gap surface plasmons in the coupled system. More than 50% of emitted photons are guided along one dimension in subwavelength scale.

JW3A.12
Current gain compression in strain-balanced SiGeSn/GeSn based transistor laser, Ravi Ranjan[1]; *[1]Electronics Engineering, Indian Inst. of Technology (Indian School of Mines), India*. We present the design of SiGeSn/GeSn based transistor laser. Collector current density as a function of collector-emitter voltage for different injected base current density in common-emitter mode is calculated to show the current gain compression.

JW3A.13
Single photon generation at 785nm in CMOS compatible photonic devices, Robert Cernansky[1], Francesco Martini[1], Alberto Politi[1]; *[1]Univ. of Southampton, UK*. Single photon sources are crucial components for any future quantum photonic technology. We demonstrate generation of non-classical states of light for quantum computation using CMOS compatible PECVD SiN ring resonator at near-visible wavelengths.

JW3A.14
Adjoint Optimization for Automated Metasurface Mirror Design, Jason Herrmann[1], Turner Silverthorne[2], Alexander Y. Piggott[3], Michal Bajcsy[2]; *[1]Physics Dept., Harvard Univ., USA; [2]IQC, Univ. of Waterloo, Canada; [3]Ginzton Lab, Stanford Univ., USA*. We apply adjoint optimization to automate the design of high-reflectivity metasurface mirrors for gaussian beams. Adjoint techniques reduce requisite computation time and power, as well as the need for a known starting structure.

JW3A.15
One Dimensional Atom Microscopy Via Surface Plasmon Polariton, Syed A. Shah[1], Sana Ullah[1], Muhammad Idrees[1], Bakht A. Bacha[1], Arif Ullah[1]; *[1]Dept. of Physics, Univ. of Malakand, Pakistan*. We demonstrate the possibility for atom localization via surface plasmon polariton. A single and double localized peaks are observed in the absorption/dispersion spectrums of surface plasmon polariton.

JW3A.16
The entangled quantum photons generation in whispering gallery mode resonator of silica microsphere, Jingming Cao[2,1]; *[1]Univ. of Erlangen-Nuremberg, Germany; [2]The school of Advanced Optics and Technology, Germany*. The modeled and fabricated apparatus to generate the nonclassic light source of entangled quantum photons in the normal dispersion regime by the enhanced higher quality factor in waveguide of silica microsphere in modern optics applications.

JW3A.17
Nondegenerate Two Photon Carrier Generation in Multiple Quantum Well for the C-Band Telecommunication, Carlos Andres Alvarez Ocampo[1,2], Rodrigo Acuna Herrera[1]; *[1]Escuela de Fisica, Universidad Nacional de Colombia-Medellin, Colombia; [2]Ciencias Basicas, Universidad de Medellin, Colombia*. We study numerically the Two Photon Carrier Generation in Multiple Quantum Well made of $Al_xGa_{1-x}As$ for the c-band telecommunication via Nondegenerate Two Photon Absorption. We show how the mole fraction x and probe wavelength are important.

JW3A.18
A Quantum Opto-plasmonic Capacitor for Low-power High-speed Information Processing, Pouya Dianat[2], Bahram Nabet[1]; *[1]Drexel Univ., USA; [2]Electrical Engineering and Computer Sciences, Northwestern Univ., USA*. A quantum plasmonic photodetector is described with integrated low-power logic operations of ~9aJ/bit and unbounded by transport limitations. This is achieved by optoelectrical exploitation of quantum-exclusive energies of interacting 2D hole plasma.

JW3A.19
Nonlinear Coupled Mode Equations for Kerr Comb Generation in Coupled Microcavity System, Shun Fujii[1], Yusuke Okabe[1], Takumi Kato[1], Ryo Suzuki[1], Atsuhiro Hori[1], Takasumi Tanabe[1]; *[1]Keio Univ., Japan*. We performed a rigorous numerical simulation of Kerr comb generation with nonlinear coupled mode equations including mode coupling between two different mode families. The calculated results agree well with experimental results.

JW3A.20
Controllable photon quantum state generation in multimode optical fibers, Hamed Pourbeyram[1], Arash Mafi[1]; *[1]Univ. of New Mexico, USA*. We present the multimode optical fiber as a robust and practical platform to manipulate and control the quantum state of light using various linear and nonlinear mechanisms.

JW3A • Joint Poster Session III—Continued

JW3A.21
Generation of near-infrared correlated photon pairs in a long optical nano-fibers, Jin-Hun Kim[1], Yong Sup Ihn[1], Heedeuk Shin[1], Yoon-Ho Kim[1]; [1]*physics, POSTECH, South Korea*. We report generation of frequency-nondegenerate correlated photon pairs in an 8 cm-long optical nano-fiber. The coincidence-to-accidental ratio bigger than 400 has been achieved at a very low average pump power of 50 μW.

JW3A.22
Evanescent field controlled entanglement modulation in a plasmonic nanoparticle-emitters hybrid system, Fan Zhang[1], Xue k. Duan[1], Juanjuan Ren[1], zhao chen[1], Ying Gu[1,2], Qihuang Gong[1,2]; [1]*State Key Lab for Mesoscopic Physics, Collaborative Innovation Center of Quantum Matter, School of Physics, Peking Univ., China;* [2]*Collaborative Innovation Center of Extreme optics, Shanxi Univ., China*. We theoretically demonstrate the evanescent-field controlled entanglement modulation in a dielectric nanowire, emitters and Ag nanoparticle hybrid system. Modulation range of 0-0.75 has been achieved by varying incident field amplitude and detunings.

JW3A.23
High Efficient Grating Couplers and an Effective Nanofabrication Method for High Performance Plasmonic Waveguides, Zahraa Al-Baiaty[1,2], Benjamin P. Cumming[2], Xiaosong Gan[1], Min Gu[2]; [1]*Swinburne Univ., Australia;* [2]*RMIT Univ., Australia*. We developing efficient and high performance nanoplasmonic waveguides. Our results show enhancement in the intensity and propagation distance of the propagating plasmons by introducing an optimized grating coupler utilizing efficient nanofabrication.

JW3A.24
Greatly enhanced strong photon-exciton coupling in two dimensional evanescent-vacuum, Juanjuan Ren[1], He Hao[1], Xue k. Duan[1], Fan Zhang[1], Tiancai zhang[2], Ying Gu[1], Qihuang Gong[1]; [1]*Peking Univ., China;* [2]*Shanxi Univ., China*. Taking the two dimensional evanescent vacuum as electromagnetic background, we theoretically investigate the enhanced strong photon-exciton coupling, where the coupling coefficients with silver plate can be 7.6 times larger than that without plate.

JW3A.25
Study of GeSn Strain Compensated Quantum Well as EAM, Prakash Pareek[1], Ravi Ranjan[1], Mukul K. Das[1]; [1]*Indian Inst. of Technology (indian School of Mines) Dhanbad, India*. Study of Stark effect in strain compensated GeSn quantum well is done by calculating field dependent absorption considering excitonic effect. A significant change in refractive index is determined which confirmed its potentiality as modulator.

JW3A.26
Modeling of Dark Count Rate of InGaAs/InP Single Photon Avalanche Photodiode Gated with Soliton Signal, Ahmed C. Kadhim[1], Susan Earles[1], Ahmad S. Azzahrani[1], Muhammad Riaz[1], Mano R. Pakalapati[1]; [1]*Electrical and Computer Engineering, Florida Inst. of Technology, USA*. Dark count rate (DCR) of InGaAs/InP SPAD is modeled using soliton gating signal and compared to experimental counts of sinusoidal gating. Simulation results show that soliton has fewer effects of excess voltage on DCR.

JW3A.27
Soliton Pulse Gated InGaAs/InP Avalanche Photodiode for Low Dark Count Rate Single Photon Detection, Ahmed C. Kadhim[1], Susan Earles[1], Muhammad Riaz[1], Ahmad S. Azzahrani[1], Mano R. Pakalapati[1]; [1]*Florida Inst. of Technology , USA*. A mathematical model for dark count rate of soliton pulse gated InGaAs/InP SPAD is developed. The results are compared with experimental counts of Gaussian gating. Simulation results show that Soliton gating width reduced the DCR.

JW3A.28
Investigations of Nonlinear Optical Properties of Diamond Nanoparticles using Z-scan Technique, Renu Tripathi[1], Michael J. Williams[1], gour s. pati[1]; [1]*Delaware State Univ., USA*. We present results from investigations of third-order nonlinear optical properties of diamond nanoparticles suspended in dimethylformamide (DMF) solvent using the single-beam Z-scan technique at 1064 nm.

JW3A.29
Withdrawn.

JW3A.30
Spatially Dependent Replica Symmetry Breaking in an Optofluidic Random Laser, Anirban Sarkar[1], Jonathan Andreasen[2], Shivakiran Bhaktha B. N.[1]; [1]*Indian Inst. of Technology Kharagpur, India;* [2]*Georgia Tech Research Inst., USA*. We study replica symmetry breaking (RSB) in an optofluidic random laser. Using a pump-probe technique recently developed to map the lasing modes results in RSB only at the edges of the pumped region.

JW3A.31
Four-Wave Mixing in Potassium Vapor, Ryan T. Glasser[1], Jon D. Swaim[1]; [1]*Tulane Univ., USA*. We demonstrate the generation of bright, squeezed twin beams via a four-wave mixing process in warm potassium vapor, in which strong asymmetric absorption is present between the two modes.

JW3A.32
Hybrid photon model bridges classical and quantum optics, Chandra Roychoudhuri[1,2]; [1]*Univ. of Connecticut, USA;* [2]*Femto Macro Continuum, USA*. Photons are transient QM energy packets at emission that evolve as Huygens wave-packets. We use the quantum cup postulate, along with known interferometric and spectrometric data to resolve the currently perceived contradictions.

JW3A.33
Size-scale analysis of spin detection sensitivity in miniature vapor cells, Ricardo Jimenez-Martinez[1]; [1]*ICFO-Inst. of Photonic Sciences, Spain*. I describe a size-scale analysis of spin-detection sensitivity in miniature, i.e. microfabricated, vapor cells and discuss tools and techniques that can be deployed to enhance it.

JW3A.34
Temporal Amplitude & Phase: Algorithmic Reconstruction via Time-domain Interferometry (TeAPARTI), Joseph H. Munns[2,1], Sang Park[1], Benjamin Brecht[1], Ian A. Walmsley[1]; [1]*Univ. of Oxford, UK;* [2]*Imperial College London, UK*. We introduce a novel protocol for the complex characterisation of nanosecond duration pulses -- TeAPARTI -- and apply it to different test pulses. In all cases, the reconstructed intensity and phase profiles agree very well with the target pulses.

JW3A.35
Influence of Counterpropagating Light on Phase Matching in Second Harmonic Generation, Amy L. Lytle[1], Thomas Lehman-Borer[1], Etienne Gagnon[1]; [1]*Franklin & Marshall College, USA*. Experimental and numerical results verify the influence of counterpropagating light on phase matching of SHG, enhancing conversion efficiency by up to 20%, toward understanding and implementation of an all-optical method for quasi-phase matching.

JW3A.36
Improving the Detection of Squeezed Light in the Presence of Loss, Tian Li[1], Brian E. Anderson[1], Travis Horrom[1], Bonnie L. Schmittberger[1], Kevin Jones[2], Paul D. Lett[1,3]; [1]*Univ. of Maryland at College Park, USA;* [2]*Williams College, USA;* [3]*Quantum Measurement Division, NIST, USA*. Squeezed light has many applications, but its quantum advantages disappear quickly with increasing loss. Here we show that a four-wave-mixing-based phase-sensitive amplifier can be used to preserve squeezing even in the presence of substantial loss.

JW3A.37
Dynamics of Quantum Dot Lasers Subject to Polarization-Rotated Feedback, Salim Ourari[1], Tianyao Huang[1], Hong Lin[1]; [1]*Bates College, USA*. Polarization-rotated optical feedback stimulates orthogonal polarization in a quantum dot laser. The frequency of feedback dynamics is decreased by a factor of 2 when the polarization of feedback is rotated by a large angle.

JW3A.38
Limints on conditional photon statistics manipulation via interference of weak lasers, Kang-Hee Hong[1], Jisung Jung[2], Young-Wook Cho[2], Sang-Wook Han[2], Sung Moon[2], Kyunghwan Oh[3], Yong-Su Kim[2], Yoon-Ho Kim[1]; [1]*Pohang Univ of Sci & Tech (POSTECH), South Korea;* [2]*Center for Quantum Information, Korea Inst. of Science and Technology (KIST), South Korea;* [3]*Dept. of Physics, Yonsei Univ., South Korea*. We report theoretical analysis on the limits of manipulating conditional photon statistics via interference of weak lasers. We demonstrate explicitly that photon anti-bunching cannot be obtained in such a scheme.

JW3A.39
Dynamic Characteristics of VCSELs with Combined Optical Injection and Feedback, Niccolo Bigagli[1], Aashu Jha[1], Hong Lin[1]; [1]*Bates College, USA*. We explore dynamics of a VCSEL with simultaneous optical injection and feedback. Broadband dynamics is achieved for combination of feedback of different polarizations and parallel injection.

JW3A.40
Von Neumann Entropy in a Cross Cavity, Julio Cesar Garcia Melgarejo[2], Nestor Lozano-Crisostomo[2], Rodolfo Mena-Montes[2], Edgar S. Arroyo-Rivera[1], J. Javier Sanchez-Mondragon[1]; [1]*Inst Nac Astrofisica Optica Electronica, Mexico;* [2]*Facultad de Ingenieria Mecanica y Electrica, Universidad Autonoma de Coahuila, Mexico*. We discuss the entropy between a two-level atom and a cross-cavity resulting in an extended lifetime of the entanglement.

JW3A.41
Waiting time distributions for the first photodetection for classical and quantum light sources, Reeta Vyas[1], Surendra Singh[1]; [1]*Univ. of Arkansas, USA*. Waiting time probabilities for detecting the first photon, starting at an arbitrary instant, from stationary quantum and classical light sources, and information they contain are discussed and analytic expressions for several sources are presented.

JW3A.42
Coherence in the Jaynes-Cumming Model, Julio Cesar Garcia Melgarejo[2], J. Javier Sanchez-Mondragon[1], Nestor Lozano-Crisostomo[2], Edgar S. Arroyo-Rivera[1], Daniel A. May-Arrioja[3], D E. Ceballos-Herrera[4], Miguel Torres-Cisneros[5]; [1]*Inst Nac Astrofisica Optica Electronica, Mexico;* [2]*FIME, Universidad Autonoma de Coahuila, Mexico;* [3]*Centro de Investigaciones en Optica, Mexico;* [4]*UNAM, Mexico;* [5]*Universidad de Guanajuato, Mexico*. We present a realistic way to explore the Coherence of the quantum field through the analysis of the JCM in a cross-cavity. We also explore the dipole and photon number coherence.

JW3A • Joint Poster Session III—Continued

JW3A.43
Dynamical Aspects of Lasing Inside Microcavities Without Resorting to the Concept of Density of Modes, Tracy Robertson[1], Serge Gauvin[1]; [1]*Physique et astronomie, Université de Moncton, Canada.* Optical confinement allows manipulation of spontaneous emission. Density of modes is used to account for this effect. However, another interpretation based on modulation of vacuum field fluctuations leads to a new description of thresholdless lasers.

JW3A.44
Unidirectional Scattering by All-dielectric Cuboidal Nanoparticle, Richa Mantri[1], Reena Dalal[1], Ajeet Kumar[1]; [1]*Delhi Technological Univ., India.* In this paper, we report unidirectional scattering by all dielectric cuboidal nanoparticle. The variation in scattering cross section, far field and directivity are studied when material of the cuboid is changed from Silicon (Si) to Germanium (Ge).

JW3A.45
Surface Plasmon Polariton Amplification in a Single Carbon Nanotube by Direct Electric Current, Sergey G. Moiseev[1], Aleksei S. Kadochkin[1], Yuliya S. Dadoenkova[1], Igor O. Zolotovskii[1]; [1]*Ulyanovsk State Univ, Russia.* A mechanism of amplification of surface plasmon polaritons due to the transfer of electromagnetic energy from a drift current into a terahertz surface wave propagating along the single-walled carbon nanotube is proposed.

JW3A.46
High-Mobility Transparent Conducting Oxides for Compact Epsilon-Near-Zero Silicon Integrated Optical Modulators, Michael G. Wood[1], Salvatore Campione[1], Darwin Serkland[1], S Parameswaran[1], Jon Ihlefeld[1], Ting Luk[1], Joel R. Wendt[1], Kent Geib[1], Gordon Keeler[1]; [1]*Sandia National Labs, USA.* We study the role of carrier mobility in transparent conducting oxides integrated into epsilon-near-zero modulators. High-mobility materials including CdO enable sub-micron length electroabsorption modulators through >4dB/μm extinction ratios.

JW3A.47
The cutoff and critical power of Modulation Instability (MI) gain in Silicon-on-insulator (SOI) Nanowaveguides , Deepa Chaturvedi[1], Ajit Kumar[1]; [1]*Indian Inst. of Technology, Delhi, India.* We have studied the effect of free-carriers (FC) on MI gain in SOI nanowaveguides. The MI analysis is carried out in the nanowaveguides with anomalous and normal group velocity dispersion (GVD) parameters.

JW3A.48
Cascaded Floquet Resonators as Dual-Carrier Optical Circulators, Ian Williamson[1], Zheng Wang[1]; [1]*The Univ. of Texas at Austin, USA.* Floquet resonances arising in temporally modulated resonators exhibit highly nonreciprocal responses when coupled to external photonic structures. We demonstrate a circulator response to a dual-carrier input compatible with on-chip photonic systems.

JW3A.49
Impact of Fourth-order dispersion (FOD) parameter on Modulation Instability (MI) in Silicon-On-Insulator (SOI) Nanowaveguides , Deepa Chaturvedi[1], Ajit Kumar[1]; [1]*Indian Inst. of Technology, Delhi, India.* We have studied the MI gain due to second-order dispersion (SOD) and FOD parameters in SOI nanowaveguides and discussed the impact of FOD parameter on the MI gain spectra existing due to SOD parameter.

JW3A.50
High-Q Optical Cavities at Visible Wavelengths in Photonic Crystals in the Anderson-localized regime, Tom Crane[1], Oliver Trojak[1], Luca Sapienza[1]; [1]*Univ. of Southampton, UK.* We demonstrate Anderson localization of visible light in silicon nitride photonic crystals. We measure optical resonances by disorder-induced light localization showing quality factors of ≈ 10000 that exceed engineered 2D photonic crystal cavities.

JW3A.51
Bloch-surface-polariton based hybrid waveguide for low loss light propagation at the subwavelength scale, Weijing Kong[1], Yuhang Wan[2], Xiaochang Ni[1], Wenhui Zhao[1], Zheng Zheng[2]; [1]*School of Electronic Engineering, Tianjin Univ. of Technology and Education , China;* [2]*School of Electronic and Information Engineering, Beihang Univ. , China.* A novel hybrid Bloch surface polariton waveguide by integrating a periodic multilayer structure with metallic nanowire is proposed and investigated. The results reveal a deep-subwavelength mode confinement with reasonable propagation distance.

JW3A.52
Disorder-Induced Light Confinement in Photonic Crystals as a Platform for Efficient Optical Sensing, Oliver Trojak[1], Tom Crane[1], Luca Sapienza[1]; [1]*Univ. of Southampton, UK.* We demonstrate optical sensing with disorder-induced confined light on silicon nitride photonic crystal waveguides. For a refractive index change of ≈0.38, we measure 14 nm wavelength shifts of an optical resonance 0.4 nm broad.

JW3A.53
Electrically Pumped Spaser Based on Semiconductor Film with Graphene Nanosheet, Sergey G. Moiseev[1], Yuliya S. Dadoenkova[1], Igor O. Zolotovskii[1]; [1]*Ulyanovsk State Univ, Russia.* A model of slow surface plasmon polariton distributed feedback laser (spaser) based on semiconductor film with pump by drift current in graphene is proposed.

JW3A.54
Extreme Twists of Light in Photonic Crystal Waveguides, Isabelle Palstra[1], Dolfine Kosters[2], Filippo Alpeggiani[2], Kobus Kuipers[2]; [1]*Center for Nanophotonics, AMOLF, Netherlands;* [2]*Dept. of Quantum Nanoscience, Kavli Inst. of Nanoscience, Netherlands.* We demonstrate that superchiral near fields, fields that are essentially more twisted than circularly polarized light, exist above conventional silicon photonic crystal waveguides. We envision using these fields to accurately sense chiral molecules.

JW3A.55
Defect States Emerging from a non-Hermitian Flat Band of Photonic Zero Modes, Bingkun Qi[1,2], Li Ge[1,2]; [1]*College of Staten Island, CUNY, USA;* [2]*Physics, The Graduate Center, CUNY, USA.* We report the emergence of a defect state in a photonic flat band with non-Hermitian particle-hole symmetry. It can be viewed as an unconventional alignment of a pseudo-spin in a complex magnetic field.

JW3A.56
Trapezoidal Sub-wavelength Grating Micro-Ring Resonator with High Quality Factor, Elnaz Akbari[1]; [1]*Electrical, GWU, USA.* We report the trapezoidal structure subwavelengeth grating waveguide micro ring resonator with high quality factors 10474 for 3.1μm radius. Trapezoidal shape can significantly reduce the bend loss and therefore increase the quality factors.

JW3A.57
Emission and lasing properties of CdS nanoribbons modulated by strain-engineering, Liaoxin Sun[1], Qi Wang[1], Fangfang Sun[1], Bo Zhang[1], Xuechu Shen[1], Wei Lu[1]; [1]*Shanghai Inst. of Technical Physics, China.* The periodic buckling of CdS nanoribbons is fabricated and the strain-modulated exciton and exciton-phonon coupling are clearly observed in PL mapping. Moreover, the strain-dominated mode selection in multi-mode laser is presented.

JW3A.58
Flexible Hybrid Microdisk Cavity for Lasing, Jie Zhou[1,2], Taojie Zhou[2], Jiagen Li[2], Kebo He[2], Zhaoyu Zhang[2]; [1]*Peking Univ., China;* [2]*Chinese Univ. of Hong Kong, China.* The authors propose a hybrid microdisk cavity embedded in flexible medium for lasing applications. The 2-μm-diameter microdisk features a lasing threshold of 1.2 μW and lasing wavelength of ~680 nm with a linewidth of 0.3 nm at room temperature.

JW3A.59
Modification of Charge Carrier Mobility by Strong Light-Matter Coupling in Organic and Inorganic Semiconductors, Henry Fernandez[1], Saverio Russo[1], William Barnes[1]; [1]*Dept. of Physics and Astronomy, Univ. of Exeter, UK.* Strong light-matter coupling is anticipated to modify the electronic properties of semiconductor materials. We discuss an experiment suited to study the charge mobility of semiconductors where exciton modes are coupled to tuneable microcavity modes.

JW3A.60
Two-dimensional Phononic Crystal Design with Large Band Gaps, Shuo Li[1], Yangfan Li[2], Fei Meng[2], Han Lin[1], Xiaodong Huang[2], Baohua Jia[1]; [1]*Centre for Micro-Photonics, Swinburne Univ. of Technology, Australia;* [2]*Faculty of Science, Engineering and Technology, Swinburne Univ. of Technology, Australia.* We present unit-cell designs for 2D phononic crystals formed by solid-solid materials with large phononic band gaps for (1) out-of-plane, (2) in-plane, and (3) combined out- and in-plane elastic waves propagation, based on Voronoi diagram.

JW3A.61
Experimental demonstration of coherent light emission by a metallic optofluidic cavity exploiting continuous pump, Hailang Dai[1], Xianfeng Chen[1]; [1]*Shanghai Jiaotong Univ., China.* Ultralow-threshold continuous wave microfluidic dye laser based on hollow-core metal-cladding optical waveguide.For Methylene blue with concentration of $2.57*10^{-13}$ mol/ml, can be observed with the launched pump threshold bolew 2.1 μW/cm^2 lasing.

JW3A.62
Ge-ZnS Mid-IR Wideband Resonant Reflectors, Daniel J. Carney[1], Robert Magnusson[1]; [1]*Univ. of Texas at Arlington, USA.* We provide design and fabrication of robust GMR devices operating in the 3-15 μm spectral range. Optimized reflectors are designed with inverse numerical methods. Preliminary experimental spectra agree qualitatively with theory.

JW3A.63
Robustness of single mode PT lasers, Mohammad Hosain Teimourpour[2], Ramy El-Ganainy[2,1]; [1]*Michigan Technological Univ. , USA;* [2]*Dept. of Physics and Henes Center for Quantum Phenomena, Michigan Technological Univ., USA.* We investigate the robustness of single longitudinal mode operation in PT symmetric lasers against instabilities triggered by spectral hole burning effects. Results, supported by numerically integrating the rate equations and linear stability analysis.

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JW3A.64
Mode selectivity in PT symmetric lasers, Mohammad Hosain Teimourpour[1], Ramy El-Ganainy[1]; [1]*Dept. of Physics and Henes Center for Quantum Phenomena, Michigan Technological Univ., USA*. We introduce a general scheme for controlling mode selectivity in PT symmetric lasers via inhomogeneous loss engineering.

JW3A.65
Non-Hermitian Particle-Hole Symmetry and its Implications in Photonic Systems, Li Ge[1,2]; [1]*College of Staten Island, CUNY, USA;* [2]*Graduate Center, CUNY, USA*. I will discuss how particle-hole symmetry, a fermionic symmetry in condensed matter systems, can be realized in non-Hermitian photonics. It leads to many interesting phenomena, including symmetry-protected flat bands and single-mode lasers.

JW3A.66
Directional Forward Scattering by Linear Chain of Cylindrical Nanoparticles, Sonam Dogra[1], Reena Dalal[1], Ajeet Kumar[1]; [1]*Delhi Technological Univ., India*. Highly directional forward scattering in the chain of cylindrical Silicon nanoparticles has been reported. There is an enhancement of directivity when the size of the chain has been increased along the direction of propagation of electric field.

JW3A.67
Fano resonant all-dielectric core-shell nanoparticles, Reena Dalal[1], Nishant Shankhwar[1], Yogita Kalra[1], Ajeet Kumar[1], Ravindra K. Sinha[2]; [1]*Applied Physics, Delhi Technological Univ., India;* [2]*Central Scientific Instruments Organisation, India*. We report directional Fano resonance in the core-shell (Silicon-$MgOTiO_2$) nanoparticle in the visible region. Interference of resonant magnetic dipole and broad electric dipole result in asymmetric profile of Fano resonance.

JW3A.68
Design of a High-Q Resonant Raman Amplifier, Ren-Jie Chen[1], Yeong H. Ko[1], Jae W. Yoon[2], Robert Magnusson[1]; [1]*Univ. of Texas at Arlington , USA;* [2]*Hanyang Univ., South Korea*. We analyze silicon-based resonant Raman amplifiers. We provide an initial design study based on nanopatterned c-Si films. By spectral and angular tuning, two resonant lines exhibit the proper spectral Raman separation for silicon.

JW3A.69
Optomechanical Pressure and Temperature Sensing, Robinjeet Singh[1], Stephen Eckel[2], James Fedchak[2], Thomas Purdy[2]; [1]*JQI/NIST, USA;* [2]*National Inst. of Standards and Technology, USA*. We analyze the dynamics of various eigenmodes of a high stress Si_3N_4 nanomechanical membrane resonator. This work explores applications of optomechanical systems for pressure and temperature metrology.

JW3A.70
Design and Fabrication of SU-8 Polymer Based Photonic Crystal Waveguide, Swagata Samanta[1], Pallab Banerji[2], Pranabendu Ganguly[1]; [1]*Advanced Technology Development Centre, Indian Inst. of Technology Kharagpur, India;* [2]*Materials Science Centre, Indian Inst. of Technology Kharagpur, India*. We make use of optical lithography along with focused ion beam milling to fabricate our designed photonic crystal waveguide; milling depth of 220nm is obtained with an ion dose of 10K, rms roughness being 33.1nm.

JW3A.71
Raman Comb Formation in Silica Rod Microresonator, Ryo Suzuki[1], Akihiro Kubota[1], Shun Fujii[1], Atsuhiro Hori[1], Takumi Kato[1], Takasumi Tanabe[1]; [1]*Keio Univ., Japan*. We report smooth Raman comb generation with a linewidth of a few kHz despite a complex Raman gain. The center wavelength was controlled depending on the pump detuning.

JW3A.72
Third Order Nonlinear Properties of GeSbS Chalcogenide Waveguides, Samuel F. Serna Otálvaro[1,4], Hongtao Lin[2], Carlos Alonso-Ramos[1], Anupama Yadav[3], Xavier Le Roux[1], Kathleen Richardson[3], Eric Cassan[1], Nicolas Dubreuil[4], Juejun Hu[2], Laurent Vivien[1]; [1]*C2N, Universite de Paris-Sud XI, France;* [2]*MIT, USA;* [3]*Univ. of Central Florida, USA;* [4]*Laboratoire Charles Fabry, Institut d'Optique Graduate School, France*. We report the characterization of highly nonlinear GeSbS chalcogenide glass integrated waveguides. Linear and nonlinear measurements were performed in the telecom window, illustrating the potential of As-free chalcogenides for photonics applications.

JW3A.73
Parity-Time Symmetric Adiabatic Elimination, Mojgan Dehghani[1], Hamidreza Ramezani[1]; [1]*Physics and Astronomy, Univ. of Texas Rio Grande Valley, USA*. We investigate the influence of parity-time symmetry on adiabatic elimination in coupled waveguides. We show that while adiabatic elimination is not affected in the symmetric phase, in the broken phase it does not hold.

JW3A.74
Temperature Dependence of Nanoscale Si_3N_4 Tuning Fork Cavity Optomechanical Transducers, Rui Zhang[1], Yundong Ren[1], Marcelo Davanço[2], Vladimir Aksyuk[2], Kartik Srinivasan[2], Yuxiang Liu[1]; [1]*Worcester Polytechnic Inst., USA;* [2]*Center for Nanoscale Science and Technology, National Inst. of Standards and Technology, USA*. We investigate the temperature dependence of doubly clamped Si_3N_4 tuning fork cavity optomechanical transducers. The temperature-induced mechanical resonance shift was experimentally measured and investigated by both numerical and analytical modeling.

JW3A.75
Differential Polarisation-sensitive Photodetectors Design Utilising Plasmonic Metasurfaces, Evgeniy Panchenko[1], Jasper J. Cadusch[1], Timothy D. James[1], Lukas Wesemann[1], Ann Roberts[1]; [1]*The Univ. of Melbourne, Australia*. We propose and demonstrate a CMOS compatible plasmonic antenna-based differential photodetector. Our design permits using differential detection techniques in telecommunication systems potentially significantly increasing the data transmission rate.

JW3A.76
Bio-sensing with asymmetric THz metasurfaces, Joshua Burrow[1], Thomas Searles[2], Imad Agha[1,3], Jay Mathews[3,1]; [1]*Electro-Optics and Photonics, Univ. of Dayton, USA;* [2]*Physics & Astronomy, Howard Univ., USA;* [3]*Physics, Univ. of Dayton, USA*. We demonstrate an asymmetric 4-gap square ring resonator terahertz (THz) metasurface as an ultra-sensitive biological sensor. Polarization-insensitive modes due to asymmetry exhibit low minimal detectable concentration of bovine serum albumin.

JW3A.77
Plasmonic Filter Arrays for Infrared Spectral Reconstruction, Benjamin Craig[1], Kenneth B. Crozier[1]; [1]*Univ. of Melbourne, Australia*. We experimentally demonstrate an array of plasmonic infrared transmission filters. We show, by simulations that include noise, reconstruction of the spectra of infared light sources from measurements of the energy transmitted through each filter.

JW3A.78
Broadband polarization-independent selective absorber enabling large angle acceptance, Xu Han[1,2], Kebo He[2], Zhaoyu Zhang[2]; [1]*School of Electronic and Computer Engineering, Shenzhen Graduate School, Peking Univ., China;* [2]*School of Science and Engineering, Chinese Univ. of Hong Kong, Shenzhen, China*. A broadband polarization-insensitive selective solar absorber is shown to have beyond 90% absorptance from 0.5μm to 1.75μm and predicted absorptance below 12.6% from 2.5μm to 4μm, while showing large angle acceptance.

JW3A.79
Magneto-optical waveguiding InSb-based structures with nonreciprocal properties, Pavel Kwiecien[1], Ivan Richter[1], Vladimir Kuzmiak[2], Jiri Čtyroký[2]; [1]*Dept. of Physical Electronics, Czech Technical Univ. in Prague, Faculty of Nuclear Sciences and Physical Engineering, Czech Republic;* [2]*Inst. of Photonics and Electronics of the Czech Academy of Sciences, Czech Republic*. We have studied theoretically surface magnetoplasmons in several types of THz guiding structures, based on a combination of InSb, dielectric, and metal parts, both in planar and more general configurations, under the external magnetic field.

JW3A.80
Planar Optics with High Numerical Apertures at Visible Wavelengths, Wei-Ting Chen[1], Alexander Zhu[1], Mohammadreza Khorasaninejad[1], Zhujun Shi[1], Federico Capasso[1]; [1]*Harvard Univ., USA*. We report high numerical aperture planar optics using metasurfaces. Meta-axicons and immersion meta-lenses with numerical apertures up to 1.1 are demonstrated; they can generate wavelength-independent Bessel beams and diffraction-limited focal spots.

JW3A.81
Hyperstructured Illumination with Metamaterial Disorder, Emroz Khan[1], Evgenii E. Narimanov[1]; [1]*School of Electrical and Computer Engineering and Birck Nanotechnology Center, Purdue Univ., USA*. Hyperstructured illumination, a super-resolution scheme based on structured illumination in hyperbolic media, must account for material disorder. We show that even with no information on disorder, the method allows for accurate image reconstruction.

JW3A.82
Organic Adhesion Layer for an Increased Waveguide-Excited Surface-Enhanced Raman Signal, Nina Turk[1], Pieter Wuytens[1], Ali Raza[1], Andre Skirtach[2], Roel Baets[1]; [1]*Ghent Univ. - imec, Belgium;* [2]*Ghent Univ., Belgium*. By replacing the titanium adhesion layer with 3-mercaptopropyltrimethoxysilane we show a 3-fold increase of the collected signal in on-chip Surface Enhanced Raman Spectroscopy using nanoplasmonic antennas integrated on a nanophotonic waveguide.

JW3A.83
Non-Linear Plasmonic Oscillations of Laser Pulse Irradiated Fullerene, Uday Chakravarty[1], Deepa Chaturvedi[2]; [1]*RRCAT, India;* [2]*Physics, IIT Delhi, India*. Intense laser energy coupling in fullerene is analytically modeled by considering fullerene as a laser driven non linear plasmonic oscillator. Efficient collisionless absorption is estimated depending upon the laser parameters and fullerene geometry.

JW3A.84
Numerical Computation of Surface Plasmon Polariton Propagation and Dispersion in the Presence of Nonlocality, Hao Yang[1], Xiang Meng[1], Shuhao Wu[1], Jerry I. Dadap[1], Richard M. Osgood[1]; [1]*Columbia Univ., USA*. We develop a surface-hydrodynamic numerical model for studying the impact of nonlocality on propagating surface plasmon polaritons in metallic nanostructures, resulting in a larger (~2×) SPP wavelength compared to the local case at plasma resonance.

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JW3A.85
Broadband unidirectional reflectionless aperiodic multilayer structure, Chenglong You[1], Corey T. Matyas[2], Yin Huang[3,4], Jonathan Dowling[1], Georgios Veronis[2,5]; *[1]Dept. of Physics and Astronomy, Louisiana State Univ. , USA; [2]School of Electrical Engineering and Computer Science, Louisiana State Univ., USA; [3]School of Physics and Electronics, Central South Univ., China; [4]Key Lab of Optoelectronic Devices and Systems of Ministry of Education and Guangdong Province, Shenzhen Univ., China; [5]Center for Computation and Technology, Louisiana State Univ., USA.* We design non-parity-time-symmetric multilayer structures, one of which consists of alternating silicon and silica layers, while the other one includes a gain material. Our structures can achieve broadband unidirectional reflectionlessness.

JW3A.86
Studies of Optical and Magnetic responses of iron Nanoparticles obtained by femtosecond laser ablation, David Muñeton[1], Jesica M. Santillán[1], Daniel C. Schinca[1], Lucía B. Scaffardi[1]; *[1]Centro de Investigaciones Opticas, Argentina.* Optical and magnetic responses of Fe colloids produced by fs-pulsed laser ablation in water and ethanol are studied. An absorption band in UV-region is measured; heterogeneous composition and superparamagnetic state of the nanoparticles are proved.

JW3A.87
Cylindrical, High-Q Surface Plasmon Cavities for Lasing and Sensing in the Visible Range, Shawn Divitt[1,2], Jared Strait[2], Wenqi Zhu[1,2], Cheng Zhang[1,2], Henri Lezec[2], Amit Agrawal[1,2]; *[1]Univ. of Maryland, USA; [2]National Inst. of Standards and Technology, USA.* We discuss recent efforts in realizing an optical resonator consisting of a metal-coated dielectric cylinder that supports whispering-gallery-type surface plasmon polaritons capable of exhibiting high quality factors in the visible frequency range.

JW3A.88
Inverse scattering method to design or determine properties of metamaterials, Nitish Chandra[1]; *[1]Univ of North Carolina Charlotte, USA.* Inverse scattering methods can be used to design/determine the permittivity and permeability of meta-atoms, metamaterials or general structures from the scattered field. These methods can be improved by using Green's functions and potentials.

JW3A.89
Exceptional Points in Passive Plasmonic Nanostructures, Ashok Kodigala[1], Thomas Lepetit[1], Boubacar Kante[1]; *[1]Univ. of California, San Diego, USA.* We present evidence of the existence of exceptional points (EPs) in three-dimensional plasmonic nanostructures. The systems are composed of coupled plasmonic nanoresonators and can be judiciously driven to EP by controlling symmetry-compatible modes.

JW3A.90
Complete absorption of broadband, unpolarized light in a deep-subwavelength graphene metamaterial, C. Martijn de Sterke[1], Han Lin[2], Bjorn Sturmberg[1], Xiaorui Zheng[2], Yunyi Yang[2], Teck K. Chong[3], Baohua Jia[2]; *[1]Univ. of Sydney , Australia; [2]Swinburne Univ. of Technology, Australia; [3]Australian National Univ., Australia.* We report total absorption of unpolarized, wide bandwidth (800-1550 nm) light in 90 nm thick graphene-based metamaterial. Grooves in the metamaterial couple incoming light into the absorber's guided modes. Fabrication is low-cost and scalable.

JW3A.91
Full Gamut of Structural Colors in All-Dielectric Mesoporous Network Metamaterials, Yoichiro Tsurimaki[1], Alejandra Ruiz de Clavijo[2], Olga Caballero[2], George Ni[1], Gang Chen[1], Marisol Martin Gonzalez[2], Svetlana V. Boriskina[1]; *[1]MIT, USA; [2]Instituto de Microelectrónica de Madrid, Spain.* We engineer and demonstrate a full gamut of structural colors in network metamaterials fabricated by the electrodeposition method. The macroscopic-size mesoporous structures are candidates for sensing, security, and color rendering applications.

JW3A.92
Giant higher-order multipoles enable strong intrinsic chirality in planar nanostructures, Alexander Y. Zhu[1], Wei-Ting Chen[1], Aun Zaidi[1], Yao-Wei Huang[1], Mohammadreza Khorasaninejad[1], Vyshakh Sanjeev[1], Cheng-Wei Qiu[2], Federico Capasso[1]; *[1]Harvard Univ., USA; [2]National Univ. of Singapore, Singapore.* We demonstrate near-unity circular dichroism and polarization rotation exceeding 100,000°/mm in planar dielectric nanostructures at visible wavelengths. Such strong intrinsic chiral behavior is due to the excitation of giant higher-order multipoles.

JW3A.93
Control of Valley Polarization in 2D Transition Metal Dichalcogenides by all Dielectric Metasurface, Sriram Guddala[1], Rezlind Bushati[1], Jie Gu[1,2], Zheng Sun[1,2], Matthew Weiner[1], Alexander Khanikaev[1], Vinod M. Menon[1,2]; *[1]Physics, City college of New York, USA; [2]Physics, The Graduate Center of the City Univ. of New York, USA.* We demonstrate control of valley polarization through the coupling of 2D materials with chiral metasurface. The modified density of states in the metasurface resulting in preferential emission with specific helicity

JW3A.94
Effect of Silver Nano-Protrusions on Field Enhancement in Tip-enhanced Raman Spectroscopy, Justin Isaac[1], Bin Zhang[2], Lina Ramanauskaite[3], Valentinas Snitka[3], Huizhong Xu[1]; *[1]Dept. of Physics & Astronomy, San Francisco State Univ., USA; [2]Inst. of Modern Physics, Fudan Univ., China; [3]Research Center for Microsystems and Nanotechnology, Kaunas Univ. of Technology, Lithuania.* The field enhancement in a gap-mode tip-enhanced Raman spectroscopy (TERS) setup with hemispherical nano-protrusions on the substrate is studied numerically and is found to display a resonant behavior as a function of the protrusion radius.

JW3A.95
Plasmonic Coupling in Metal Nanocavities, Basudeb Sain[1], Roy Kaner[1], Yaara Bondy [1], Yehiam Prior[1]; *[1]Dept. of Chemical Physics, Weizmann Inst. of Science, Israel.* Optical Fabry-Perot like modes, situated diagonally as a function the gap, are observed in transmission through pairs of coupled nanocavities in gold film, while plasmonic wakes are observed from a linear array of individual cavities.

JW3A.96
Implications of Active Material and Optical Mode on Nanoscale Electro-Optic Modulation, Rubab Amin[1], Can Suer[1], Zhizhen Ma[1], Ibrahim Sarpkaya[1], Jacob B. Khurgin[2], Ritesh Agarwal[3], Volker J. Sorger[1]; *[1]The George Washington Univ., USA; [2]Johns Hopkins Univ., USA; [3]Univ. of Pennsylvania, USA.* Motivated by index-tuning-to-loss tradeoff dictated by fundamental Kramers-Kronig relations, we demonstrate a comprehensive analysis for high-performance compact on-chip electro-optic modulators for a set of active materials and optical modes.

JW3A.97
Confining Low Energy Light with Tapered Conical Plasmonic Nanowires, Kiana Montazeri[1], Zhihuan Wang[1], Bahram Nabet[1]; *[1]Drexel Univ., USA.* We show tapered conical nanowires modified to have embedded two-dimensional electron gas plasmons enhance low-energy, long-wavelength light confinement at the tip of the formed resonant optical cavity, making them useful for optoelectronic devices.

JW3A.98
Achieving arbitrary control over pairs of polarization states using complex birefringent meta-materials, Alexander Cerjan[1], Shanhui Fan[1]; *[1]Stanford Univ., USA.* We demonstrate a specific class of meta-material, termed complex birefringent meta-materials, are able to produce two orthogonally polarized states from two non-orthogonal initial states, realizing arbitrary control over pairs of polarization states.

JW3A.99
On the Coupling Efficiency of Tamm Plasmon Polaritons, Samir Kumar[1], Mukesh K. Shukla[1], Ritwick Das[1]; *[1]School of Physical Sciences, National Inst. of Science Education and Research, HBNI, India.* A novel design technique based on structural parameters is proposed for the efficient coupling of light to Tamm plasmon-polaritons (TPPs). Optimization of the structure is essential to completely utilize the field enhancement due to TPPs.

JW3A.100
Unidirectional Excitation of Radiative-Loss-Free Surface Plasmon Polaritons in Parity-Time Symmetric Systems, Zhong Huang[1,2]; *[1]Northeastern Univ., USA; [2]School of Physics and National Lab of Solid State Microstructures, Nanjing Univ., China.* We investigate unidirectionally surface plasmon polaritons at flat metal dielectric interface with parity time symmetric modulation. We show that the SPPs life time and propagation distance can be significantly improved.

JW3A.101
Optical effects in magnetoplasmonic crystals with burried gold grating, Alexander Chekhov[1], Pavel Naydenov[3], Alexander Stognij[2], Tatiana Murzina[1]; *[1]M. V. Lomonosov Moscow State Univ., Russia; [2]Scientific-Practical Materials Research Centre of NAS of Belarus, Belarus; [3]Moscow Technological Univ. (MIREA), Russia.* We present a study of magnetoplasmonic crystals with a gold grating in bismuth iron garnet surrounding. Experimental results for the first time evidence the excitation of long-range surface plasmon polariton mode in a magnetic material.

JW3A.102
Dispersion-tailored Metasurfaces and Meta-lenses, Wei-Ting Chen[1], Vyshakh Sanjeev[1,2], Alexander Zhu[1], Zhujun Shi[1], Mohammadreza Khorasaninejad[1], Federico Capasso[1]; *[1]Harvard Univ., USA; [2]Univ. of Waterloo, Canada.* We report dispersion-tailored metasurfaces in the visible, including an achromatic meta-lens capable of keeping a constant focal length within a continuous bandwidth. The dispersion of meta-lenses can also be tailored with tunable Abbe numbers.

JW3A.103
Intra-cavity Spin Controlled Geometric Phase Metasurface, Nir . Davidson[1], Ronen Chriki[1], Elhanan Maguid[2], Chene Tradonsky[1], Vladimir Kleiner[2], Asher Friesem[1], Erez Hasman[2]; *[1]Weizmann Inst. of Science, Israel; [2]Technion, Israel.* Geometric phase metasurface elements were incorporated into laser cavities, to generate unique output beams. These include, coherent and partially coherent vortex beams, multiple harmonic vortex beams, and vectorial vortices.

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JW3A.104
Nanoimprinted Resonant Filters Made with Organic-Inorganic Nanocomposites, Hafez Hemmati[1], Robert Magnusson[1]; [1]*Univ. of Texas at Arlington, USA.* Guided-mode resonance devices are fabricated by nanoimprint lithography applied to a nanocomposite containing silicon nanoparticles in a polymer host. Optical transmission spectra of the experimental and simulated devices are in good agreement.

JW3A.105
Ghost Resonance in Optical Scattering, Sanjay Debnath[1], Evgenii E. Narimanov[1]; [1]*Purdue Univ., USA.* We demonstrate the presence of ghost resonance in optical scattering from dielectric particles.

JW3A.106
Nonlinear saturations effects in non-Hermitian scattering systems, Oksana Shramkova[1], Konstantinos Makris[2], Giorgos Tsironis[2], Demetrios Christodoulides[3]; [1]*Research & Innovation, Technicolor R&D France, France;* [2]*Univ. of Crete, Greece;* [3]*Univ. of Central Florida, USA.* The nonlinear scattering properties of non-Hermitian dispersive system with saturable gain/loss are examined. It is shown that the non-reciprocal response of nonlinear medium depends on gain/absorption coefficient and total thickness of the bilayer.

JW3A.107
Excitation of Surface Plasmons in Subwavelength Gratings, Nikolai I. Petrov[1], Viktor Danilov[1], Vladimir Popov[2], Boris Usievich[3]; [1]*Scientific Research Center of Unique Instrumentation of the Russian Academy of Sciences, Russia;* [2]*Moscow State Univ., Russia;* [3]*General Physics Inst. of the Russian Academy of Sciences, Russia.* The results of computer calculations and measurements of subwavelength diffraction gratings in the visible spectral range are presented. It is shown that the plasmon resonance via a grating coupling occurs at the determined conditions.

JW3A.108
Integrated zero-index supercouplers, Daryl Vulis[1], Philip Camayd-Munoz[1], Yang Li[1], Orad Reshef[1], Marko Loncar[1], Eric Mazur[1]; [1]*Harvard Univ., USA.* Zero-index supercoupling offers a mechanism through which light is confined to sub-diffraction scales and coupling between disparate modes is achieved. We consider this phenomena in an integrated metamaterial toward experimental demonstration.

JW3A.109
Active beam steering based on reconfigurable phase-change metasurface, Ren Jie Lin[1], Cheng Hung Chu[2], Yu Han Chen[1], Ting-Yu Chen[1], Wei-Yi Tsai[1], Din Ping Tsai[2,1]; [1]*National Taiwan Univ., Taiwan;* [2]*Research Center for Applied Sciences, Academia Sinica, Taiwan.* We present the tunable optical response of phase change material $Ge_2Sb_2Te_5$, which can be used to metasurfaces with varied functionalities. The research is promising to apply to the area of the metadevice.

JW3A.110
Versatile Polarization Generation by using Aluminum Plasmonic Metasurface, Mu Ku Chen[1], Pin Chieh Wu[1,2], Wei-Yi Tsai[1], Hsiang-Chu Wang[2], Jia-Wern Chen[1], Chun Yen Liao[1], Cheng Hung Chu[1,2], Greg Sun[3], Din Ping Tsai[1,2]; [1]*Dept. of Physics, National Taiwan Univ., Taiwan;* [2]*Research Center for Applied Sciences, Academia Sinica, Taiwan;* [3]*Dept. of Engineering, Univ. of Massachusetts Boston, USA.* We demonstrate a reflective metasurface polarization generator (MPG) capable of producing light beams of any polarizations all from a linearly polarized light source with a single optically thin chip.

JW3A.111
Plasmonically tailored nanotraps for neutral atoms based on periodic ring nanocavities, Zhao Chen[1], Qi Zhang[1], Fan Zhang[1], Ying Gu[1], Qihuang Gong[1]; [1]*Peking Univ., China.* We have theoretically demonstrated the atom trapping based on periodic ring nanocavities by circular blue-detuned light. A three-dimensional trapping potential are achieved with ultra-low optical power, scattering rate and large trapping lifetime.

JW3A.112
Carcinogenic Chromium (VI) sensing using fiber Bragg grating based on swelling of stimulus responsive hydrogel, Pabbisetti Vayu Nandana Kishore[1]; [1]*National Inst of Technology, Warangal, India.* This Paper proposes a Chemo-mechanical-optical approach of sensing the Chromium (VI) metal ion. Transducing property of both FBG and hydrogels is utilized for sensing. Traces of Cr (VI) even in the orders of 10ppb can be sensed by the method.

JW3A.113
Novel applications of hyperlens, Jingbo Sun[1], Tianboyu Xu[1], Natalia M. Litchinitser[1]; [1]*State Univ. of New York at Buffalo, USA.* By exploiting strongly anisotropic optical properties of engineered nanostructures, we proposed and demonstrated several hyperlens-based devices that integrate super resolution properties into the practical applications.

JW3A.114
Plasmonic Resonance of Trapezoidal Nanograting Shined with Normal Incident Light, Kang Tae-young[1], Dong-Myeong Shin[1], Kyujung Kim[1], Hyerin Song[1]; [1]*Pusan National Univ., South Korea.* The plasmon polaritons of the structure can be quantitatively controlled by the geometries. also showed a correlation between the enhancements in electric field intensity and the nanostructure geometry under the normal incident light.

JW3A.115
Large-scale Day-time Radiative Cooling Metafilm, Yao Zhai[1], Yaoguang Ma[1], Sabrina David[3], Dongliang Zhao[1], Runnan Lou[1], Chuanwei Wu[1], Gang Tan[2], Ronggui Yang[1], Xiaobo Yin[1,3]; [1]*Dept. of Mechanical Engineering, Univ. of Colorado Boulder, USA;* [2]*Dept. of Civil and Architectural Engineering, Univ. of Wyoming, USA;* [3]*Materials Science and Engineering Program, Univ. of Colorado, USA.* We demonstrate a large-scale day-time radiative cooling metafilm that is fabricated by a roll-to-roll process. The metafilm has demonstrated 93 W/m^2 cooling power at noon-time, which is a performance promising for large-scale cooling applications.

JW3A.116
Uniaxially Stretched Flexible Surface Plasmon Resonance Film for Versatile Surface Enhanced Raman Scattering Diagnostics, Kaichen Xu[1,2], Rong Ji[2], Minghui Hong[1]; [1]*National Univ. of Singapore, Singapore;* [2]*Data Storage Inst., (A*STAR), Singapore.* A flexible SERS film is demonstrated via irreversibly and longitudinally stretching metal deposited poly(ε-caprolactone) film. The stretched surface plasmon resonance film exhibits ~10 times signal enhancement compared to unstretched composite film.

JW3A.117
Effective Permittivity and Permeability of Metamaterial from Rectilinear Thin Wires Array, L. N. Butko[2], A. P. Anzulevich[2], D. A. Pavlov[2], Sergey G. Moiseev[1]; [1]*Ulyanovsk State Univ, Russia;* [2]*Chelyabinsk State Univ, Russia.* The effective permittivity and permeability of the composite structure consisting of rectilinear thin wires array forming a 2D square lattice within the non-conductive host media are theoretically investigated.

JW3A.118
A Fully Automated Dual-Probe Scanning Near-Field Optical Microscopy Technique, Najmeh Abbasirad[1]; [1]*Inst. of Applied Physics, Abbe Center of Photonics, Friedrich Schiller Univ. Jena, Germany.* An automated, robust dual-probe scanning near-field optical microscope is demonstrated by measuring surface plasmon polaritons. To measure the probe-probe crosstalk, the collision prevention implements two probes oscillating at different frequencies.

JW3A.119
Surface-Plasmon-Polariton Laser with Narrow Linewidth and Low Threshold, Wenqi Zhu[1], Cheng Zhang[1], Ting Xu[1], Amit Agrawal[1], Henri Lezec[1]; [1]*NIST, USA.* We demonstrate a surface-plasmon-polariton laser with narrow linewidth and low threshold based on a low-loss open cavity resonator that leverages grating-coupled SPPs to pump the lasing SPPs with improved spatial overlap and minimum perturbation.

JW3A.120
Disordered Nanoantennas: A New Paradigm in Space-Division Multiplexing, Mohammad Haghtalab[1], Safieddin Safavi-Naeini[1]; [1]*Univ. of Waterloo, Canada.* A novel approach for information multiplexing is introduced. The degrees of freedom provided by disordered structures can be employed for realizing information processing devices. Disordered highly coupled nanoantennas are investigated for this purpose.

JW3A.121
Fresnel Coefficients for Electromagnetic Propagation across a Non-Chiral and Chiral Dispersive Interface with Negative Index, Monish R. Chatterjee[1], Rajab Y. Ataai[1]; [1]*Univ. of Dayton, USA.* Fresnel coefficients are found for a non-chiral/chiral (first-order) dispersive interface with permittivity, permeability and chirality parameters functions of sideband frequency *en route* to possible negative index behavior in the second medium.

JW3A.122
Room-temperature quantum emitter arrays in hexagonal boron nitride, Nicholas Proscia[1,2], Zav Shotan[1], Harishankar Jayakumar[1], Prithvi Reddy[3], Marcus Doherty[3], Audrius Alkauskas[4], Carlos Meriles[1,2], Vinod Menon[1,2]; [1]*CUNY City College of New York, USA;* [2]*Physics, Graduate Center Cuny, USA;* [3]*Physics and Engineering, Australian National Univ., Australia;* [4]*Center for Physical Sciences and Technology, Lithuania.* We demonstrate deterministic formation of quantum emitter arrays in hexagonal Boron Nitride (hBN) at room temperature. The emitters are localized around the location of high strain provided by the nanopillar substrate.

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

12:00–13:00 Congressional Fellowship Program Information Session, *Science Showcase Theater, Columbia, Terrace Level*

12:00–13:00 OSA Optical Material Studies Technical Group Special Talk, *Georgetown West, Concourse Level*

12:00–13:00 Polarization Optics - Design and Fabrication Trends and Challenges, *Georgetown East, Concourse Level*

12:00–13:30 OIDA VIP Industry Leaders Speed Meetings Lunch, *Kalorama, Lobby Level*

13:00–13:30 Coffee Break, *Science & Industry Showcase, Columbia, Terrace Level*

13:00–15:00 JW4A • Science & Industry Showcase
Exhibits, Poster Session & E-Posters
Rapid-Fire Oral Presentations IV in Theater
Columbia, Terrace Level

Science Showcase Theater

JOINT FiO + LS

13:00–14:00
JW4A • Rapid-Fire Oral Presentations IV

JW4A.12 • 13:00 *RAPID*
Interaction-free All-optical Modulation on Chip, Jiayang Chen[1], Yong Meng Sua[1], Zi-Tong Zhao[1], Mo Li[1], Yuping Huang[1]; *[1]Stevens Inst. of Technology, USA.* We report the observation of quantum Zeno blockade on chip, where a lightwave is modulated by another in a distinct ``interaction-free'' manner. For quantum applications, we also verify its operations on single photons.

JW4A.14 • 13:05 *RAPID*
Generation of Qudits Using Four Photons and a Single Degree of Freedom, José Ferraz[1,2], Pierre L. de Assis[2,3], Marcos A. Carvalho[2,4], Sebastião de Pádua[2]; *[1]Departamento de Física, Universidade Federal Rural de Pernambuco, Brazil; [2]Departamento de Física, Universidade Federal de Minas Gerais, Brazil; [3]Instituto de Física, Universidade Estadual de Campinas, Brazil; [4]Departamento de Física, Instituto Federal do Norte de Minas Gerais, Brazil.* We present the controlled generation of two copies of two-qudit states using four photons and a single degree of freedom, transverse momentum. It's experimentally and theoretically shown that both highly-entangled and separable states were generated.

JW4A.15 • 13:10 *RAPID*
Linear optical computing of matrix permanent via thermal light boson sampling, Yosep Kim[1], Kang-Hee Hong[1], Joonsuk Huh[2], Yoon-Ho Kim[1]; *[1]Dept. of Physics, Pohang Univ. of Science and Technology (POSTECH), South Korea; [2]Dept. of Chemistry, Sungkyunkwan Univ., South Korea.* We show linear optical calculation of permanent of Hermitian positive semidefinite matrices via thermal light boson sampling. The experimental results are in good agreement with the calculation and are compared with the Gaussian sampling results.

JW4A.16 • 13:15 *RAPID*
Temporal-mode selection with a Raman quantum memory, Joseph H. Munns[1,3], Sarah E. Thomas[1,3], Krzysztof T. Kaczmarek[1], Patrick M. Ledingham[1], Dylan J. Saunders[1], Joshua Nunn[2], Benjamin Brecht[1], Ian A. Walmsley[1]; *[1]Univ. of Oxford, UK; [2]Univ. of Bath, UK; [3]Imperial College London, UK.* We demonstrate temporal-mode-selective storage and retrieval of weak coherent pulses in a Raman quantum memory in warm atomic Caesium vapour with a switching fidelity of 86.5%. This paves the way to scalable photonic quantum networks.

JW4A.23 • 13:20 *RAPID*
Electro-optic frequency beamsplitter for quantum networking applications, Hsuan-Hao Lu[1], Joseph M. Lukens[2], Nicholas A. Peters[2], Ogaga Odele[1], Andrew M. Weiner[1], Pavel Lougovski[2]; *[1]Purdue Univ., USA; [2]Oak Ridge National Lab, USA.* We implement a frequency beamsplitter for spectrally encoded photons, based on electro-optic modulation and Fourier-transform pulse shaping. The ultrahigh fidelity, bandwidth, and dense mode packing offer new potential for quantum interconnects.

JW4A.24 • 13:25 *RAPID*
New Coherence Theorem, Xiao-Feng Qian[1], S Kizhakkumpurath Manikandan[1], A Al Qasimi[1], Nickolas Vamivakas[1], Joseph Eberly[1]; *[1]Univ. of Rochester, USA.* A new identity for optical coherence is derived. It generalizes the notion of polarization so that it is applicable in more than one way to any optical beam with multiple degrees of freedom.

JW4A.29 • 13:30 *RAPID*
Generation of hybrid entangled two photon state using classical non-separable state of the pump beam, Jabir M. V.[1], Apurv Chaitanya Nellikka[1], Goutam K Samanta[1]; *[1]Physical Research Lab, India.* We report on transfer of classical non-separable state in down-conversion process to generate twin photons entangled in both OAM and polarization degree of freedom. Measurement on entanglement witness operator showed that the state is entangled.

JW4A.40 • 13:35 *RAPID*
Raman spectroscopy study of Hydrogen Plasma Treatment effect on a single layer Graphene/MoS_2 hybrid structure, Anishkumar Soman[1], Jianping Shi[2], Ugochukwu Nsofor[1,3], Steve Hegedus[1,3], Yanfeng Zhang[2], Robert Burke[4], Tingyi Gu[1]; *[1]Univ. of Delaware, USA; [2]Peking Univ., China; [3]Inst. of Energy Conversion, USA; [4]US Army Research Lab, USA.* In this study we report the effect of hydrogen plasma treatment on Graphene/ MoS_2 hybrid heterostructures using Raman spectroscopy. The effect of plasma voltage on the defects has been investigated on graphene, MoS_2 and the hybrid structure.

JW4A.56 • 13:40 *RAPID*
Analysis of Stimulated Raman Scattering and Four-Wave Mixing Effects on Crosstalk of Multicore Fibers, Daniel Ceballos[2], Ramon Gutierrez-Castrejon[2], J. Javier Sanchez-Mondragon[1]; *[1]INAOE, Mexico; [2]Instituto de Ingenieria, Universidad Nacional Autonoma de Mexico (UNAM), Mexico.* We report a numerical analysis of inter-core crosstalk in multicore fibers (MCFs) based on a dual-core-fiber model that includes Stimulated Raman Scattering (SRS) and Four Wave Mixing (FWM) nonlinearities in the presence of random perturbations.

JW4A.66 • 13:45 *RAPID*
Near-field absorption imaging by two color Raman nano-light source, Ryo Kato[1], Yuika Saito[2], Takayuki Umakoshi[1], Prabhat Verma[1]; *[1]Osaka Univ., Japan; [2]Gakusyuin Univ., Japan.* We demonstrate new nano-imaging technique for intrinsic absorption properties of materials using near-field scanning optical microscopy. Raman scattering from the apex of a silicon nano-tip was used as probe light for nano-scale absorption analysis.

JW4A.76 • 13:50 *RAPID*
Nonlinear Optical Properties of *Hoplia coerulea*, Charlotte Verstraete[1], Sébastien R. Mouchet[2], Stijn Van Cleuvenbergen[1], Peter Vukusic[2], Branko Kolaric[3], Thierry Verbiest[1]; *[1]Chemistry, KU Leuven, Belgium; [2]School of Physics, Univ. of Exeter, UK; [3]Physics, Univ. of Mons, Belgium. H. coerulea*'s elytra show a strong two-photon fluorescence signal, which depends on the presence of water in the photonic structure. A polarization-dependent Third Harmonic Generation signal was detected as well and thoroughly investigated.

JW4A.77 • 13:55 *RAPID*
Fabrication and Characterization of an All-solid Double-clad Tellurite Photonic Bandgap Fiber, Tonglei Cheng[1], Shunta Tanaka[1], Tong Hoang Tuan[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; *[1]ofmlab, Japan.* An all-solid double-clad tellurite photonic bandgap fiber is fabricated based on three glasses. Photonic bandgap properties are calculated by the plane wave expansion method, and the results agree well with the measured transmission spectrum.

13:00–15:00
JW4A • Joint Poster Session IV

JW4A.1 *E-Poster*
Chaos-Based Mitigation of Image Distortion under Anisoplanatic Electromagnetic Signal Propagation through Turbulence, Monish R. Chatterjee[1], Ali Mohamed[1]; *[1]Univ. of Dayton, USA.* Electromagnetic (EM) propagation across a slanted anisoplanatic turbulent path is examined for EM carrier-embedded information and an image-bearing transparency through optical lensing, and distortion mitigation using a chaotic carrier is examined.

JW4A.2 *E-Poster*
Deterministic spectral tuning of InAs quantum dots in photonic crystal membrane diodes with laser annealing, Joel Q. Grim[1], Allan S. Bracker[1], Sam G. Carter[1], Mijin Kim[2], Helen H. Parks[3], Bumsu Lee[4], Brennan Pursely[4], Michael Yakes[1], Dan Gammon[1]; *[1]U.S. Naval Research Lab, USA; [2]Sotera Defense Solutions, USA; [3]ASEE research associate residing at the U.S. Naval Research Lab, USA; [4]NRC research associate residing at the U.S. Naval Research Lab, USA.* The spectral inhomogeneity of semiconductor quantum dots (QDs) is a major challenge preventing the development of scalable QD quantum networks. Using laser annealing, three QDs are tuned into resonance, paving the way for on-chip quantum networks.

JW4A.3 *E-Poster*
A monolithic, doubly-resonant parametric down-conversion source for Caesium Raman memories, Benjamin Brecht[1], Oscar Lazo-Arjona[1], Krzysztof T. Kaczmarek[1], Thomas Parker[1], Raimund Ricken[2], Viktor Quiring[2], Christof Eigner[2], Kai Hong Luo[2], Harald Herrmann[2], Christine Silberhorn[2], Ian A. Walmsley[1]; *[1]Univ. of Oxford, UK; [2]Univ. of Paderborn, Germany.* We demonstrate a simple, bright, resonant parametric down-conversion source generating spectrally single-mode photons at 852.4nm and 1601nm. Bandwidths of around 250MHz make the photons compatible with cavity Raman memories in warm Caesium vapour.

JW4A.4 *E-Poster*
Near-field frequency-to-time mapping for arbitrary shaping of biphoton correlations, Hsuan-Hao Lu[1,2], Ogaga Odele[1,2], Daniel E. Leaird[1,2], Andrew M. Weiner[1,2]; *[1]School of Electrical and Computer Engineering, Purdue Univ., USA; [2]Purdue Quantum Center, USA.* We demonstrate a shaper-assisted near-field frequency-to-time mapping technique using biphotons. By pre-modifying the two-photon spectral amplitude and phase, arbitrary temporal correlations can be achieved with dispersion in the near-field region.

JW4A.5 *E-Poster*
Programmable unitary transformation of spectro-temporal modes, Valérian Thiel[2], Alex O. Davis[2], Peru D'Ornellas[2], Nicolas Treps[1], Brian J. Smith[2]; *[1]Laboratoire Kastler Brossel, France; [2]Univ. of Oxford, Clarendon Lab, Univ. of Oxford, UK.* We present simulations of ultrafast temporal pulse shaping with a fiber-coupled EOM and fiber Bragg grating. The scheme can be used to realize unitary transformations of pulse modes allowing lossless manipulation of a multimode quantum state.

JW4A.6 *E-Poster*
Near-infrared photon-pair generation by intermodal four-wave mixing in a few-mode fiber, Erik N. Christensen[1], Søren M. Friis[1], Jacob G. Koefoed[1], Mario Usuga Castaneda[1], Karsten Rottwitt[1]; *[1]DTU Fotonik, Denmark.* We demonstrate a photon-pair source based on intermodal four-wave mixing in a few-mode fiber generating photons at 965 nm and 1187 nm in the LP_{01} and LP_{02} modes, respectively, with a coincidence-to-accidental ratio of 12.

JW4A.7 *E-Poster*
Scalar and Vector Vortex Modes through SLM-based Kolmogorov Turbulence, Mitchell A. Cox[1], Andrew Forbes[1]; *[1]Univ. of the Witwatersrand, South Africa.* Both scalar and vector vortex modes are often used as transmission bases for mode division multiplexing. We demonstrate theoretically and experimentally that the crosstalk within either mode set due to turbulence is the same.

JW4A.8 *E-Poster*
Experimental Investigation of Cascaded Raman and Intermodal Nonlinear Interaction Based Supercontinuum Generation in Corning® LEAF® Fiber, Partha Mondal[1], Nitin Bhatia[1], Vishwatosh Mishra[1], Raktim Haldar[1], Shailendra K. Varshney[1]; *[1]Indian Inst. of Technology Kharagpur, India.* We demonstrate spectral broadening based on cascaded Raman and intermodal nonlinear interaction in Corning®LEAF® fiber pumped by a picosecond laser source. The effect of fiber length and pump power over spectral broadening are also investigated.

JW4A.9 *E-Poster*
Bent Negative Curvature Fibers Using Circular or Elliptical Cladding Tubes, Chengli Wei[1], Curtis Menyuk[2], Jonathan Hu[1]; *[1]Electrical and Computer Enginnering, Baylor Univ., USA; [2]Computer Science and Electrical Engineering, Univ. of Maryland Baltimore County, USA.* We study nondegenerate modes in bent negative curvature fibers. Fibers with circular tubes perform better than fibers with elliptical tubes when the bend radius is less than 12 cm.

JW4A.79 *E-Poster*
Terahertz detection mechanisms in black phosphorus, Martin Mittendorff[1], Ryan J. Suess[1], Edward Leong[1], Andrei Sushkov[1], H. Dennis Drew[1], Thomas E. Murphy[1]; *[1]Univ. of Maryland, USA.* We present three THz detection mechanisms in black phosphorus: bolometric detection, photothermoelectric detection, and photoconductive sampling of THz fields. Photothermal detection exhibits an internal responsivity of 44V/W and 20ps response time.

JW4A.10
Withdrawn.

JW4A.11
Investigation of two-pulse photon echo in acetylene-filled photonic-crystal fiber at 1530nm, Nayeli Casillas-Rodríguez[1], Manuel Ocegueda[2], Eliseo Hernández-Hernández[1], Serguei Stepanov[1]; *[1]CICESE, Mexico; [2]UABC, Mexico.* Two-pulse photon echo in acetylene-filled HC-PCF at 1530.37nm is reported. Initial transverse relaxation time $T_2 \approx 11$ ns, determined by the molecule flight-time across fiber mode diameter, decreased to 7ns at acetylene pressure 0.6Torr.

JW4A.12
Interaction-free All-optical Modulation on Chip, Jiayang Chen[1], Yong Meng Sua[1], Zi-Tong zhao[1], Mo Li[1], Yuping Huang[1]; *[1]Stevens Inst. of Technology, USA.* We report the observation of quantum Zeno blockade on chip, where a lightwave is modulated by another in a distinct ``interaction-free'' manner. For quantum applications, we also verify its operations on single photons.

JW4A.13
Intensity correlations of twisted photons generated by spontaneous parametric down-conversion, NIJIL LAL C. K.[1,2], Ali Anwar[1], Chithrabhanu Perumangatt[1], R P Singh[1]; *[1]Physical Research Lab, India; [2]Physics, Indian Inst. of Technology, India.* We generate heralded single photons carrying orbital angular momentum (OAM) by spontaneous parametric down-conversion (SPDC). We study the influence of orbital angular momentum of the photon on the second-order optical coherence.

JW4A.14
Generation of Qudits Using Four Photons and a Single Degree of Freedom, José Ferraz[1,2], Pierre L. de Assis[2,3], Marcos A. Carvalho[2,4], Sebastião de Pádua[2]; *[1]Departamento de Física, Universidade Federal Rural de Pernambuco, Brazil; [2]Departamento de Física, Universidade Federal de Minas Gerais, Brazil; [3]Instituto de Física, Universidade Estadual de Campinas, Brazil; [4]Departamento de Física, Instituto Federal do Norte de Minas Gerais, Brazil.* We present the controlled generation of two copies of two-qudit states using four photons and a single degree of freedom, transverse momentum. It's experimentally and theoretically shown that both highly-entangled and separable states were generated.

JW4A.15
Linear optical computing of matrix permanent via thermal light boson sampling, Yosep Kim[1], Kang-Hee Hong[1], Joonsuk Huh[2], Yoon-Ho Kim[1]; *[1]Dept. of Physics, Pohang Univ. of Science and Technology (POSTECH), South Korea; [2]Dept. of Chemistry, Sungkyunkwan Univ., South Korea.* We show linear optical calculation of permanent of Hermitian positive semidefinite matrices via thermal light boson sampling. The experimental results are in good agreement with the calculation and are compared with the Gaussian sampling results.

JW4A.16
Temporal-mode selection with a Raman quantum memory, Joseph H. Munns[1,3], Sarah E. Thomas[1,3], Krzysztof T. Kaczmarek[1], Patrick M. Ledingham[1], Dylan J. Saunders[1], Joshua Nunn[2], Benjamin Brecht[1], Ian A. Walmsley[1]; *[1]Univ. of Oxford, UK; [2]Univ. of Bath, UK; [3]Imperial College London, UK.* We demonstrate temporal-mode-selective storage and retrieval of weak coherent pulses in a Raman quantum memory in warm atomic Caesium vapour with a switching fidelity of 86.5%. This paves the way to scalable photonic quantum networks.

JW4A.17
Pursuing many-body dynamics of NV centers in diamond, Demitry Farufnik[1], Yahel Horowicz[1], Nir Alfasi[2], Sergai Masis[2], Yaron Kauffmann[2], Elad Farchi[1], Yoav Romach[1], Eyal Buks[1], Nir Bar-Gill[1]; *[1]Hebrew Univ. of Jerusalem, Israel; [2]Technion, Israel Inst. of Technology, Israel.* We study the interactions of optically addressable spin ensembles (NV centers) in diamond through optimized electron irradiation, confocal microscopy, and dynamical decoupling sequences, to reach the dipolar NV-NV interaction-dominated regime.

JW4A.18
Experimental Test for the Finite-TimeWave Function Collapse, José Ferraz[1], Raoni S. Moreira[2], Alyson J. Carvalho[2], Fernando R. Parisio[2], Lucio H. Acioli[2], Daniel Felinto[2]; *[1]Departamento de Física, Universidade Federal Rural de Pernambuco, Brazil; [2]Departamento de Física, Universidade Federal de Pernambuco, Brazil.* An experimental test for the wave function collapse is realized. The experimental results reaffirms the epistemic interpretation for the state vector and opposes the ontic view.

JW4A.19
Extreme Phase-Amplification under Direct Detection of Atomic States for Heisenberg Limited Sensitivity in an Atomic Interferometer Employing Schroedinger Cat States, Renpeng Fang[1], Resham Sarkar[1], Selim M. Shahriar[1]; *[1]Northwestern Univ., USA.* We show that for an N-particle atom interferometer, an N-fold reduction in fringe-width due to phase amplification can be achieved via direct detection of atomic states, employing Schroedinger Cat states, yielding Heisenberg limited sensitivity

JW4A • Joint Poster Session IV—Continued

JW4A.20
Competition between Incoherent Pumping and Losses in a System of Two Interacting Qubits, Julian C. Triana[1], Karen M. Fonseca Romero[1]; *[1]Universidad Nacional de Colombia, Colombia.* We consider a model of two qubits. We calculate and compare two quantifiers of non-classical correlations: the quantum discord and the entanglement of formation, in the steady state.

JW4A.21
Detecting nonlocal correlated errors: Bob gets caught faking a Bell-inequality violation, Meghan Feldman[1], Gabe Juul[1], Steven J. van Enk[2], Mark Beck[1]; *[1]Whitman College, USA; [2]Univ. of Oregon, USA.* We demonstrate that loop state-preparation-and-measurement tomography is capable of detecting nonlocal correlated errors by catching Bob as he tries to fake a Bell-inequality violation while using nonlocal knowledge of Alice's measurement settings.

JW4A.22
Generation of Multi-mode NOON States with Three Photons Using Linear Optics, Lu Zhang[1], Kam Wai Clifford Chan[1]; *[1]Univ. of Oklahoma, USA.* We propose a setup to generate multi-mode NOON states with N=3 using single photons, coherent states, and single-photon detectors, which has great importance in simultaneous multi-phase estimation with higher efficiency than individual estimation.

JW4A.23
Electro-optic frequency beamsplitter for quantum networking applications, Hsuan-Hao Lu[1], Joseph M. Lukens[2], Nicholas A. Peters[2], Ogaga Odele[1], Andrew M. Weiner[1], Pavel Lougovski[2]; *[1]Purdue Univ., USA; [2]Oak Ridge National Lab, USA.* We implement a frequency beamsplitter for spectrally encoded photons, based on electro-optic modulation and Fourier-transform pulse shaping. The ultrahigh fidelity, bandwidth, and dense mode packing offer new potential for quantum interconnects.

JW4A.24
New Coherence Theorem, Xiao-Feng Qian[1], S Kizhakkumpurath Manikandan[1], A Al Qasimi[1], Nickolas Vamivakas[1], Joseph Eberly[1]; *[1]Univ. of Rochester, USA.* A new identity for optical coherence is derived. It generalizes the notion of polarization so that it is applicable in more than one way to any optical beam with multiple degrees of freedom.

JW4A.25
A low-power, electrically-controllable alkali source for cold-atom microsystems, Songbai Kang[1], Russell Mott[2], Kevin Gilmore[1,3], Logan Sorenson[2], Mattew Rakher[2], Elizabeth A. Donley[1], John . Kitching[1], Christopher Roper[2]; *[1]NIST, USA; [2]HRL , USA; [3]physics Dept., Univ. of Colorado Boulder, USA.* We develop a low-power, solid-state electrochemical alkali source. Vapor-phase sinking and sourcing of Rb atoms have been demonstrated with just 5 V opposite-polarity voltages. The device is of considerable interest for cold-atom microsystems.

JW4A.26
Generation of frequency-bin entangled narrowband biphotons and their Bell test, Xianxin Guo[1], Yefeng Mei[1], shengwang Du[1]; *[1]Physics, the Hong Kong Univ. of Science and Technology, Hong Kong.* We report the generation of frequency-bin entangled narrowband biphotons from spontaneous four-wave mixing (SFWM). Making use of time-resolved detection, we observe violation of the CHSH Bell inequality and confirm the genuine entanglement.

JW4A.27
Selective Detection of Picosecond Overlapping Quantum Modes, Amin Shahverdi[1], Yong Meng Sua[1], Yu-Ping Huang[1]; *[1]Stevens Inst. of Technology, USA.* We demonstrate selective frequency conversion of single photons in overlapping quantum modes of picosecond waveforms, achieving a detection signal-to-noise well exceeding the theoretical limit of the optimal time-frequency filtering.

JW4A.28
Cavity QED based Sequential Atom Entangler for Heisenberg-Limited Atom Interferometry, Sylvester Amoah[1]; *[1]Western Illinois Univ., USA.* We propose a cavity QED based sequential N-atom GHZ state generator. As GHZ states can be easily converted to path-entangled N00N states, this would open new pathways for Heisenberg-limited atom interferometry.

JW4A.29
Generation of hybrid entangled two photon state using classical non-separable state of the pump beam, Jabir M. V.[1], Apurv Chaitanya Nellikka[1], Goutam K Samanta[1]; *[1]Physical Research Lab, India.* We report on transfer of classical non-separable state in down-conversion process to generate twin photons entangled in both OAM and polarization degree of freedom. Measurement on entanglement witness operator showed that the state is entangled.

JW4A.30
Robust, bright entangled photon source based on type-0, non-collinear phase matching in periodically poled crystal, Jabir M. V.[1], Goutam K Samanta[1]; *[1]Physical Research Lab, India.* We demonstrate a novel source of high-brightness polarization entangled photons at room temperature. Using non-collinear phase-matching of PPKTP crystal we generate entangled state with 18.76kHz/mW/nm number of photon pairs, with fidelity ~0.975.

JW4A.31
Optimizing Coincidence Measurementsof Entangled Photons, Matthew Reichert[1], Hugo Defienne[1], Jason W. Fleischer[1]; *[1]Princeton Univ., USA.* We present the general SNR of coincidence measurements of joint probability of entangled-photon-pairs. Experiments with an EMCCD camera show excellent agreement for count rates up to saturation, and an optimum based on electronic noise.

JW4A.32
Withdrawn.

JW4A.33
Composable Security Analysis for Continuous-Variable Measurement-Device-Independent Quantum Key Distribution, Song Yu[1], Zhengyu Li[2], Yichen Zhang[1], Hong Guo[2]; *[1]Beijing Univ of Posts & Telecom, China; [2]Peking Univ., China.* We report the composable security analysis for continuous-variable measurement-device-independent quantum key distribution protocol, in which detection is conducted by an untrusted third party and naturally defend all detector side channels.

JW4A.34
Information Capacities of LTI Quantum Bosonic Channels, Jacob M. Leamer[1], Chenglong You[2], Bhaskar Roy Bardhan[3]; *[1]Physics, Grove City College, USA; [2]Physics, Hearne Inst. for Theoretical Physics and Louisiana State Univ., USA; [3]Physics, State Univ. of New York Geneseo, USA.* We investigate various information capacities of linear time invariant quantum bosonic channels representing amplification and attenuation in optical fiber communications. We compare these capacities with those of optical coherent detection.

JW4A.35
Periodic suppression and enhancement of spontaneous two-photon emission via interference, Dong-Gil Im[1], Yosep Kim[1], Yoon-Ho Kim[1]; *[1]Dept. of Physics, POSTECH, South Korea.* An effective periodic boundary condition can be introduced to spontaneous parametric down-conversion by using a continuous-wave multi-mode pump. We show this effect can result in periodic suppression and enhancement of spontaneous two-photon emission.

JW4A.36
High Speed Information Reconciliation for Long Distance Continuous-variable Quantum Key Distribution System, Xiangyu Wang[1], Yichen Zhang[1], Song Yu[1], Hong Guo[2]; *[1]Beijing Univ of Posts & Telecom, China; [2]Peking Univ., China.* We report the experiment realization of high speed information reconciliation for continuous-variable quantum key distribution system with multi-edge LDPC codes based on graphic processing unit where the average speed is up to 30.39 Mb/s.

JW4A.37
Joint Characterization of Two Single Photon Detectors with a Fiber-based Source of Entangled Photon Pairs, Daniel E. Jones[1], Brian T. Kirby[1], Michael Brodsky[1]; *[1]U.S. Army Research Lab, USA.* By simultaneously measuring individual and coincidence counts of two single photon detectors connected to an entangled photon pair source, we extract the detector efficiencies, the average number of generated pairs, and the Raman noise floor.

JW4A.38
Recovery of distributed quantum information in quantum networks, Ankur Raina[1], Priya Nadkarni[1], Shayan G. Srinivasa[1]; *[1]Electronic Systems Engineering, Indian Inst. of Science, India.* We use quantum networks to store quantum information in a distributed setting. We propose recovery methods to restore the stored quantum information in the event of failure of any of the nodes of the network.

JW4A.39
Entanglement enabled synthetic aperture in decohering environments, Siddhartha Santra[1], Brian T. Kirby[1], Vladimir S. Malinovsky[1], Michael Brodsky[1]; *[1]Army Research Lab, USA.* We propose a protocol for synthesizing large apertures in interferometry using imperfectly entangled quantum states shared between remote telescopes. The protocol is feasible in any environment and provides high-resolution images of distant sources.

JW4A.40
Raman spectroscopy study of Hydrogen Plasma Treatment effect on a single layer Graphene/MoS_2 hybrid structure, Anishkumar Soman[1], Jianping Shi[2], Ugochukwu Nsofor[1,3], Steve Hegedus[1,3], Yanfeng Zhang[2], Robert Burke[4], Tingyi Gu[1]; *[1]Univ. of Delaware, USA; [2]Peking Univ., China; [3]Inst. of Energy Conversion, USA; [4]US Army Research Lab, USA.* In this study we report the effect of hydrogen plasma treatment on Graphene/ MoS_2 hybrid heterostructures using Raman spectroscopy. The effect of plasma voltage on the defects has been investigated on graphene, MoS_2 and the hybrid structure.

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JW4A.41
All-Silicon Directional Coupler Electro-Optic Modulator Utilizing Transparent Conducting Oxides, Mohamed Badr[1], Mohamed Abdelatty[1,2], Mohamed A. Swillam[1]; *[1]Physics, American Univ. in Cairo, Egypt; [2]Basic Sciences, The British Univ. in Egypt, Egypt.* An all-silicon electro-optic modulator based on a transparent conducting oxide-integrated directional coupler is proposed. An extinction ratio (ER) of 8.45 dB and an insertion loss (IL) of 0.75 dB are achieved at 1.55 μm wavelength.

JW4A.42
Germanium metal-semiconductor-metal photodetectors grown on Silicon using low temperature RF-PECVD, Ghada Dushaq[1], Ammar Nayfeh[1], Mahmoud Rasras[1]; *[1]Masdar Inst., United Arab Emirates.* This paper presents a direct growth of germanium on silicon using standard RF-PECVD process at substrate temperature of 500C. Ge Metal-Semiconductor-Metal photodetectors (MSM) are fabricated and characterized based on this low temperature growth.

JW4A.43
Hybrid Plasmonic Electro-Optical Directional Coupler Based Modulator Based on Electrically Tuning the ITO's Properties, Mohamed Abdelatty[1,2], Mohamed M. Badr[1], Mohamed A. Swillam[1]; *[1]American Univ. in Cairo, Egypt; [2]Basic Sciences Dept., Faculty of Engineering, The British Univ. in Egypt, Egypt.* An optical directional coupler (ODC) based on two silicon-on-insulator waveguides separated by a hybrid plasmonic waveguide is studied. An extinction ratio of 5.275 dB is achieved at the telecommunications wavelength (1.55 μm).

JW4A.44
U-Bend Silicon Waveguide Interconnect for 3-D Multilayer Photonics Integrated Circuit, Vishnu Priye[1], Vikash Kumar[1]; *[1]Indian Inst. of Technology (ISM), Dhanbad, India.* Critical physical and geometrical parameters of the proposed U-bend silicon waveguide interconnect are ascertained for its application in multi-layered hybrid 3-D Photonics Integrated circuits. A possible fabrication methodology is also discussed.

JW4A.45
A Core-Shell Nanowire Platform for Silicon Photonics, Zhihuan Wang[1], Pouya Dianat[5], Kiana Montazeri[1], Baris Taskin[1], Marc Currie[2], Paola Prete[3], Nico Lovergine[4], Bahram Nabet[1]; *[1]Drexel Univ., USA; [2]Optical Sciences Division, Naval Research Lab, USA; [3]IMM-CNR, Inst. for Microelectronics and Microsystems, Italy; [4]Dept. of Innovation Engineering, Univ. of Salento, Italy; [5]Center for Quantum Devices, Northwestern Univ., USA.* Core-shell nanowires are versatile optoelectronic devices that can serve as light emitters, detectors and modulators. Here we offer a high-performance low-cost platform for heterogeneous photonic integrated circuits on silicon based on such nanowire.

JW4A.46
On-chip Integrated All-Optical Fast Fourier Transform: Design and Analysis, Hani Nejadriahi[1], Volker J. Sorger[1]; *[1]George Washington Univ., USA.* We report the design of an all-optical fast Fourier transform (FFT) on a silicon-photonics on-chip platform, show the phase-, amplitude-, and delay sensitivity of the transfer function, and a delay performance of 20 Tbps.

JW4A.47
Experimental Study of Integrated Cascade Silicon Bragg Gratings for Optical Delay Lines, Lingjun Jiang[1], Zuoxi Li[1], Stephen Anderson[1], Weimin Zhou[2], Zhaoran R. Huang[1]; *[1]Electrical, Computer and Systems Engineering, Rensselaer Polytechnic Inst., USA; [2]Sensors &Electron Devices Directorate, US Army Research Lab, USA.* We demonstrated cascade integrated silicon Bragg gratings for optical delay line applications. A maximum group index of 8.3 has been achieved. Long delay time is also enabled by cascading the gratings in dense integration.

JW4A.48
Design of a Novel Polarization-Independent Power Splitter Using Coupled Silicon Rib Waveguides, Swagata Samanta[1], Pallab Banerji[2], Pranabendu Ganguly[1]; *[1]Advanced Technology Development Centre, Indian Inst. of Technology Kharagpur, India; [2]Materials Science Centre, Indian Inst. of Technology Kharagpur, India.* Design of a three-coupled silicon rib waveguide based polarization-independent power splitter is presented taking into account excess loss in coupled region and total bending loss for double arc S-bends at the output.

JW4A.49
A Full Three-Dimensional Isotropic Carpet Cloak Designed by Transformation Optics, Daniely G. Silva[1], Poliane A. Teixeira[1], Lucas Gabrielli[2], Mateus Junqueira[1], Danilo Spadoti[1]; *[1]Federal Univ. of Itajubá, Brazil; [2]Univ. of Campinas, Brazil.* This work presents a 3D isotropic carpet cloak designed via transformation optics. A quasi-conformal mapping was obtained using numerical optimization. Simulations demonstrate the invisibility effect for arbitrary directions of incident waves.

JW4A.50
Research on cavity solitons in Kerr combs with pump feedback for flat broadband multi-wavelength source, Shaowu Chen[1], Xun Lei[1]; *[1]Inst. of Semiconductors, CAS, China.* We propose a Kerr comb generation scheme with pump feedback loop. Simulations show that the scheme can enhance the nonlinear energy conversion efficiency of comb and reduce the pump power level by about 32%.

JW4A.51
Hyperdoped Silicon Characterization and Photodetectors, Yining Liu[1]; *[1]Univ. of Dayton, USA.* Hyperdoped silicon is a promising material for infrared detection *via* intermediate band absorption. In this work, enhancement of IR absorption of hyperdoped silicon is demonstrated and methods for fabrication of Ohmic contacts are explored.

JW4A.52
Simulation of an Improved Beam Combiner Module (BCM) for Spatial Domain Multiplexing (SDM), Syed H. Murshid[1], Ce Su[1]; *[1]Florida Inst. of Technology, USA.* Spatial Domain Multiplexing (SDM) is a MIMO architecture that can significantly increase the bandwidth of optical fiber. A stable multiplexer is crucial for SDM. This paper presents a simulation for an improved multiplexer for SDM.

JW4A.53
Waveguide Superstructure Bragg Grating based Multiparametric Sensor for Pressure and Acceleration Measurement, Chandrika T. Nataraj[1], Shafeek A. Samad[1], Srinivas Talabatula[1], Gopalakrishna Hegde[1], Gurusiddappa R. Prashanth[2]; *[1]Indian Inst. of Science, India; [2]National Inst. of Technology, Goa, India.* We report here superstructure Bragg grating based multiparametric sensor using micro-machined diaphragm and cantilever beam. Coupled mode theory has been used to design and analyze the shift in wavelength due to applied pressure and acceleration.

JW4A.54
FDTD with an off-diagonal permittivity tensor component to study the magneto-optical effect in a slow light waveguide, Naotaka Kamioka[1], Tomohiro Tetsumoto[1], Takasumi Tanabe[1]; *[1]Keio Univ., Japan.* We develop and calculate the impact of the slow light effect on a magneto-optical isolator in a photonic crystal waveguide. We obtained an eight times larger isolation ratio in the slow light regime.

JW4A.55
Hybrid Photonic-Plasmonic Directional Coupler Enabled Optical Transceiver, Shuai Sun[1], Ruoyu Zhang[1], Jiaxin Peng[1], Vikram Narayana[1], Tarek El-Ghazawi[1], Volker J. Sorger[1]; *[1]George Washington Univ., USA.* We proposed a novel device structure termed Mo-detector for on-chip signal modulation and detection. With 180um^2 footprint, 37.4 fJ/bit energy efficiency and 167 GHz operating speed, Mo-detector has a great potential in inter-chip communication.

JW4A.56
Analysis of Stimulated Raman Scattering and Four-Wave Mixing Effects on Crosstalk of Multicore Fibers, Daniel Ceballos[2], Ramon Gutierrez-Castrejon[2], J. Javier Sanchez-Mondragon[1]; *[1]INAOE, Mexico; [2]Instituto de Ingenieria, Universidad Nacional Autonoma de Mexico, Mexico.* We report a numerical analysis of inter-core crosstalk in multicore fibers (MCFs) based on a dual-core-fiber model that includes Stimulated Raman Scattering (SRS) and Four Wave Mixing (FWM) nonlinearities in the presence of random perturbations.

JW4A.57
Reconfigurable All-Photonic Inter-Rack Interconnect for Data-Centers, Priyankar Roychowdhury[1], Ahmed Louri[1]; *[1]The George Washington Univ., USA.* In this paper, we have proposed a reconfigurable optical interconnect that can provide Tera bits per second throughput with micro second network latency to handle increasing machine-to-machine traffic in data-centers.

JW4A.58
Design of Elliptical Ring Core Fiber with support of four LP modes in SDM applications, Vigneswaran Dhasarathan[1], Manirajan Senthil[2]; *[1]Electronics and Communication, Sri Krishna College of Inst. of Technology, India; [2]Annna Univ., India.* We propose a novel fiber used for space division multiplexing (SDM) system which has elliptical ring core with dual cladding on the silica background.

JW4A.59
Experimental verification of two spatially multiplexed 10Gbps channels in single core multimode fibers for data center applications, Syed H. Murshid[1], Bilas Chowdhury[1], Engine Eyceyurt[1], Saud Alanzi[1]; *[1]Florida Inst. of Technology, USA.* This presents experimental validation of spatially multiplexed optical communication architecture by supporting two 9.95–11 Gbps, C-band channels of exactly the same wavelength in a single core multimode fiber to double the LAN channel capacity.

JW4A.60
Designing the Coupling Ratios in a Binary Driven 64-QAM Transmitter, Naji Albakay[1]; *[1]Univ. of Nebraska-Lincoln, USA.* This paper describes the design for the coupling ratios of the optical couplers in a binary driven 64-QAM transmitter. The design considers the optical insertion loss in order to generate a proper 64-QAM symbol constellation.

JW4A.61
Amplitude Equalization Analysis of Optical Frequency Combs Generated by Dual Drive Mach-Zehnder Modulator for High Capacity Optical Transmissions, Leonid A. Huancachoque[1], Aldario C. Bordonalli[1]; *[1]Dept. of Communications, Univ. of Campinas, Brazil.* An amplitude equalization analysis of optical frequency comb generation by a dual-drive Mach-Zehnder modulator is presented. The resulting algorithm allowed lower than 0.01 comb intensity standard deviation via modulating signal amplitude control.

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JW4A.62
Propagation Model for Spatially Multiplexed MIMO Optical Channels Combining Electromagnetic Wave and Modified Laguerre-Gaussian Beams, Syed H. Murshid[1], Bilas Chowdhury[1], Greg Lovell[1], Ibrahim Barka[1]; [1]*Florida Inst. of Technology, USA.* : A model characterizing spatially multiplexed (SDM) based optical channels, utilizing the modified LG beam equations is presented. This model allows for determination of independent modes of the SDM system architecture.

JW4A.63
Investigation of under/over sampling impact on the modulation format identification for high speed optical networks, Latifa Guesmi[1]; [1]*Sup'Com, Tunisia.* Sampling rate impact to the formats recognition is investigated in this paper. We report a novel method using pattern-recognition algorithm trained by amplitude histograms. Results show high recognition probabilities at increased sampling frequencies.

JW4A.64
Characterizing Large-Scale Production Reliability for 100G Optical Interconnect in Facebook Data Centers, Abhijit Chakravarty[1], Srinivasan Giridharan[1], Matt Kelly[1], Ashwin Poojary[1], Vincent Zeng[1]; [1]*Facebook Inc., USA.* Facebook is deploying cost effective 100G CWDM4 transceivers in data centers. This paper describes the post production performance monitoring system which is being implemented to identify optical interconnect early failure modes.

JW4A.65
100Gb/s CWDM4 Optical Interconnect at Facebook Data Centers for Bandwidth Enhancement, Abhijit Chakravarty[1], Katharine Schmidtke[1], Vincent Zeng[1], Srinivasan Giridharan[1], Cathie Deal[1], Reza Niazmand[1]; [1]*Facebook Inc, USA.* Facebook has developed 100G data centers from the ground-up by fine tuning optical technologies, optimizing link-budget, limiting operating temperatures and ultimately improving manufacturability. 100G-CWDM4 is an effective technology to enable connectivity over duplex single-mode fiber.

JW4A.66
Near-field absorption imaging by two color Raman nano-light source, Ryo Kato[1], Yuika Saito[2], Takayuki Umakoshi[1], Prabhat Verma[1]; [1]*Osaka Univ., Japan;* [2]*Gakusyuin Univ., Japan.* We demonstrate new nano-imaging technique for intrinsic absorption properties of materials using near-field scanning optical microscopy. Raman scattering from the apex of a silicon nano-tip was used as probe light for nano-scale absorption analysis.

JW4A.67
Fiber Cantilever Based Acoustic Sensor, Sumit Dass[1], Suman halder[1], Jitendra Sharma[1], Rajan Jha[1]; [1]*Indian Inst of Technology, Bhubaneswar, India.* A low-cost high sensitivity SMF micro tip in cantilever configuration based acoustic sensor is demonstrated. For cantilever length of 11.2 mm, sensor shows a linear response in frequency range of 100 - 600 Hz.

JW4A.68
Refractive index liquid sensing based on bound states in photonic crystal slabs, Yonghao Liu[1], Deyin Zhao[1], Weidong Zhou[1], Yuze Sun[1]; [1]*Univ. of Texas at Arlington, USA.* We theoretically investigate the bound states in free-space coupled defect-free photonic crystal slabs at discrete vector ***k*** points for refractive index sensing to achieve low detection limit.

JW4A.69
SPR Based Fiber Optic Quercetin Biosensor Utilizing rGO: PPy: Chitosan Nanocomposite Network, Ravi Kant[1], Banshi D. Gupta[1]; [1]*Indian Inst. of Technology, Delhi, India.* Synthesis of nanocomposite network of rGO: PPy: Chitosan and its application for quercetin detection utilizing fiber optic SPR is presented. The sensor is loaded with myriad advantages with an operating range of 0.001-10 μM.

JW4A.70
Temperature Sensor Based on two twin biconical-taper fiber fabricated with Standard Fiber, Julian Moises Estudillo Ayala[1], Emmanuel A. Hernández-Robles[1], Juan M. Sierra Hernandez[1], Roberto Rojas-Laguna[1], Daniel Jauregui-Vazquez[1], Yanelis Lopez-Dieguez[1], Javier A. Martin Vela[1], Juan C. Hernandez-Garcia[1]; [1]*Universidad De Guanajuato, Mexico.* A temperature sensor based on a Mach-Zehnder interferometer is proposed. In the SMF-28 fiber the Mach- Zehnder interferometer is fabricated with two concatenated tapers, with a waist diameter of 25 ~ 40 μm.

JW4A.71
CW Triggering in CW Pumped Supercontinuum Generation, Cai Wen[1], Peng Lu[1], H.Y. Fu[2], Qian Li[1]; [1]*Peking Univ. Shenzhen Graduate School, China;* [2]*Tsinghua-Berkeley Shenzhen Inst., China.* We investigate the influence of the CW trigger's intensity on CW pumped SC generation and a moderate intensity of the CW trigger is further suggested.

JW4A.72
Tunable dual-wavelength thulium-doped fiber laser in the range from 2067 to 2073.5 nm, Manuel Duran-Sanchez[1], Ricardo Ivan Alvarez Tamayo[2], B. Posada-Ramirez[1], Baldemar Ibarra-Escamilla[1], Evgeny Kuzin[1], Miguel Vicente Andres[3]; [1]*INAOE, Mexico;* [2]*Universidad Autónoma de Nuevo Leon, Mexico;* [3]*Universidad de Valencia, Spain.* A tunable dual-wavelength lineal cavity Tm-doped fiber laser is presented. The generation of the laser lines is based on the use of cascaded fiber Bragg gratings and a Hi-Bi fiber optic loop mirror.

JW4A.73
Results for the Measured Field of View for an Omni-directional Free Space Optical Receiver Architecture, Syed H. Murshid[1], Bilas Chowdhury[1], Michael Finch[1], Greg Lovell[1], Charles Curt[1]; [1]*Florida Inst. of Technology, USA.* Free space optical communication provides fiber optic bandwidths in a wireless environment. A fiber bundle employed as an omni-directional O-FSO receiver will be experimentally studied and normalized received optical power patterns will be presented.

JW4A.74
Intermodal Suppression of Spectral Broadening in Normal Dispersion Few-Mode Fibers, Shaival Buch[1], Govind P. Agrawal[1]; [1]*Univ. of Rochester, USA.* We observe and investigate suppression of spectral broadening in the fundamental mode of a few-mode fiber owing to intermodal nonlinear effects caused by the presence of energy in the higher-order mode.

JW4A.75
Formation of Optical Trajectories in the Photopolymer Material during Self-Written Waveguides Process, Ra'ed Malallah[1,2], Derek Cassidy [1], Inbarasan Muniraj [1], Liang Zhao [1], John Sheridan[1]; [1]*Univ. College Dublin, Ireland;* [2]*Physics, Univ. of Basrah, Iraq.* During the SWWs process, the optical waveguide trajectories formed in an AA/PVA a photopolymer material photosensitive at 532 nm are examined. The largest index changes taking place at any time during the exposure are present.

JW4A.76
Nonlinear Optical Properties of *Hoplia coerulea*, Charlotte Verstraete[1], Sébastien R. Mouchet[2], Stijn Van Cleuvenbergen[1], Peter Vukusic[2], Branko Kolaric[3], Thierry Verbiest[1]; [1]*Chemistry, KU Leuven, Belgium;* [2]*School of Physics, Univ. of Exeter, UK;* [3]*Physics, Univ. of Mons, Belgium. H. coerulea*'s elytra show a strong two-photon fluorescence signal, which depends on the presence of water in the photonic structure. A polarization-dependent Third Harmonic Generation signal was detected as well and thoroughly investigated.

JW4A.77
Fabrication and Characterization of an All-solid Double-clad Tellurite Photonic Bandgap Fiber, Tonglei Cheng[1], Shunta Tanaka[1], Tong Hoang Tuan[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; [1]*ofmlab, Japan.* An all-solid double-clad tellurite photonic bandgap fiber is fabricated based on three glasses. Photonic bandgap properties are calculated by the plane wave expansion method, and the results agree well with the measured transmission spectrum.

JW4A.78
Independent-Tunable Dual-wavelength Thulium-Doped Fiber Laser Based on an In-Fiber Interferometers Array, Marco V. Hernández-Arriaga[1], Baldemar Ibarra-Escamilla[1], Manuel Durán-Sánchez[2], Hector Santiago-Hernandez[1], Evgeny Kuzin[1]; [1]*INAOE, Mexico;* [2]*CONACyT, Mexico.* A tunable dual-wavelength ring cavity Tm-doped fiber laser is presented. This configuration based on tapered fibers enables independent-tunable laser peaks (λ_1, λ_2) from 1844.6 to 1835.1 nm and from 1930.3 to 1934.3 nm, respectively.

JW4A.80
Geometrical Volume-Nonlinear Optical Property Relationship of Carbon Nanotubes, Vijayakumar Sadasivan Nair[1], Chandra S. Yelleswarapu[1]; [1]*Univ. of Massachusetts Boston, USA.* We studied the influence of geometrical volume on nonlinear absorption and scattering properties of carbon nanotube (CNT) suspensions. Results show an inverse relationship attributing to the generation of nonlinear laser induced scattering sites.

JW4A.81
Yb-Doped Fluorosilicate Optical Fiber Development For Laser Cooling and Radiation Balancing Applications, Peter D. Dragic[1], Maxime Cavillon[2], Andrey Mironov[1], courtney kucera[2], Thomas Hawkins[2], J. G. Eden[1], John Ballato[2]; [1]*Univ of Illinois at Urbana-Champaign, USA;* [2]*Clemson Univ., USA.* With F content greater than about 5at%, Yb-doped fluorosilicate fibers exhibit the short average emission wavelengths and long lifetimes characteristic of the fluoride glasses used in cooling applications. Evidence of cooling behavior is presented.

JW4A.82
Analysis of Long Period Fiber Gratings Sensor Systems for Aircraft Wing Drag Optimization, Alex A. Kazemi[1]; [1]*MC 0L73, The Boeing Compnay, USA.* In this paper we focus on the testing and aviation requirements for LPFG sensors. We discuss drag analsysie optimization and the bases of aviation standards for fiber optic sensor measurements, and the quantities that are measured.

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JW4A.83
Transport Quantities in Random 1D System, Yiming Huang[1,2], Xujun Ma[1,2], Xiaojun Cheng[1,2], Cassandra Imperato[1], YUHAO KANG[1,2], Azriel Genack[1], Victor Gopar[1,3], Miztli Yepez[4], Pier Mello[5]; [1]*Physics, Queens College, CUNY, USA;* [2]*Physics, The Graduate Center, USA;* [3]*Universidad de Zaragoza, Spain;* [4]*Departamento de Física, Universidad Autónoma Metropolitana-Iztapalapa, Mexico;* [5]*Instituto of Física, Universidad Nacional Autónoma de México, Mexico.* We find the statistics of the logarithm of energy density inside random 1D system with and without a reflector using random matrix theory and microwave experiments. The results extend and correct the single-parameter scaling hypothesis.

JW4A.84
Low-loss photonic Nulling Interferometer in the Mid-Infrared for Astronomical Applications, Thomas Gretzinger[1,2], Simon Gross[1,2], Alexander Arriola[1,2], Peter Tuthill[3], Michael Withford[1,2]; [1]*Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS), Australia;* [2]*Physics and Astronomy, MQ Photonics Research Centre, Macquarie Univ., Australia;* [3]*Sydney Inst. for Astronomy, School of Physics, The Univ. of Sydney, Australia.* We report the fabrication of a photonic Nulling Interferometer in Gallium Lanthanum Sulphide operating at 4 µm. The device has low propagion loss waveguides of 0.22 ± 0.02 dB/cm, which is sufficient enough to perform on-sky experiments.

JW4A.85
Fiber Bragg Strain Sensor Calibration System Based on Mechanical Nanomotion Transducer, Vladimir A. Lazarev[1], Mikhail K. Tarabrin[1,2], Valerii E. Karasik[1]; [1]*Science and Education Center for Photonics and IR-Technology, Bauman Moscow State Technical Univ., Russia;* [2]*Frequency Standards Lab, P. N. Lebedev Physical Inst. of the Russian Academy of Sciences, Russia.* FBG strain sensor fabrication processes can lead to nonlinear behavior that affects the accuracy of measurements. We present a calibration technique for FBG sensors. The performance of FBG sensor was investigated, and calibration curve is presented.

JW4A.86
Nonlinear Optical Characterization of Gorilla® Glass Waveguides, Franciele Henrique[1], Gustavo F. Almeida[1], Jonathas P. Siqueira[1], Renato J. Martins[1], Cleber R. Mendonça[1]; [1]*São Carlos Inst. of Physics, Univ. of São Paulo, Brazil.* We performed Dispersive-scan measurements in waveguides produced in Gorilla® Glass to determine the nonlinear refractive index of the compression layer. Our results indicate that its value is close to the one for fused silica.

JW4A.87
Generation of flat supercontinuum spectrum pumped by amplified noise-like pulses from a figure-eight fiber laser, Erika N. Hernandez[1], Miguel Ángel Bello Jiménez[1], Olivier Pottiez[2], Baldemar Ibarra-Escamilla[3], Rosa E. López-Estopier[1,4], Manuel Duran-Sanchez[3,4], Evgeny Kuzin[3]; [1]*Instituto de Investigación en Comunicación Óptica,Universidad Autónoma de San Luis Potosí, Mexico;* [2]*CIO, Mexico;* [3]*INAOE, Mexico;* [4]*Consejo Nacional de Ciencia y Tecnología (CONACYT), Mexico.* A figure-eight fiber laser and their application for supercontinuum generation in the anomalous dispersion regime is presented. Flat uniformity of around 3-dB in the range from 1261 to 2261 nm is achieved.

JW4A.88
Objective-lens-free Fiber based Position Detection with Nanometer Resolution in a Fiber Optical Trapping System, Chaoyang Ti[1], Yao Shen[1], Minh-Tri Ho Thanh[1], Qi Wen[1], Yuxiang Liu[1]; [1]*Worcester Polytechnic Inst., USA.* We develop an objective-lens-free fiber optical trapping system for applying force and sensing particle motion with nanometer resolution. We used this system to measure cellular response to external mechanical stimuli in real time.

JW4A.89
Stability of a Fiber Optical Parametric Oscillator With and Without a Seed Signal, Ioannis Begleris[1], Peter Horak[1]; [1]*Univerity of Southampton, UK.* We present a numerical model of a unidirectional fiber optical parametric oscillator. Power fluctuations between signal round-trips are investigated and found to be significant. Finally, the option of seeding the signal wave is discussed.

JW4A.90
Laser Linewidth and the Thermal Grating Generation of TMI in kW-class Fiber Amplifiers, Marc D. Mermelstein[1]; [1]*MDM Optics, LLC, USA.* Abstract: The laser linewidth dependence to TMI generated by a thermal grating (TG) is examined. Laser linewidths comparable to the thermal relaxation time are required for TMI generation. This result conflicts with experimental demonstrations.

JW4A.91
Two-Photon Circular-Linear Dichroism on a Binaphtalene-based Polymer, Jessica -. Dipold[1], Guy Koeckelberghs[3], Marcelo G. Vivas[2], Leonardo De Boni[1], Cleber R. Mendonça[1]; [1]*Instituto de Física de São Carlos, Brazil;* [2]*Instituto de Ciência e Tecnologia, Universidade Federal de Alfenas, Brazil;* [3]*Lab of Macromolecular and Physical Organic Chemistry, Katholieke Universiteit Leuven, Belgium.* Two-photon absorption cross-section and circular-linear dichroism spectra of a polymer was studied for different polarization.The studies show that there are 2 possible final states for the two-photon transition, with largest cross-section of 584 GM.

JW4A.92
Investigation of an optimal coupling condition with a nanobeam cavity made of low refractive index material, Tomohiro Tetsumoto[1], Hajime Kumazaki[1], Kentaro Furusawa[2], Norihiko Sekine[2], Takasumi Tanabe[1]; [1]*Keio Univ., Japan;* [2]*National Inst. of Information and Communications Technology, Japan.* We investigated an optimized coupling condition in a side-coupled cavity system consisting of a silica nanobeam cavity and a nanofiber. We achieved a high coupling efficiency of 89% with a loaded Q of over 10^4.

JW4A.93
Bi-tapered fiber sensor using a supercontinuum light source, Diego Garcia Mina[1], Andy Chong[1], Ankita Khanolkar[1], Karolyn Hansen[1], Joseph W. Haus[1]; [1]*Univ. of Dayton, USA.* We developed a bi-tapered optical fiber and studied its transmission properties using a sub-micron wavelength, fiber-based, supercontinuum light source. We successfully tested the sensitivity of our fiber sensor with aqueous solutions.

JW4A.94
Waveguide Grating Couplers in Overlaid Chips: Efficiency Optimization and Angular Misalignment Simulation, Congshan Wan[1], Muhannad S. Bakir[1], Thomas K. Gaylord[1]; [1]*Georgia Inst. of Technology, USA.* Applying reflectors adds 30%~40% to the diffraction efficiencies of binary waveguide gratings. The greatest angular misalignment sensitivity occurs for rotations about the grating groove axis and rotation should be limited to ±3°.

JW4A.95
Effect of Linear Coupling on Nonlinear Phase Noise in Two-Core Fibers, Nestor Lozano-Crisostomo[1], Julio C. Garcia-Melgarejo[1], Jose E. Rocha Medina[1], Alfonso J. Salas-Sanchez[4], Daniel A. May-Arrioja[2], J. Javier Sanchez-Mondragon[3]; [1]*Facultad de Ingenieria Mecanica y Electrica, Universidad Autonoma de Coahuila, Mexico;* [2]*Centro de Investigaciones en Óptica, Mexico;* [3]*Departamento de Optica, Instituto Nacional de Astrofisica, Optica y Electronica, Mexico;* [4]*Universidad Autonoma de Sinaloa, Mexico.* Considering the elementary two-core fiber (TCF) switching process, we describe how the linear coupling in a TCF affects the nonlinear phase noise of initial amplified pulses.

JW4A.96
Spatial coherence of localized modes in an Anderson localizing optical fiber, Behnam Abaie[1], Thomas Hawkins[2], John Ballato[2], Arash Mafi[1]; [1]*Univ. of New Mexico, USA;* [2]*Clemson Univ., USA.* Exciting a localized beam in an Anderson localizing fiber results in a high degree of output spatial coherence. The fringe patterns resemble those from singlemode fibers, indicating that a single localized mode is predominantly excited.

JW4A.97
Langevin Approach Analysis of the Frequency Noise in Quantum Cascade Lasers, Xing-Guang Wang[1], Cheng Wang[1]; [1]*ShanghaiTech Univ., China.* This work investigates the frequency noise of quantum cascade lasers using the Langevin approach. It is found that the frequency noise spectrum exhibits a broad peak, and the intrinsic linewidth deviates from the Schawlow-Townes limit.

JW4A.98
Laser Line Selection from a Broadband Erbium Doped Fiber Ring Laser Using a Versatile Intra-Cavity Filter, Suchita Yadav[2], Vijaya R[2,1]; [1]*Centre for Lasers and Photonics, Indian Inst. of Technology Kanpur, India;* [2]*Dept. of Physics, Indian Inst. of Technology Kanpur, India.* The possibility of selecting multiple spectrally narrow laser lines of width up to 0.08nm is demonstrated using a Mach-Zehnder interferometer-based filter inside the cavity of a broadband erbium doped fiber ring laser.

JW4A.99
Non-permanent graded-index waveguide-inscription in bulk chalcogenides., Nicholas Nye[1], Soroush Shabahang[1], Christos Markos[1,2], Demetrios Christodoulides[1], Ayman Abouraddy[1]; [1]*Univ. of Central Florida, CREOL, USA;* [2]*DTU Fotonik, Denmark.* Conventional waveguide-writing techniques in bulk chalcogenides rely on permanent photo-structural changes,which lead to ridge-like guiding channels. Here, we demonstrate non-permanent opto-thermally induced graded-index waveguides in As_2Se_3 glass.

JW4A.100
Writing 2nd Order Reflective Volume Bragg Grating in PQ:PMMA, Te-yuan Chung[1], Yu-Hua Hsieh[1], Wan-Ting Hsu[1], Bao-Jen Shih[1], Shiuan-Huei Lin[2]; [1]*National Central Univ., Taiwan;* [2]*National Chiao Tung unversity, Taiwan.* A thorough study on the rate equations of recording PQ:PMMA volume Bragg grating is performed. Base on the rate equations, 2nd order grating recording in PQ:PMMA is confirmed by the experiment.

JW4A.101
Effects of Fog in Free-Space Optics Communication System, Indira Marília A. Almeida[2,1], Eduardo J. Aiub[1], Lucia A. Saito[1], Jose J. Ribeiro[2]; [1]*Mackenzie Presbyterian Univ., Brazil;* [2]*Instituto Nacional de Telecomunicações (INATEL), Brazil.* We demonstrated experimental results of fog effects in Free Space Optics system in visible and near-infrared for different relative humidity. Ultrashort pulses and eye diagram analysis indicate acceptable transmission requirements at 90% RH.

JW4A.102
Multimode Interference based All-Fiber Selective Mode Launcher for Few Mode Fiber Applications, Nitin Bhatia[1], Shailendra K. Varshney[1]; [1]*Indian Inst. of Technology Kharagpur, India.* We demonstrate an all-fiber multimode interference device for achieving controlled and repeatable mode launching condition in a few mode fiber. The device is easy to design, quick to customize, and require bare minimum equipments for fabrication.

JW4A • Joint Poster Session IV—Continued

JW4A.103
Modulation Instability in the Weak Dispersion Regime of Dispersion Oscillating Fiber-ring Cavity, Francois Copie[2], Matteo Conforti[2], Alexandre Kudlinski[2], Stefano Trillo[1], Arnaud Mussot[2]; *[1]Dept. of Engineering, Univ. of Ferrara, Italy; [2]Physique des Lasers Atomes et Molécules (PhLAM), Univ. of Lille, France.* We investigate modulation instability in a dispersion modulated passive fiber-ring cavity with very a low local dispersion. In this configuration, an unprecedented number of spectral sidelobes are observed, related to Faraday parametric resonances.

JW4A.104
Fabrication of Fiber Based Inline Micro Air Cavities with Tunable Geometrical Parameters, Jitendra N. Dash[1], Rajan Jha[1]; *[1]IIT bhubaneswar, India.* We report a novel procedure to fabricate fiber based inline micro air cavities with tunable geometrical parameters over a wide range by tuning the length of hollow core photonic crystal fiber and splicing parameters.

JW4A.105
Application of optical analog of two-photon Rabi oscillations in polarization splitter, Pragati Aashna[1], K Thyagarajan[1]; *[1]Indian Inst. of Technology, Delhi, India.* We report the design of a polarization splitter based on two-photon Rabi oscillations in a three waveguide directional coupler. We show the practical feasibility of the device by carrying out simulations in lithium niobate waveguides.

JW4A.106
Optical Temperature Sensing in NaYSiO4:Er3+/Yb3+ Upconvesion Phosphors, Xiaojie Xue[1], Tonglei Cheng[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; *[1]Toyota Technological Inst., Japan.* Er3+/Yb3+ co-doped NaYSiO4 upconversion phosphors were successfully synthesized for optical temperature sensing. The sensitivity of this sensor was about 0.0047 K^{-1} at 573 K.

JW4A.107
An Efficient Spatial Domain Optical De-Multiplexer Design, Syed H. Murshid[1], Engine Eyceyurt[1]; *[1]Florida Inst. of Technology, USA.* An efficient optical based spatial domain de-multiplexer design is presented and simulation results of the demodulation in CODE V are given. The system is designed to minimize the light power loss in de-multiplexer part.

JW4A.108
Control of Optical Rogue Waves in CW Pumped Supercontinuum With a Weak Femtosecond Pulse Seed, peng lu[1], Qian Li[1]; *[1]Peking Univ., China.* We numerically demonstrate the improvement of spectrum bandwidth and pulse-to-pulse stability of continuous wave pumped supercontinuum generation by applying a weak coherent femtosecond pulse seed.

JW4A.109
Energy Density Distributions in the Interior of Random and Periodic Samples, Xiaojun Cheng[1,2], Yuhao Kang[1,2], Yiming Huang[1,2], Azriel Genack[1,2]; *[1]CUNY Queens College, USA; [2]Graduate Center, City Univ. of New York, USA.* We find the average of the logarithm of the energy density decays linearly inside samples with different degrees of structural correlation. The fall-off rate initially decreases and then increases slightly with increasing disorder.

JW4A.110
Simulation of multi-wavelength SDM systems with OAM using ZEMAX and MATLAB, Syed H. Murshid[1], Bilas Chowdhury[1], Han Wang[1]; *[1]Florida Inst. of Technology, USA.* Experimental analysis of spatial multiplexed systems has shown independence of both wavelength division and orbital angular momentum multiplexing. In order to validate this a simulated analysis is performed on the system and presented.

JW4A.111
Optical rouge wave generation in dielectrics with correlated fluctuations of refractive index, Mostafa Peysokhan[1], Esmaeil Mobini[1], John Keeney[1], Arash Mafi[1]; *[1]Univ. of New Mexico, USA.* We study rouge wave generation for the propagation of light in a dielectric with correlated fluctuations of its refractive index and observe that with increasing the correlation length, the probability of rouge wave generation increases.

JW4A.112
Application of Bessel-Gaussian Beams to Model Spatial Domain Multiplexing, Syed H. Murshid[1], Greg Lovell[1]; *[1]Florida Inst. of Technology, USA.* Presented is a basic mathematical model for single core spatial domain multiplexing (SDM) utilizing Bessel-Gaussian Beams. This model will theoretically allow accurate modeling of SDM to allow more optimal use in optical fiber communication systems.

JW4A.113
Edge states between photonic topological insulator domains emulating Quantum Spin Hall and Quantum Valley Hall effects, Yuhao Kang[1,2], Xiaojun Cheng[1,2], Xiang Ni[3,2], Alexander Khanikaev[3,2], Azriel Genack[1,2]; *[1]Queens College, CUNY, USA; [2]The Graduate Center of the City Univ. of New York, USA; [3]The City College of the City Univ. of New York, USA.* We observe edge states between domains of photonic systems emulating quantum valley-Hall and spin-Hall states by measuring transmission spectra. The robustness of photonic transport along the edge is tested by measuring group velocity.

JW4A.114
Conservation of Topological Charge During Diffraction Through a Triangular Aperture, José Carlos A. Rocha[1], João Paulo Amaral[1], Alcenísio José Jesus Silva[1], Eduardo Jorge Silva Fonseca[1]; *[1]Universidade Federal de Alagoas, Brazil.* We break the symmetry of non-generic singularities in Laguerre-Gauss fields by diffraction through a triangular aperture and studied their propagation. Conservation of topological charges is also observed.

JW4A.115
Multi-pulse dynamics in a full polarization-controlled passively mode-locked Er-Fiber laser, HECTOR SANTIAGO-HERNANDEZ[1], Yazmin E. Bracamontes-Rodríguez[4], Baldemar Ibarra-Escamilla[1], Manuel Durán-Sánchez[2,1], G. Beltrán-Pérez[3], Olivier Pottiez[4], Ivan Armas-Rivera[3], Luis A. Rodríguez-Morales[1], Marco Hernández-Arriaga[1], Evgeny Kuzin[1]; *[1]Óptica, Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico; [2]Consejo Nacional de Ciencia y Tecnología, Mexico; [3]Benemérita Universidad Autónoma de Puebla, Mexico; [4]Centro de Investigaciones en Optica, Mexico.* We report the experimental study of multi-pulse dynamics in a passively mode locked-fiber laser with total control of polarization finding the condition to generate reproducible noise-like pulse, soliton molecules, bound solitons and single soliton.

JW4A.116
Unique propagation characteristics of Airy pulsen under cubic phase modulation in linear regime, Aritra Banerjee[1], Samudra Roy[1]; *[1]IIT Kharagpur, India.* We theoretically demonstrate that temporal flipping and distortion of a propagating truncated airy pulse under third order dispersion can be prevented by cubic phase modulation (CMP). The shape preservation of pulse under CPM is confirmed numerically.

JW4A.117
GaSb-core Optical Fibers, Seunghan Song[1], Noel Healy[3], Ulf Österberg[1], Michael Fokine[2], Trygve Sørgård[1], Anna Peacock[4], Ursula J. Gibson[1,2]; *[1]Norges Teknisk Naturvitenskapelige Univ, Norway; [2]Dept. of Applied Physics, KTH Royal Inst. of Technology, Sweden; [3]Newcastle Univ., UK; [4]Univ. of Southampton, UK.* This paper reports recent results on the formation of GaSb-core fibers, formed by molten-core drawing. Purity, crystallographic results and preliminary photoluminescence data are provided for both the as-drawn and laser annealed fibers.

JW4A.118
Effect of two-photon absorption on cavity soliton: stability and perturbation analysis, Ambaresh Sahoo[1], Samudra Roy[1]; *[1]Indian Inst. of Technology Kharagpur, India.* We study the stability criteria and propagation dynamics of cavity soliton under two-photon absorption by solving Lugiato-Lefever equation numerically. A semi-analytical variational technique is further adopted to explain the complete dynamics.

JW4A.119
Nonreciprocal modal conversion via strongly coupled nonlinear dynamics in multimode fibers, Hamed Pourbeyram[1], Arash Mafi[1]; *[1]Univ. of New Mexico, USA.* Strong coupling between a phase-matched parametric process and a nonlinear mode coupling results in a non-reciprocal mode conversion in a multimode fiber. The novel experimental features can be used for greater modal control in fibers.

JW4A.120
Nanostructural-Core Photonic Crystal Fiber with Very Low Negative Dispersion for Nonlinear Applications, Pooja Chauhan[1], Ajeet Kumar[1], Than Singh Saini[2], Yogita Kalra[1]; *[1]Delhi Technological Univ., India; [2]Advanced Materials and Sensors Division, CSIR-Central Scientific Instruments Organization, Sector-30C, Chandigarh, India.* We have designed a nanostructural–core photonic crystal fiber in pure silica glass. The reported structure has a very low and flat dispersion of -0.07 ps/nm.Km and very high nonlinear coefficient of 64.57 $W^{-1}Km^{-1}$ at zero dispersion wavelength.

JW4A.121
On possibility of substance absorption lines identification at the THz pulse frequency up-conversion, V. A. Trofimov[1], Dmitry Y. Zagursky[1], Irina Zakharova[1]; *[1]M. V. Lomonosov Moscow State Univ., Russia.* Using computer simulation we demonstrate a transform of substance absorption properties due to SHG of few-cycle THz pulse that transmits through the substance.

JW4A.122
Effects of Fluctuations of Pulse Duration and Peak Power on the Coherence Properties of Supercontinuum Spectra, Lai Liu[1], Kenshiro Nagasaka[1], Takenobu Suzuki[1], Yasutake Ohishi[1]; *[1]Toyota Technological Inst., Japan.* The effects of fluctuations of pulse duration and peak power on the coherence properties of supercontinuum spectra in fibers with all-normal dispersion have been numerically investigated by solving the generalized nonlinear Schrödinger equation.

JW4A.123
Optical Bistability in dual core directional coupler with negative index material channel, Kanagaraj Nithyanandan[1]; *[1]Dept. de Physique, Universite de Bourgogne, France.* We observe that the oppositely directed coupler possesses Bistability. This property arises due to effective feedback mechanism as a result of opposite directionality of the phase velocity and energy flow in the negative index materials.

15:00–16:30
FW5A • Silicon Photonics II
Presider: Oleg Sinkin; Subcom, USA

FW5A.1 • 15:00 Invited
Amorphous silicon photonics for nonlinear and quantum interactions, Amy C. Foster[1]; [1]*Johns Hopkins Univ., USA.* Hydrogenated amorphous silicon (a-Si:H) is a promising CMOS-compatible material for nonlinear integrated photonics due to its high nonlinearity and compatibility with 3D integration. Recent progress in a-Si:H for nonlinear and quantum applications will be discussed.

FW5A.2 • 15:30
Photonic Crystal with Buried Heterostructure Platform for Laser Devices Directly Bonded to Si, Aurimas Sakanas[1], Yi Yu[1], Elizaveta Semenova[1], Luisa Ottaviano[1], Hitesh K. Sahoo[1], Jesper Mørk[1], Kresten Yvind[1]; [1]*Technical Univ. of Denmark, Denmark.* In pursuit of fabricating compact and efficient light sources for optical interconnects on Si, our directly bonded InP buried heterostructure photonic crystal membrane lasers benefit from the separation between active and passive material regions.

FW5A.3 • 15:45
Lens-Free Chip-to-Chip Free-Space Laser Communication Link with a Silicon Photonics Optical Phased Array, Christopher V. Poulton[1], Diedrik Vermeulen[1], Ehsan Hosseini[1], Erman Timurdogan[1], Zhan Su[1], Ben Moss[1], Michael R. Watts[1]; [1]*Analog Photonics, USA.* We demonstrate a record free-space 50m laser communication link between a silicon photonics optical phased array and an avalanche photodetector at 100Mbps. This lens-free technology opens the door to compact low-cost long-distance optical links.

FW5A.4 • 16:00
Characterization of a Coherent-Perfect-Absorption-based DPSK Demodulator for Si Photonics, Asif Ahmed[1], Hao Yang[1], Brian Souhan[2], Zhao Wang[3], Christopher Evans[5], Joel M. Hensley[5], Jerry I. Dadap[1], Andrew P. Knights[3], Richard Grote[4], Richard M. Osgood[1]; [1]*Columbia Univ., USA;* [2]*USA Military Academy, USA;* [3]*McMaster Univ., Canada;* [4]*Univ. of Pennsylvania, USA;* [5]*Physical Sciences Inc, USA.* We characterize a novel DPSK demodulator for Si photonics using coherent perfect absorption in ring resonator. The fabricated devices are matched with design parameters by measuring transmission spectra in the C-band of telecommunication wavelength.

FW5A.5 • 16:15
A hybrid silicon-phosphorene nanolaser, Chad A. Husko[1], Joohoon Kang[2], Joshua Wood[2], Gregory moille[3], Zheng Han[3], David Gosztola[1], Xuedan Ma[1], Sylvain Combrie[4], Alfredo De Rossi[4], Mark Hersam[2], Xavier Checoury[3], Jeff Guest[1]; [1]*Argonne National Lab, USA;* [2]*Northwestern Univ., USA;* [3]*Centre de Nanosciences et de Nanotechnologies, France;* [4]*Thales Research and Technology, France.* We show evidence of lasing from a hybrid nanostructure composed of a silicon optical resonator and a two-dimensional phosphorene film. The ~1555 nm emission wavelength opens possibilities for optically-active devices for integrated silicon photonics.

15:00–16:30
FW5B • Shaping, Phase and Microscopy
Presider: Laura Waller; University of California Berkeley, USA

FW5B.1 • 15:00 Invited
Structural microscopy via engineered scattered light, Hilton B. de Aguiar[1], Sylvain Gigan[3], Sophie Brasselet[2]; [1]*Département de Physique, Ecole Normale Supérieure/Paris, France;* [2]*Institut Fresnel, France;* [3]*Laboratoire Kastler-Brossel, France.* Scattered light has always been seen as a nuisance in high resolution structural microscopy. We will review our recent efforts on using wavefront shaping to control complex light in order to enable molecular-level structural microscopy.

FW5B.2 • 15:30
Customizing Speckle Statistics, Nicholas Bender[1], Hasan Yilmaz[1], Yaron Bromberg[2], Hui Cao[1]; [1]*Yale Univ., USA;* [2]*The Racah Inst. of Physics, The Hebrew Univ. of Jerusalem, Israel.* We develop a general method for customizing speckle statistics. Using a phase-only spatial light modulator we experimentally generate speckle patterns with arbitrarily-tailored intensity probability-distributions, over a finite intensity range.

FW5B.3 • 15:45
Achieving the gauge potential in a synthetic space using coherent Raman sideband generation, Luqi Yuan[1], Da-wei Wang[2], Shanhui Fan[1]; [1]*Dept. of Electrical Engineering and Ginzton Lab, Stanford Univ., USA;* [2]*Dept. of Physics & Astronomy and Inst. for Quantum Science and Engineering, Texas A&M Univ., USA.* We study nontrivial topological effect in the Raman sideband generation process, where probe field shows features of one-way transport and Landau levels. Our proposal provides a unique connection between topological photonics and nonlinear optics.

FW5B.4 • 16:00
Surface Plasmons Carry a Pancharatnam-Berry Phase, Taco D. Visser[1], Ari Friberg[2], Salman Daniel[2], Toni Saastamoinen[2], Kimmo Saastamoinen[2], Ismo Vartiainen[2]; [1]*Vrije Universiteit, Amsterdam, Netherlands;* [2]*Univ. of Eastern Finland, Finland.* We show that when Surface Plasmon Polaritons are manipulated and then converted to light, the light acquires not just a dynamic phase, but also a geometric Pancharatnam-Berry phase that is associated with polarization changes.

FW5B.5 • 16:15
Plasma Q-Plate for Intense Laser Beam Shaping, Kenan Qu[1], Qing Jia[1], Nathaniel J. Fisch[1]; [1]*Princeton Univ., USA.* A q-plate for manipulating wavefronts of high-intensity laser beams is proposed in a magnetized plasma. Using particle-in-cell simulations, we demonstrate that light with orbital angular momentum above ionization intensity can be generated.

15:00–16:30
FW5C • Optical Systems for VA/AR
Presider: Groot Gregory; Synopsys, Inc, USA

FW5C.1 • 15:00 Invited
Advances in Computational Display for Virtual & Augmented Reality, Kaan Aksit[1]; [1]*NVIDIA Corporation, USA.* Computational displays" for virtual and augmented reality co-design the optics, display, and rendering algorithm for the human visual system, achieving new tradeoffs in size, focus cues, and resolution. I describe challenges, opportunities, and several prototypes.

FW5C.2 • 15:30 Invited
Toward occlusion-capable optical see-through head-mounted displays, Hong Hua[1]; [1]*The Univ. of Arizona, USA.* Most of the state-of-the-art optical see-though head-mounted displays (OST-HMD) lack the ability to occlude bright real-world view with the virtual objects. In this paper, we will present the development of an occlusion-capable OST-HMD prototype.

FW5C.3 • 16:00 Invited
Waveguide-type See-through 3D Head-mounted Displays Without Accommodation Vergence Mismatch, Jae-Hyeung Park[1]; [1]*Inha Univ., South Korea.* We introduce holographic and Maxwellian head mounted displays to avoid vergence-accommodation conflict in augmented reality applications. Principles and our recent implementation results using waveguide configuration are presented.

15:30–17:00 Meet the APS Journal Editors Reception, *International Terrace, Terrace Level*

16:30–17:00 Pairing Photons to Electrons: An OSA Nanophotonics Technical Group Networking, *OSA Technical Group Booth, International Terrace, Terrace Level*

15:00–16:30
FW5D • Advanced Microscopy and Imaging

Presider: Francisco Robles; Georgia Institute of Technology, USA

FW5D.1 • 15:00
Compact Module for High-Throughput Label-Free Imaging with Custom Field of View, biagio mandracchia[1], Vittorio Bianco[1], Zhe Wang[2,1], Melania Paturzo[1], Pietro Ferraro[1]; *[1]Inst. for Applied Sciences and Intelligent Systems, Italian National Research Council, Italy; [2]College of Applied Sciences, Beijing Univ. of Technology, China*. We designed a LoC with embedded optofluidic holographic microscopy capabilities. Object flow allows unlimited FoV microscopy of samples in a liquid volume. High-throughput counting and 3D tracking of RBCs is demonstrated.

FW5D.2 • 15:15
Holographic 3D Microscopy of Optically Cleared Tissue, Yibo Zhang[1], Yoonjung Shin[1], Kevin Sung[1], Sam Yang[1], Harrison Chen[1], Hongda Wang[1], Da Teng[1], Yair Rivenson[1], Rajan Kulkarni[1], Aydogan Ozcan[1]; *[1]UCLA, USA*. Using on-chip holographic microscopy and a simplified CLARITY method with colorimetric staining, we present 3D imaging of optically cleared mouse brain tissue over a large volume of ~5.2 mm × 3.9 mm × 0.2 mm.

FW5D.3 • 15:30
Spectral and lifetime measurements of endogenous fluorescence using endoscopic and benchtop microscope configuration, ali ibrahim[2], Hussein Mehidine[2], Fanny Poulon[2], Johan Pallud[3], Pascale varlet[3], Bertrand Devaux[3], Darine Abi Haidar[1]; *[1]Laboratoire IMNC/ Université Paris diderot, France; [2]Laboratoire IMNC, France; [3]Hopital Sainte Anne, France*. We study the spectral and fluorescence lifetime of endogenous fluorescence of tumoral and healthy human tissues. Measurements were taken using endoscope and classical microscopy.

FW5D.4 • 15:45
Time-Gated Optical Diffraction Tomography, Seth D. Smith-Dryden[1], Shengli Fan[1], Guifang Li[1], Bahaa Saleh[1]; *[1]CREOL, Univ. of Central Florida, USA*. Optical diffraction tomography algorithms typically assume weak scattering, and are therefore not applicable to multiple-scattering objects. A time-gating approach extending the validity of these algorithms is proposed and numerically demonstrated.

FW5D.5 • 16:00
Crimp Analysis of Connective Tissue Using Quantitative Second-harmonic Generation Microscopy , Woowon Lee[1], Hafizur Rahman[1], Mariana E. Kersh[1], Kimani C. Toussaint[1]; *[1]Univ. of Illinois, Urbana-Champaign, USA*. We assess the capacity for second-harmonic generation (SHG) microscopy by quantitatively characterizing collagen fiber crimp pattern in the posterior cruciate ligament (PCL) and disclosing the 3D structure in PCL and porcine tendon.

FW5D.6 • 16:15
Background Removal in Pump-Probe Microscopy, Subir Das[1], Bo-Wei Ho[1], Fu-Jen Kao[1]; *[1]Inst. of Biophotonics, National Yang-Ming Univ., Taiwan*. We have established a pump-probe microscopy with lock-in amplifier for the detection of spontaneous loss and stimulated gain into a single configuration.

15:00–16:30
FW5E • Quantum Nonlinear Optics and Nanophotonics

Presider: Nir Davidson; Weizmann Institute of Science, Israel

FW5E.1 • 15:00 Invited
Nonreciprocal on the Nanoscale: Nonlinear Generation via Multipole Interference, Ekaterina Poutrina[1,2], Augustine Urbas[1]; *[1]Air Force Research Lab, USA; [2]UES, Inc., USA*. We demonstrate that nonreciprocal directionality of nonlinear generation is inherent to the nonlinear multipolar response of nanostructures. Similarly, nonlinear multipole interference allows directionally selective inhibition of a nonlinear process.

FW5E.2 • 15:30 Invited
Propagation and Scaling of Pure Quartic Solitons, C. Martijn de Sterke[1], Gordon H. Li[1], Chih Wei Lo[1], Alessio Stefani[1], Andrea Blanco Redondo[1]; *[1]Univ. of Sydney , Australia*. Through numerical simulations and analytical developments we show the propagation behaviour, stability, and energy scaling of the recently discovered pure quartic solitons, indicating excellent potential for pure-quartic solitons in ultrafast lasers.

FW5E.3 • 16:00 Invited
AlGaAs photonic devices for quantum information, Giorgio Maltese[1], Jonathan Belhassen[1], Saverio Francesconi[1], Aristide Lemaître[2], Florent Baboux[1], Maria Amanti[1], Sara Ducci[1]; *[1]Université Paris Diderot, France; [2]Centre de Nanosciences et de Nanotechnologies, France*. We present our last achievements on AlGaAs photonic devices emitting non-classical states of light at room temperature. Different device designs can be adopted to engineer the generated quantum state depending on the target application.

15:30–17:00 Meet the APS Journal Editors Reception, *International Terrace, Terrace Level*

16:30–17:00 Pairing Photons to Electrons: An OSA Nanophotonics Technical Group Networking,
OSA Technical Group Booth, International Terrace, Terrace Level

15:00–16:30
LW5F • High-harmonic Generation: Time, Energy, and Complexity

Presider: Josh Vura-Weis; Department of Chemistry, UIUC, USA

LW5F.1 • 15:00 Invited
Attosecond Charge-transfer Dynamics in Condensed Matter, Martin Schultze[1]; *[1]Max Planck Institut fuer Quantenoptik, Germany*. Electronic population transfer in band-gap materials is the basis of modern electronics. Now attosecond spectroscopy allows us to track this process in real time and explore possible routes towards light-frequency opto-electronic signal processing.

LW5F.2 • 15:30
High Peak Power and Repetition Rate Laser Systems with Thin Disk Ti:Sa Amplifiers , Vladimir V. Chvykov[1], Roland Nagymihaly[1], Huabao Cao[1], Mihkail Kalashnikov[1], Karoly Osvay[1]; *[1]ELI-HU Non-Profit Ltd., Hungary*. Resuts of the proof-of-principal experiments with two types thin disc water cooled Ti:Sa amplifiers will be presented. Scaling simulations based on experimental results demonstrate feasibility of hundreds Hz sub-PW Ti:Sa laser systems.

LW5F.3 • 15:45 Invited
Electron Motion Induced by HHG and Strong Fields, Philip H. Bucksbaum[1]; *[1]Stanford Univ., USA*. We present time-resolved X-ray absorption spectroscopy of ammonium iron(III) oxalate trihydrate and anatase TiO₂ nanoparticles in aqueous solutions using an X-ray free electron laser in combination with a synchronized ultraviolet femtosecond laser.

LW5F.4 • 16:15
Multi-port Intra-Cavity High Harmonic Generation in a Yb:YAG Thin Disk Mode-Locked Oscillator with MHz Repetition Rate, Natsuki Kanda[1,2], Tomohiro Imahoko[3], Koji Yoshida[3], A. Amani Eilanlou[1], Yasuo Nabekawa[1], Tetsumi Sumiyoshi[3], Makoto Kuwata-Gonokami[4,5], Katsumi Midorikawa[1,4]; *[1]RIKEN center for Advanced Photonics, RIKEN, Japan; [2]Photon Science Center, The Univ. of Tokyo, Japan; [3]Cyber Laser Inc., Japan; [4]Inst. for Photon Science and Technology, The Univ. of Tokyo, Japan; [5]Dept. of Physics, The Univ. of Tokyo, Japan*. We demonstrated intra-cavity high harmonic generation (HHG) in a Yb:YAG thin disk mode-locked oscillator with a repetition rate of 3MHz. Two HHG ports are simultaneously operated in a single mode-locked oscillator.

16:45–18:15
FW6A • Optical Fibers and Transmission
Presider: Greg Raybon; Nokia/Bell Labs, USA

FW6A.1 • 16:45 Invited

High-Capacity Undersea Transmission, Oleg V. Sinkin[1], Alexey Turukhin[1], Jin-Xing Cai[1], Hussam Batshon[1], Matthew Mazurzcyk[1], Ding Wang[1], Milen Paskov[1], Carl Davidson[1], Greg Wolter[1], William Patterson[1], Pat Corbett[1], Tim Hammon[1], Maxim Bolshtyansky[1], Dmitri Foursa[1], Alexei Pilipetskii[1]; *[1]TE SubCom, USA*. We discuss technologies that enable high-capacity and power-efficient undersea transmission. We review recent long-haul transmission experiments using conventional single mode fibers and multicore fibers for space division multiplexing.

FW6A.2 • 17:15

Ultra-broadband mode conversion with length-apodized long-period grating on polymer waveguide, Wen Wang[1], JieYun Wu[1], Kaixin Chen[1], Wei Jin[2], Kin Seng Chiang[2]; *[1]Univ of Science and Tech of China, China; [2]Electronic Engineering, City Univ. of Hong kong, Hong Kong*. We design and fabricate a length-apodized long-period grating on a polymer waveguide for ultra-broadbandLP_{01}-LP_{11b} mode conversion. The fabricated device provides a mode-conversion efficiency higher than 99% over a bandwidth of ~150 nm.

FW6A.3 • 17:30

Multicore Optical Fibre Components Fabricated Using a Femtosecond Laser Direct Writing, Andrei Donko[1], Yongmin Jung[1], Yun Wang[1], John Hayes[1], Shaif Alam[1], Gilberto Brambilla[1], David Richardson[1], Martynas Beresna[1]; *[1]Univ. of Southampton, UK*. We report the fabrication of optical components in multicore fibers based on femtosecond laser direct writing, including core selective writing of fibre Bragg gratings and optical attenuator for channel equalization.

FW6A.4 • 17:45

Impact of Intercore Cross-talk of a 7-core EDFA in a Photonic Beamformer System, Vanessa C. Duarte[1], Rogério N. Nogueira[1,2], Miguel V. Drummond[1]; *[1]Instituto de Telecomunicações, Portugal; [2]Watgrid, Lda, Portugal*. In this paper we present a numerical assessment of intercore cross-talk coming from a 7-core multi-core EDFA when used in a photonic beamforming system. It was observed that the distribution increases as path lengths get increasingly mismatched.

FW6A.5 • 18:00

Optical phase response to thermal strain in a multi-layered hollow-core photonic crystal fiber, Seth Meiselman[1], Geoffrey Cranch[2]; *[1]Sotera Defense Solutions, Inc., USA; [2]Optical Sciences Division, Naval Research Lab, USA*. Measurements of thermal phase sensitivity in hollow core photonic crystal and kagome type fibers are presented, resolving a discrepancy in previously reported results. We extend an existing derivation to include kagome lattice photonic crystal fiber.

16:45–18:15
FW6B • Novel Studies of Waveguides, Lasers and Atomic Interactions

FW6B.1 • 16:45 Invited

Higher Order Modes of Ultrathin Optical Fibers for Particle Manipulation, Cindy Esporlas[1], Aili Maimaiti[1], Viet G. Truong[1], Sile Nic Chormaic[1]; *[1]Okinawa Inst of Science & Technology, Japan*. We exploit some of the properties of the first group of higher order ultrathin optical fiber modes for particle manipulation. This allows us to exploit features such as negative torque and spin-orbital angular momentum transfer.

FW6B.2 • 17:15

Comparison Among Microchannels Fabricated by Nano, Pico and Femtosecond-Laser Technologies for Microfluidic Applications, María Aymerich López[1], María Teresa Flores-Arias[1], Carlos Molpeceres[2], David Canteli[2], Javier Rodriguez Vazquez de Aldana[3]; *[1]USC, Spain; [2]UPM, Spain; [3]USAL, Spain*. Microchannels fabrication by laser direct writing over soda-lime glass is presented. Three different laser in the IR are employed working on different temporal regimes. Differences among them are evaluated in terms of their topological surfaces.

FW6B.3 • 17:30

Observation of New Mechanism for Slowing Femtosecond Pulses by Liquid-Crystalline Chiral Photonic Crystals, Chun-Wei Chen[1], Xuexue Guo[1], Xingjie Ni[1], Iam Choon Khoo[1]; *[1]Pennsylvania State Univ., USA*. Studies with ultrafast laser pulses in cholesteric liquid crystalline photonic crystal have revealed a new and more effective mechanism than bandedge dispersion for slowing light when the laser wavelength is located *within* the photonic bandgap.

FW6B.4 • 17:45

Intrinsic Optical Bistability in a Rydberg Ensemble, Natalia R. de Melo[1], Christopher G. Wade[2], Nikola Sibalic[2], Jorge M. Kondo[2], Charles S. Adams[2], Kevin J. Weatherill[2]; *[1]Universidade de Pernambuco, Brazil; [2]Joint Quantum Centre (JQC) Durham Newcastle, Dept. of Physics, Durham Univ., UK*. We investigate intrinsic optical bistability and hysteresis in diluted cesium vapor as function of different parameters. The results are consistent with theoretical model based on the semiclassical Maxwell-Bloch equations adding interaction effects.

FW6B.5 • 18:00

Elimination of Spatial Hole Burning in Microlasers, Zhifeng Zhang[1], Pei Miao[1], Jingbo Sun[1], Stefano Longhi[2], Natalia M. Litchinitser[1], Liang Feng[1]; *[1]SUNY Buffalo, USA; [2]Dipartimento di Fisica, Politecnico di Milano and Istituto di Fotonica e Nanotecnologie del Consiglio Nazionale delle Ricerche, Italy.* By tailoring the complex index modulations at an exceptional point, we demonstrate a microring laser without spatial hole burning effect and producing a robust single-mode emission with enhanced laser slop efficiency and stability.

16:45–18:15
FW6E • Nanophotonics Devices and Instrumentation
Presider: Junsuk Rho; POSTECH, South Korea

FW6E.1 • 16:45 Invited

Semiconductor Nanolasers Based on 2D Monolayer Gain Media Integrated with Silicon Waveguides, Cun-Zheng Ning[2,1]; *[1]Arizona State Univ., USA; [2]Electronic Engineering, Tsinghua Univ., China*. We review recent progress in studying 2D monolayer transition metal dichalcogenides as gain materials to be integrated with various micro and nano-cavities for the realization of low energy lasers including room-temperature operation.

FW6E.2 • 17:15

Performance analysis of surface plasmon resonance sensors in the spectral mode: polarimetric vs. intensity. What is better? and under which conditions?, Ibrahim Watad[1], Ibrahim S. Abdulhalim[1]; *[1]Ben-Gurion Univ., Israel*. Recently we have proposed a new spectropolarimetric method to extract the phase information in surface plasmon resonance sensors. Here, we present a detailed study of the technique together with comparison to the conventional intensity measurement.

FW6E.3 • 17:30

Fabrication and Performance Analysis of Mach-Zehnder Interferometer Coupled Polymer Microring Resonator with Microfluidic Channel for Refractive-Index Sensing, Saawan Kumar Bag[1], Raktim Haldar[1], Meher Wan[1], Shailendra K. Varshney[1]; *[1]Indian Inst. of Technology Kharagpur, India*. Mach-Zehnder interferometer coupled polymer microring resonator possessing microfluidic channel is proposed, numerically studied and fabricated for refractive-index sensing applications. Numerical results suggest an improved sensitivity of 202nm/RIU.

FW6E.4 • 17:45

Single-Process Fabrication Technique for Multi-Level Photonic Structures, Mutasem A. ODEH[1], Marcus S. Dahlem[1]; *[1]Electrical and Computer Engineering, Masdar Inst., Khalifa Univ. of Science and Technology, United Arab Emirates*. We propose an alignment-free fabrication process to realize two-level photonic structures using a bilayer resist. The high contrast of the resist is preserved, and the technique can therefore be used in integrated nanophotonics.

FW6E.5 • 18:00

Two-photon fabrication of type I optical Weyl points in photonic crystals, Elena Goi[1,2], Zengji Yue[1], Benjamin P. Cumming[1,2], Min Gu[1,2]; *[1]RMIT, Australia; [2]Centre for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS), Australia*. High refractive-index gyroid photonic crystals with broken inversion symmetry exhibit two pairs of Type I Weyl points. We realize micron-scale structures exhibiting Weyl points by means of laser direct writing and high refractive-index coating.

18:30-20:00 Networking with the OSA Biomedical Optics Technical Groups, *OSA Headquarters, 2010 Massachusetts Ave., NW*

FiO

LS

16:45–18:15
FW6D • Super-resolution and Extreme Microscopy
Presider: Felix Fanjul-Velez; University of Cantabria, Spain

FW6D.1 • 16:45 Invited
Nanoscale phase imaging of live cells, Adam Wax[1]; [1]*Duke Univ., USA.* Quantitative phase imaging uses interferometry to obtain nanoscale information on live cells. Here we describe its use for disease diagnosis and analysis of cell biomechanical properties.

FW6D.2 • 17:15 Invited
Ultraviolet Hyperspectral Interferometric Microscopy, Francisco E. Robles[1]; [1]*Georgia Inst. of Technology, USA.* We present ultraviolet hyperspectral interferometric microscopy, a method that provides molecular information based on absorption and dispersion properties of biological samples, with subcellular resolution, in the ultraviolet region of the spectrum.

FW6D.3 • 17:45
High-Resolution Light-Field Microscopy, Haoyu Li[1], Changliang Guo[1], Shu Jia[1]; [1]*Stony Brook Univ., USA.* We report a high-resolution light-field microscopy (LFM) system using a focused optical design. The system has been characterized both numerically and experimentally. 3D volumetric imaging of cellular structures has been demonstrated.

FW6D.4 • 18:00
Increasing Acquisition Speeds in Structured Illumination Microscopy and its Limits, Florian Stroehl[1], Clemens F. Kaminski[1]; [1]*Univ. of Cambridge, UK.* We present a framework for structured illumination microscopy (SIM) reconstructions that enables superresolution from 3 raw frames. This pushes SIM's speed to its boundaries but also defines a limit beyond which deconvolution microscopy is superior.

16:45–18:15
FW6E • Quantum Electronics of Ultrafast Signals and Atmospheric Propagation
Presider: Brian Smith; University of Oregon USA

FW6E.1 • 16:45 Invited
Attosecond Sampling of Arbitrary Optical Waveforms, Adam S. Wyatt[1,2], Tobias Witting[4,3], Andrea Schiavi[2], Davide Fabris[4], Paloma Matia-Hernando[4], Ian Walmsley[2], Jon Marangos[4], John Tisch[4]; [1]*STFC Central Laser Facility, UK;* [2]*Physics, Univ. of Oxford, UK;* [3]*Max Born Inst. for Nonlinear Optics and Short Pulse Spectroscopy, Germany;* [4]*Physics, Imperial College, UK.* An interferometric measurement of the real electric field of arbitrary optical waveforms with attosecond resolution via high harmonic generation is experimentally demonstrated and the linearity and temporal/spectral response is numerically analysed.

FW6E.2 • 17:15
Theory-experiment comparison of a quantum based light-matter interaction model for optical filamentation, Anand Bahl[1], Miroslav Kolesik[1], Jared Wahlstrand[2,3], Howard Milchberg[3]; [1]*College of Optical Sciences, Univ. of Arizona, USA;* [2]*Engineering Physics Division, National Inst.s of Standards, USA;* [3]*Inst. for Research and Applied Physics, Univ. of Maryland, USA.* We present an extensive, experiment-theory comparison of the Metastable Electronic State Approach to describe light-matter interaction in nonlinear optics. Excellent agreement validates the method for large-scale space-time resolved simulations.

FW6E.3 • 17:30
Measurements of the nonlinear refractive index of noble gases and major air constituents at 10 µm using four-wave mixing, Jeremy Pigeon[1], Sergei Tochitsky[1], Eric C. Welch[1], Chandrashekhar Joshi[1]; [1]*UCLA, USA.* We report measurements of the nonlinear refractive index of air, N_2, O_2, Kr, and Xe at a wavelength near 10 µm by four-wave mixing of an intense, 200 ps, CO_2 laser beat-wave.

FW6E.4 • 17:45 Invited
Creating and dissipating clouds in the atmosphere with ultrashort lasers, Jean Pierre Wolf[1]; [1]*Universite de Geneve, Switzerland.* Ultrashort intense lasers are able to efficiently condensate water vapor in air into droplets, even without ionization (mid-IR sub-TW lasers). In addition, existing droplets can be expelled from the beam to transmit information through fogs.

16:45–18:15
LW6F • Novel Lasers I
Presider: Ursula Keller; ETH Zurich, Switzerland

LW6F.1 • 16:45 Invited
Advances in Microscale Parity-time-symmetric Lasers, Mercedeh Khajavikhan[1]; [1]*Univ. of Central Florida, CREOL, USA.* Microscale semiconductor lasers are an indispensable part of integrated photonic circuits. In this paper, we review some of the efforts in our group towards the realization of such sources using the concept of parity-time-symmetry.

LW6F.2 • 17:15
Hybrid Microlaser Resonators Stabilized by Spherical Waveguides or Unicellular Organisms, Jose A. Rivera[1], Thomas Galvin[1], J. G. Eden[1]; [1]*UIUC, USA.* Micro-refractive element stabilized lasers afford the opportunity to synthesize composite beam wave-fronts in the far-field. We achieve lasing from open and closed resonator topologies based on either spherical waveguides or unicellular organisms.

LW6F.3 • 17:30 Invited
Simulating Spins with Coupled Lasers, Nir . Davidson[1]; [1]*Weizmann Inst. of Science, Israel.* We present a system of coupled lasers used for simulating XY spins and finding their ground state.

LW6F.4 • 18:00
Demonstration of a Self-Stabilized Highly Subluminal Laser with a Factor of 400 Suppression in Sensitivity to Fluctuations, Joshua Yablon[1], Zifan Zhou[1], Nicholas Condon[1,2], Devin Hileman[1,2], Shih Tseng[1,2], Selim M. Shahriar[1]; [1]*Northwestern Univ., USA;* [2]*Digital Optics Technologies, USA.* We demonstrate a self-stabilized, highly-subluminal laser in which frequency shift due to cavity length change is suppressed by a factor of the group-index, with a value as high as ~400, with applications in precision metrology.

18:30-20:00 Networking with the OSA Biomedical Optics Technical Groups, *OSA Headquarters, 2010 Massachusetts Ave., NW*

07:30–11:30 Registration, *Concourse Foyer*

08:00–08:45 FTh1A • Visionary Speaker: Marc Taubenblatt, *International Ballroom West*
FTh1B • Visionary Speaker: Michael Godwin, *International Ballroom East*
LTh1C • Visionary Speaker: Vladimir M. Shalaev, *Jefferson East*

08:45–09:00 Break

09:00–10:00
FTh2A • Tailoring Light with Naonophotonic Structures

Presider: Aristeidis Karalis; Massachusetts Institute of Technology, USA

FTh2A.1 • 09:00
Non-Hermiticity Induced Flat Bands, Hamidreza Ramezani[1]; *[1]Univ. of Texas,Rio Grande Valley, USA.* We demonstrate generation of a robust entire flat band at the exceptional point of a PT symmetric lattice. The obtained flat band is embedded in between dispersive bands and can be considered as BIC [1].

FTh2A.2 • 09:15
Chiral Photonic Limiters Utilizing Topologically Protected Defect States, Ulrich Kuhl[3], Fabrice Mortessagne[3], Eleana Makri[1], Ilya Vitebskiy[2], Tsampikos Kottos[1]; *[1]Wesleyan Univ., USA; [2]Sensors Directorate, Air Force Research Lab, USA; [3]Institut de Physique de Nice, Université Côte d'Azur, France.* We propose the design of waveguide limiters based on resonances via a topologically protected mode supported by coupled microwave resonator arrays. The operational principle is demonstrated by theoretical analysis and scattering measurements.

FTh2A.3 • 09:30
Measuring the complex weak value of photon wavefunctions beyond weak interaction regime, Kai Wang[1,2], Steffen Weimann[1,3], Tim Richardt[1], Felix Zimmermann[1], Alexander S. Solntsev[2], Stefan Nolte[1], Andrey A. Sukhorukov[2], Alexander Szameit[1,3]; *[1]Inst. of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Germany; [2]Nonlinear Physics Centre, Research School of Physics and Engineering, The Australian National Univ., Australia; [3]Inst. for Physics, Rostock Universität, Germany.* We measure the complex weak value beyond the weak interaction regime between the measurement apparatus and the measured photon wavefunction based on the direct measurement scheme.

09:00–10:00
FTh2B • High Harmonics and Novel Photomemission

Presider: Christian Reimer; INRS-EMT, Canada

FTh2B.1 • 09:00
High Harmonic Generation (HHG) inside a Modelocked Thin-Disk Laser, Maxim S. Gaponenko[1], François Labaye[1], Valentin Wittwer[1], Clément Paradis[1], Norbert Modsching[1], Loïc Merceron[1], Andreas Diebold[2], Florian Emaury[2], Ivan Graumann[2], Christopher R. Phillips[1], Clara J. Saraceno[3], Christian Kränkel[4,5], Ursula Keller[2], Thomas Südmeyer[1]; *[1]Univ. of Neuchatel, Switzerland; [2]ETH Zurich, Switzerland; [3]Ruhr-Universität Bochum, Germany; [4]Institut für Laser-Physik, Universität Hamburg, Germany; [5]Center for Laser Materials, Leibniz Inst. for Crystal Growth, Germany.* We demonstrate a compact coherent XUV source based on intracavity high harmonic generation inside a modelocked thin-disk laser, generating photons with energy up to 20.4 eV (17th harmonics) at a repetition rate of 17.4 MHz.

FTh2B.2 • 09:15
Tailoring Semiconductors for High Harmonic Generation, Marco Taucer[1], Murat Sivis[1,2], Kyle Johnston[1], Giulio Vampa[1], André Staudte[1], Andrei Naumov[1], David Villeneuve[1], Claus Ropers[2], Paul Corkum[1]; *[1]National Research Council of Canada, Canada; [2]4th Physical Inst., Univ. of Goettingen, Germany.* We demonstrate new possibilities to tailor high harmonic emission in semiconductors using nanofabrication. Morphology and local composition can each localize and enhance emission, which can be used to realize new high harmonic devices.

FTh2B.3 • 09:30
(Angle Resolved) Photoemission Spectroscopy Utilizing Attosecond Pulse Trains in Argon and Tungsten, Stephan Heinrich[2,1], Alexander Guggenmos[2,1], Fabian Apfelbeck[2], Michael Stanislawski[2], Jürgen Schmidt[2], Ulf Kleineberg[2,1]; *[1]Max-Planck-Institut für Quantenoptik, Germany; [2]Fakultät für Physik, Ludwig-Maximilians-Universität München, Germany.* We report on experiments with attosecond pulse trains that are focused on gas and solid state targets. Using the RABBITT-technique the emitted photoelectrons reveal information about the pulse train itself and the system under study.

09:00–10:00
FTh2C • Optical Coherence Tomography in Biomedical Optics

Presider: Felix Fanjul-Velez; University of Cantabria, Spain

FTh2C.1 • 09:00 Invited
Optical Coherence Tomography in Ophthalmology: Current Applications and Future Directions, Danuta M. Sampson[1,2], Avenell L. Chew[1,2], David Alonso-Caneiro[3], Peijun Gong[1], Karol Karnowski[1], David A. Mackey[1,2], Fred K. Chen[1,2]; *[1]Univ. of Western Australia, Australia; [2]Lions Eye Inst., Australia; [3]Queensland Univ. of Technology,, Australia.* Optical coherence tomography (OCT) has been the most revolutionary diagnostic tool in eye care over the past 20 years. This paper reviews the current status and future directions of OCT in ophthalmic application.

FTh2C.2 • 09:30
Active Microrheology of Hydrogels Based on Oscillations Induced by Optical Radiation Pressure, Nichaluk Leartprapun[1], Rishyashring R. Iyer[1], Steven G. Adie[1]; *[1]Cornell Univ., USA.* Using phase-sensitive OCT, we detect sub-nanometer bead oscillation induced by radiation pressure from a low-NA beam in agar hydrogels. Our method may enable characterization of microscale viscoelastic properties, with applications in cell mechanics.

07:30–11:30 Registration, *Concourse Foyer*

08:00–08:45 FTh1A • Visionary Speaker: Marc Taubenblatt, *International Ballroom West*
FTh1B • Visionary Speaker: Michael Godwin, *International Ballroom East*
LTh1C • Visionary Speaker: Vladimir M. Shalaev, *Jefferson East*

08:45–09:00 Break

09:00–10:00
FTh2D • Fabrication for Nanophotonics
Presider: Euan McLeod; University of Arizona, USA

FTh2D.1 • 09:00 Invited
Realization of 3D Metamaterial and Plasmonic Devices at Optical Frequencies, Junsuk Rho[1]; [1]*POSTECH, South Korea.* I will discuss recent development of fabrication for three-dimensional metamaterials based on two different approaches. The examples include 3D chiral metamaterials (at terahertz and infrared) and self-assembled 3D chiral materials.

FTh2D.2 • 09:30
Electro-Optically Sampled Time Response of Core-Shell Nanowires, Marc Currie[2], Anna Persano[3], Adriano Taurino[3], Fabio Quaranta[3], Adriano Cola[3], Paola Prete[3], Nico Lovergine[4], Pouya Dianat[5], Zhihuan Wang[1], Bahram Nabet[1]; [1]*Drexel Univ., USA;* [2]*Optical Sciences Division, Naval Research Lab, USA;* [3]*IMM-CNR, Inst. for Microelectronics and Microsystems, Italy;* [4]*Dept. of Innovation Engineering, Univ. of Salento, Italy;* [5]*Northwestern Univ., Center for Quantum Devices, USA.* We present time response measurements of single GaAs/AlGaAs core-shell nanowire using high-resolution electro-optic sampling technique. These nanowires show high quantum efficiency and a response speed faster than comparable devices in bulk.

09:00–10:00
FTh2E • Optics in Computing
Presider: Alexander Sergienko; Boston University, USA

FTh2E.1 • 09:00
High Speed Self-testing Quantum Random Number Generation Without Detection Loophole, Yang Liu[1,2], Xiao Yuan[1,2], Ming-Han Li[1,2], Weijun Zhang[4], Qi Zhao[3], Jiaqiang Zhong[5], Yuan Cao[1,2], Yu-Huai Li[1,2], Luo-Kan Chen[1,2], Hao Li[4], Tianyi Peng[3], Yu-Ao Chen[1,2], Cheng-Zhi Peng[1,2], Sheng-Cai Shi[5], Zhen Wang[4], Lixing You[4], Xiongfeng Ma[3], Jingyun Fan[1,2], Qiang Zhang[1,2], Jian-Wei Pan[1,2]; [1]*Shanghai Branch, National Lab for Physical Sciences at Microscale, Univ. of Science and Tech. of China, China;* [2]*Shanghai Branch, CAS Center for Excellence and Synergetic Innovation Center in Quantum Information and Quantum Physics, Univ. of Science and Tech of China, China;* [3]*Center for Quantum Information, Inst. for Interdisciplinary Information Sciences, Tsinghua Univ., China;* [4]*State Key Lab of Functional Materials for Informatics, Shanghai Inst. of Microsystem and Information Tech, Chinese Academy of Sciences, China;* [5]*Purple Mountain Observatory and Key Lab of Radio Astronomy, Chinese Academy of Sciences, China.* We experimentally demonstrate a self-testing quantum random number generation based on an detection-loophole free Bell test with entangled photons. We achieve a final random bit rate of 114 bits/s, with a failure probability less than 10^-5.

FTh2E.2 • 09:15
All Optical Rapid Solver of the Inverse Scattering Problem, Nir . Davidson[1], Chene Tradonsky[1], Ronen Chriki[1], Vishwa Pal[1], Asher Friesem[1]; [1]*Weizmann Inst. of Science, Israel.* An all-optical approach for very rapidly solving inverse scattering problems by means of novel computer controlled digital degenerate cavity laser is presented, along with supporting simulated and experimental results.

FTh2E.3 • 09:30 Invited
Photonic Networks for Neuromorphic Computing, Daniel Brunner[1], Ingo Fischer[2], Maxime Jacquot[1], Laurent Larger[1]; [1]*CNRS - FEMTO-ST, France;* [2]*IFISC, UIB-CSIC, Spain.* We introduce a novel scheme for optically coupling photonic emitters. Our network of 1600 nonlinear oscillators raises current limits by orders of magnitude.We implement neuromorphic computing in our photonic network and predict a chaotic timeseries.

09:00–10:00
LTh2F • Plasmonics
Presider: Ursula Keller; ETH Zurich, Switzerland

LTh2F.1 • 09:00 Invited
Quantifying Optical Coherence Modulation with Plasmonic Interferometry, Domenico Pacifici[1]; [1]*Brown Univ., USA.* Plasmonic interferometry can be employed to measure and modulate the spectral degree of coherence of light. This technique lends itself as a new tool to design multifunctional optical elements beyond conventional refractive- and diffractive-based photonics.

LTh2F.2 • 09:30
Robust enhancement of random laser action assisted by hyperbolic metamaterials, Hung-I Lin[1], Yu-Ming Liao[1], kun-ching Shen[1], Yang-Fang Chen[1]; [1]*National Taiwan Univ., Taiwan.* We use hyperbolic metamaterials to strongly enhance random laser action and reduce lasing threshold. The excited high-*k* modes can increase the possibility of forming closed loop paths and decrease the energy consumption of photon propagation.

FTh2A • Tailoring Light with Naonophotonic Structures—Continued

FTh2A.4 • 09:45
Unidirectional Localized Modes, Hamidreza Ramezani[1], Pankaj Jha[2], Yuan Wang[2], Xiang Zhang[2]; *[1]Univ. of Texas,Rio Grande Valley, USA; [2]Mechanical Engineering, Univ. of California Berkeley, USA.* we demonstrate the generation of unidirectional localized mode in a spatiotemporally modulated photonic lattice containing a static defect. Our proposal might help the design for devices such as non-reciprocal sensors, and unidirectional lasers.

FTh2B • High Harmonics and Novel Photomemission—Continued

FTh2B.4 • 09:45
Frequency comb generation in continuously pumped optical parametric oscillator, maria parisi[1], Iolanda Ricciardi[1], Francois Leo[2], Tobias Hansson[3], Miro Erkintalo[4], Pasquale Maddaloni[1], Paolo De Natale[5], Stefan Wabnitz[6,1], Maurizio De Rosa[1], simona mosca; *[1]CNR-INO, Istituto Nazionale di Ottica, Italy; [2]OPERA-photonics, Université Libre de Bruxelles, Belgium; [3]INRS-EMT, Canada; [4]The Dodd-Walls Centre for Photonic and Quantum Technologies, Dept. of Physics, The Univ. of Auckland, New Zealand; [5]CNR-INO, Istituto Nazionale di Ottica, Italy; [6]Dipartimento di Ingegneria dell'Informazione, Università di Brescia, Italy.* We demonstrate and theoretically explain optical frequency comb generation in a cw-pumped, doubly resonant optical parametric oscillator. Numerical simulations are in pretty good agreement with the observed comb patterns.

FTh2C • Optical Coherence Tomography in Biomedical Optics—Continued

FTh2C.3 • 09:45
A Hand-Held Optical Coherence Tomography and Vibrometry Device for Human Inner Ear Imaging with Subnanometer Sensitivity to Vibration, Wihan Kim[1], Sangmin Kim[1], John Oghalai[2], Brian E. Applegate[1]; *[1]Dept. of Biomedical Engineering, Texas A&M Univ., USA; [2]Dept. of Otolaryngology-Head and Neck Surgery, Stanford Univ., USA.* We are developing endoscopic OCT to visualize the morphology and functional vibratory response of the human inner ear through the round window. Preliminary results show good image quality with 41±21 pm sensitivity on piezo element while hand-held.

10:00–10:30 Coffee Break, *International Terrace, Terrace Level*

NOTES

FTh2D • Fabrication for Nanophotonics—Continued

FTh2D.3 • 09:45
Omniresonant Absorption in a One-Dimensional Cavity Containing Monolayer Graphene, Ali Kazemi Jahromi[1], Massimo Villinger[1], Ahmed Elhalawany[1], Soroush Shabahang[1], H. E. Kondakci[1], Ayman Abouraddy[1]; [1]*Univ. of Central Florida, CREOL, USA.* Coherent perfect absorbers are deemed to exhibit total absorption only at discrete wavelengths. By pre-conditioning wavelength-angle relation of an incoming beam, we demonstrate a resonant absorption in continuously broadband range of wavelengths.

FTh2E • Optics in Computing—Continued

LTh2F • Plasmonics—Continued

LTh2F.3 • 09:45
Refractive Index Sensing With 1D Photonic Crystal, Samir Kumar[1], Ritwick Das[1]; [1]*School of Physical Sciences, National Inst. of Science Education and Research, HBNI, India.* A refractive index sensor is proposed based on the cavity mode formed in a thin analyte layer sandwiched between multilayers of SiO2/Ta_2O_5, and a metal film. This study opens up alternatives to the SPR based biochemical sensors.

10:00–10:30 Coffee Break, *International Terrace, Terrace Level*

NOTES

10:30–12:30
FTh3A • Nanophotonics for Computing and Sensing

FTh3A.1 • 10:30 Invited
Silicon Photonics, Thomas van Vaerenbergh[1]; [1]*Hewlett Packard, USA*. Abstract not provided.

FTh3A.2 • 11:00
Organically modified microresonators for high efficiency microlasers , Xiaoqin Shen[2], Rigoberto C. Beltran[2,1], Vinh Diep[2], Soheil Soltani[2], Andrea Armani[2]; [1]*Universidad de Guanajuato, Mexico;* [2]*Univ. of Southern California , USA*. We report a strategy to excite specific frequency conversion processes by organically modified microresonators with a monolayer of small molecules. Frequency comb generation and Raman lasing are selectively activated and enhanced up to three orders.

FTh3A.3 • 11:15
Low-threshold Rhodamine B doped microlasers fabricated via two-photon polymerization, Nathalia B. Tomazio[1], Leonardo De Boni[1], Cleber R. Mendonça[1]; [1]*USP Inst de Fisica de Sao Carlos, Brazil*. We present dye whispering gallery mode (WGM) microlasers fabricated via two-photon polymerization. Threshold pump energies as low as 13 nJ with slope efficiency of 30% were obtained for free space pulsed excitation at 532 nm.

FTh3A.4 • 11:30
Improvement of sensing performance of ITO grating assisted SPR sensor using ITO-metal configuration, Ashish Bijalwan[1], Vipul Rastogi[1]; [1]*Physics, Indian Inst. of Technology Roorkee, India*. We propose an ITO grating and metallic (Au or Ag or Al) film based SPR sensor. Here, we report a comparative study of conventional ITO grating and proposed ITO grating-metallic film based sensors using RCWA.

FTh3A.5 • 11:45
Thermally-Tunable-Silicon-Ring-Resonator-Based High-Speed Optical Sensor Interrogator for Impact Monitoring, Hyun-Tae Kim[1], Miao Yu[1]; [1]*Univ. of Maryland at College Park, USA*. We demonstrate dynamic strain measurement using a high-speed (100 kHz) optical sensor interrogator with a thermally tunable silicon ring resonator. Resonance frequencies of the aluminum cantilever under impact loading were measured up to 7.36 kHz.

10:30–12:30
FTh3B • Optomechanics and Sensors

FTh3B.1 • 10:30
Inertial Injection Locking in an Electro-optomechanical System, Christiaan Bekker[1], Christopher Baker[1], Rachpon Kalra[1], Warwick P. Bowen[1]; [1]*School of Mathematics and Physics, The Univ. of Queensland, Australia*. Electro-optomechanical systems are a platform for exploring rich physics such as frequency conversion and synchronization. Here we demonstrate the first case of inertial injection locking in a radiation pressure driven electro-optomechanical system.

FTh3B.2 • 10:45
Magnetometry via spin-mechanical coupling in levitated optomechanics, Pardeep Kumar[1], Mishkatul Bhattacharya[1]; [1]*Rochester Inst. of Technology, USA*. We investigate magnetometry with a levitated nanodiamond. Our results indicate that high magnetic field gradient sensitivity (50 $\mu T m^{-1} Hz^{-1/2}$) can be achieved by interrogating the nanodiamond position or spin.

FTh3B.3 • 11:00
Optomechanical cooling without added damping, Seunghwi Kim[1], Xunnong Xu[2], Jacob Taylor[2,3], Gaurav Bahl[1]; [1]*Univ. of Illinois at Urbana-Champaign, USA;* [2]*Univ. of Maryland, USA;* [3]*National Inst. of Standards and Technology, USA*. We demonstrate optomechanical cooling without added damping in a whispering gallery mode resonator by means of disorder-induced scattering. The phenomenon results from a reduction of thermal loading so that it eventually induces chirality of phonons.

FTh3B.4 • 11:15
Ergoregion in Metamaterials Mimicking a Kerr Spacetime, Danilo Pires[1], Paulo A. Brandão[2], José C. Rocha[1]; [1]*GON, Brazil;* [2]*Instituto de Física, Brazil*. We design metamaterials which simulate an ergoregion that is, in the context of general relativity, a region surrounding rotating black holes in which all particles must rotate in the same sense as the hole.

FTh3B.5 • 11:30
Polarization-independent, Narrowband Transmission Filter Using Symmetry-protected Bound States in the Continuum, Justin M. Foley[1], Yichen Shuai[1], Navin Lingaraju[1], John Lawall[1]; [1]*Physical Measurement Lab, National Inst. of Standards and Technology, USA*. We compututationally and experimentally demonstrate a narrowband, polarization-independent transmission filter using a subwavelength, 2D photonic crystal slab that operates through coupling to symmetry-protected bound states in the continuum.

FTh3B.6 • 11:45
Mid IR focusing in Doped-Semiconductor Hyperbolic Metamateial, Mai desouky[1], Ahmed Mahmoud[1], Mohamed A. Swillam[1]; [1]*Physics, American Univ. in Cairo, Egypt*. Doped semiconductors with plasmonic resonance in the mid IR have been realized for mid IR Metamaterials. We theoretically demonstrate sub-wavelength focusing at 7.32 μm using doped InAs/InAs Hyperbolic Metamaterial with focusing resolution of 0.128λ.

10:30–12:30
FTh3C • Vision and Color
Presider: Gabriel Diaz; Rochester Institution of Technology, USA

FTh3C.1 • 10:30 Invited
Visual and Multi-modal In-vehicle Collision Warnings, Carryl Baldwin[1]; [1]*George Mason Univ., USA*. In-vehicle forward collision warnings can be presented in visual, auditory or tactile modalities. Unimodal and bimodal warning combinations were compared. Audiovisual and visuotactile FCWs hold promise for improving traffic safety.

FTh3C.2 • 11:00 Invited
Perceptual considerations for building a foveated display for VR/AR, Joohwan Kim[1], David Luebke[1]; [1]*NVIDIA Corporation, USA*. Foveated display is a promising paradigm for achieving the challenging requirements of immersive and comfortable VR/AR experiences. In this talk, a set of perceptual considerations for building a foveated display will be reviewed.

FTh3C.3 • 11:30 Invited
The Potential for Improving Impaired Vision with Augmented Reality, Emily Cooper[1]; [1]*Dartmouth College, USA*. I will present work assessing whether current-generation augmented reality systems can be used to improve the functional vision of people with low vision or blindness.

10:30–12:30
FTh3D • Instrumentation for Optical Devices and Systems

Presider: Junsuk Rho; Seoul National University, South Korea

FTh3D.1 • 10:30 Invited

How Freeform Optics Induced Optical Aberrations Matter, Jannick P. Rolland[1], Aaron Bauer[1]; [1]*Univ. of Rochester, USA*. Aberration theory and optical design walk hand-in-hand, whether it is human or computer driven. We shall take a peek at the aberrations of freeform optics and their impact on design strategies – is the past obsolete?

FTh3D.2 • 11:00

Efficient Measurement of Nonstationary Complex Coherence Functions, Heath E. Gemar[1], Roxana Rezvani Naraghi[1], Mahed Batarseh[1], Andre Beckus[1], George Atia[1], Sergey Sukhov[1], Aristide Dogariu[1]; [1]*Univ. of Central Florida, USA*. We demonstrate an accurate, two-step procedure for measuring the full complex coherence function. The measurement relies on a wavefront shearing interferometer that permits characterizing nonstationary fields over an extended angular domain.

FTh3D.3 • 11:15

Automated Multiple Target Superresolution Imaging, Farzin Farzam[1], Keith A. Lidke[1]; [1]*Univ. of New Mexico, USA*. Single molecule superresolution of multiple targets is challenging due to limited availabe dyes with right photophysical properties and emission path differential aberrations. We present an automated high-throughput microscope to overcome challenges.

FTh3D.4 • 11:30

Withdrawn.

FTh3D.5 • 11:45

Sub-Diffraction Feature Size in Conventional I-Line Photoresists, David Miller[1], Adam Jones[2], Robert R. McLeod[1]; [1]*Univ. of Colorado at Boulder, USA;* [2]*Sandia National Labs, USA*. Applying a technique from super-resolution microscopy to photolithography, we achieve feature sizes below the diffraction limit. Using conventional i-line photoresists exposed with near UV, we demonstrate individual feature sizes below 100 nm.

10:30–12:30
FTh3E • Quantum Simulation, Communication and Entanglement

FTh3E.1 • 10:30 Invited

Quantum Simulation of Complex Hamiltonians with Directionally Unbiased Linear-Optical Multiports, Alexander V. Sergienko[1], David S. Simon[2,1], Shuto Osawa[1], Casey Fitzpatrick[1]; [1]*Boston Univ., USA;* [2]*Stonehill College, USA*. The directionally unbiased optical multiport is introduced, in which photons may reflect back out the input direction. Quantum walks on arrays of such multiports allow the simulation of a range of complex quantum Hamiltonians.

FTh3E.2 • 11:00

Integrated generation of high-dimensional entangled photon states and their coherent control, Christian Reimer[1], Michael Kues[1], Piotr Roztocki[1], Luis Romero Cortes[1], Stefania Sciara[1], Benjamin Wetzel[1], Yanbing Zhang[1], Alfonso Cino[2], Sai Chu[3], Brent Little[4], David Moss[5], Lucia Caspani[6], Jose Azana[1], Roberto Morandotti[1]; [1]*INRS-EMT, Canada;* [2]*Univ. of Palermo, Italy;* [3]*City Univ. of Hong Kong, China;* [4]*Xi'an Inst. of Optics and Precision Mechanics of CAS, China;* [5]*Swinburne Univ. of Technology, Australia;* [6]*Univ. of Strathclyde, UK*. We demonstrate the generation of high-dimensional entangled photon pairs with a Hilbert-space dimensionality larger than 100 from an on-chip nonlinear microcavity, and introduce a coherent control scheme using standard telecommunications components.

FTh3E.3 • 11:15

Frequency-bin entangled qutrits in an on-chip microresonator, Poolad Imany[1], Jose A. Jaramillo-Villegas[1], Ogaga Odele[1], kyunghun han[1], minghao Qi[1], Daniel E. Leaird[1], Andrew M. Weiner[1]; [1]*Electrical and Computer Engineering, Purdue Univ., USA*. We demonstrate three-dimensional frequency-bin entanglement using three contiguous frequency mode pairs from a quantum frequency comb generated in an integrated optical microresonator.

FTh3E.4 • 11:30

Quantum fingerprinting without a shared phase reference, Michal Lipka[1], Michal Jachura[1], Marcin Jarzyna[1], Konrad Banaszek[1]; [1]*Univeristy of Warsaw, Poland*. We present a quantum fingerprinting protocol relying on two-photon interference which does not require phase stabilization between the parties. Application of non-classical single photon states enhances its performance even for high transmission loss.

FTh3E.5 • 11:45

Entanglement Detection of a Mixed State without Coincidence Measurement, Mayukh Lahiri[1], Gabriela B. Lemos[2], Armin Hochrainer[1], Anton Zeilinger[1,2]; [1]*VCQ, Faculty of Physics, Univ. of Vienna, Austria;* [2]*Inst. for Quantum Optics and Quantum Information, Vienna, Austria*. We consider two spatially separated identical bi-photon sources each of which can produce a polarization entangled mixed state. We show that it is possible to determine whether the state is entangled without any coincidence measurement.

10:30–12:30
LTh3F • Plasmonics and Lasing

Presider: Domenico Pacifici; Brown University , USA

LTh3F.1 • 10:30 Invited

Broadband Hot Electron Creation and Ultrafast Optical Responses in Nanoscale Gap Plasmon Metasurfaces, Gary Wiederrecht[1]; [1]*Argonne National Lab, USA*. Ultrafast photoexcitation of plasmonic nanostructures can produce highly energetic "nonthermal" electrons. We report on the unusual ability of gap plasmon metasurfaces to produce nonthermal electrons at high efficiency over broad spectral ranges.

LTh3F.2 • 11:00

Formation of Spatial Solitons in a Colloid of Biosynthesized Gold Nanoparticles, Argelia Balbuena Ortega[1], Martha Yadira Salazar Romero[1], Valentin López Gayaou[2], Alejandro Vasquez Arzola[1], Karen Volke Sepulveda[1]; [1]*UNAM, Mexico;* [2]*CIBA-IPN, Mexico*. The nonlinear optical properties of gold nanoparticles were investigated. As a result of the characterization, samples with the higher nonlinear optical response were selected, to demonstrate the formation of bright spatial solitons propagating 10mm.

LTh3F.3 • 11:15

Stretchable random lasers with tunable coherent loops, Shih-Yao Lin[1], Tzu-Min Sun[1], Cih-Su Wang[1], Chi-Shiun Liao[1], Packiyaraj Perumal[1], Chia-Wei Chiang[1], Yang-Fang Chen[1]; [1]*National Taiwan Univ., Taiwan*. We have successfully demonstrated a stretchable random laser with tunable coherent loops based on ZnO nanobrushes deposited on PDMS elastomer substrate. The number of laser modes increases with increasing external strain applied on the substrate.

LTh3F.4 • 11:30 Invited

Solid-state quantum optics with atomically thin semiconductors, Nickolas Vamivakas[1]; [1]*Univ. of Rochester, USA*. Excitons and trions in transition metal dichalcogenides are providing new opportunities for solid-state quantum optics. In this talk I will describe recent work on both quantum dots and cavity polaritons in these materials.

FTh3A • Nanophotonics for Computing and Sensing—Continued

FTh3A.6 • 12:00
Fiber optic biosensor for the detection of Bovine Serum Albumin using Graphene Oxide , Jeeban Nayak[1], Rajan Jha[1]; [1]*Indian Inst of Technology, Bhubaneswar, India.* Fiber optic biosensor using Graphene Oxide (GO) decorated gold nanoparticles (AuNPs) has been reported. GO is immobilized on AuNPs coated fiber probe. The interaction of GO with BSA reduces the absorbance peak at resonance wavelength.

FTh3A.7 • 12:15
Compact Automotive Optical Current Sensor Based on Evanescent-Wave Scattering by Ferromagnetic Particles, Binghui LI[1], Hau Ping Chan[1], Kazi T. Ahmmed[1], Zhe Huang[1]; [1]*City Univ. of HONG KONG, Hong Kong.* A compact optical sensor is proposed for automotive current monitoring. Dynamic sensitivity of 0.0357 dB/mA is achieved with good linearity. Multiple sensor outputs can be transmitted through a single fiber by wavelength-division-multiplex scheme.

FTh3B • Optomechanics and Sensors—Continued

FTh3B.7 • 12:00
Acousto-Optic Filter with Metamaterial Inclusions, Nikolai I. Petrov[1], Vladislav I. Pustovoit[2]; [1]*Scientific Research Center of Unique Instrumentation of the Russian Academy of Sciences, Russia.* The problem of Bragg diffraction of light in the Fabry-Perot resonator formed by two dynamic acousto-optic mirrors is considered. Significant increase in spectral resolution due to the spatial variation of the medium properties is shown.

FTh3B.8 • 12:15
Transparent conducting electrodes for efficient near-field thermophotovoltaics, Aristeidis Karalis[1], John D. Joannopoulos[1]; [1]*MIT, USA.* Doped semiconductors, conducting oxides and graphene are compared as transparent front electrodes for resonant near-field thin-film TPV cells, with resulting efficiencies up to 54% at 2100K thermal-emitter temperature and >20W/cm^2 load power-density.

FTh3C • Vision and Color—Continued

FTh3C.4 • 12:00 (Recorded)
Spectral Considerations for Transportation Lighting Systems, John D. Bullough[1]; [1]*Rensselaer Polytechnic Inst., USA.* Transportation lighting specifications using photopic photometry are poorly correlated with many relevant visual responses such as peripheral detection, brightness perception and discomfort glare. Potential impacts on specifications are discussed.

FTh3C.5 • 12:15
Improved method to simulate the halos induced by simultaneous vision, Guillermo Perez[1], Henk Weeber[1], Patricia Piers[1]; [1]*Jonhson & Johnson Vision, Netherlands.* Halos may be noticed by patients implanted with intraocular lenses. An improved method has been developed to simulate the perception of halos that solves inaccuracies and mimics the characteristic veiling effect induced by this phenomenon.

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

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FTh3D • Instrumentation for Optical Devices and Systems—Continued

FTh3D.6 • 12:00
Rapid Single-Exposure Fabrication of 2D and 3D Custom-Modified Interference Patterns by Pattern-Integrated Interference Lithography, Shruthi Kumara Vadivel[1], Matthieu C. Leibovici[1], Thomas K. Gaylord[1]; [1]*Georgia Inst. of Technology, USA.* The Pattern-Integrated Interference Lithography (PIIL) exposure system is analyzed. Experimental results of custom-modified interference patterns show good agreement with simulations, thus validating the modeling and fabrication methods employed.

FTh3D.7 • 12:15
Polarization and phase shifting interferometry, Sergej Rothau[1], Klaus Mantel[2], Norbert Lindlein[1]; [1]*Inst. of Optics, Information, and Photonics, Friedrich-Alexander-Univ. Erlangen-Nuremberg, Germany;* [2]*Max Planck Inst. for the Science of Light, Germany.* The theory and experimental results of a novel interferometric approach for simultaneous characterization of the optical elements with respect to their impact on the polarization and the phase of an incoming light wave are presented.

FTh3E • Quantum Simulation, Communication and Entanglement—Continued

FTh3E.6 • 12:00
The Quantum Entanglement of Measurement, Shota Yokoyama[1,2], Nicola D. Pozza[1,2], Takahiro Serikawa[1,3], Katanya B. Kuntz[1,4], Trevor A. Wheatley[1,2], Daoyi Dong[1], Elanor H. Huntington[1,5], Hidehiro Yonezawa[1,2]; [1]*School of Engineering and Information Technology, The Univ. of New South Wales, Australia;* [2]*Centre for Quantum Computation and Communication Technology, Australian Research Council, Australia;* [3]*Dept. of Applied Physics, School of Engineering, The Univ. of Tokyo, Japan;* [4]*Inst. for Quantum Computing, Univ. of Waterloo, Canada;* [5]*Research School of Engineering, College of Engineering and Computer Science, Australian National Univ., Australia.* We demonstrate two-mode detector tomography on a detector consisting of two superconducting nanowire single photon detectors. The entangling properties of the detector is verified through a new entanglement measure of a multi-mode detection.

FTh3E.7 • 12:15
Towards practical characterization of quantum systems with quantum Hamiltonian learning, Raffaele Santagati[3], Jianwei Wang[3], Stefano Paesani[3], Sebastian Knauer[3], Antonio Gentile[3], Nathan Wiebe[1], Matteo Petruzzella[2], Jeremy O'Brien[3], John Rarity[3], Anthony Laing[3], Mark Thompson[3]; [1]*Quantum Architectures and Computation Group, Microsoft Research, Microsoft, USA;* [2]*Dept. of Applied Physics, Eindhoven Univ. of Technology, Netherlands;* [3]*Quantum Engineering Technology Labs, H. H. Wills Physics Lab and Dept. of Electrical and Electronic Engineering, Univ. of Bristol, UK.* Here we show the first experimental implementation of quantum Hamiltonian Learning, where a silicon-on-insulator quantum photonic simulator is used to learn the dynamics of an electron-spin in an NV center in diamond.

LTh3F • Plasmonics and Lasing—Continued

LTh3F.5 • 12:00
Lasing from Bound States in the Continuum, Ashok Kodigala[1], Thomas Lepetit[1], Qing Gu[1], Babak Bahari[1], Yeshaiahu Fainman[1], Boubacar Kante[1]; [1]*Univ. of California, San Diego, USA.* We have designed a high quality factor cavity that is based on a bound state in the continuum and harnessed its properties to demonstrate a novel type of surface emitting laser operating at room temperature.

LTh3F.6 • 12:15
Experimental and theoretical study of single-mode 1018 nm ytterbium-doped fiber laser with 100 W output power, Jian H. Lin[1], Wei-Ting Lin[1], Chiang-Hsin Lin[1], Wei-Lin Chen[1], Wen-Cheng Huang[1], Po-Tse Tai[1]; [1]*Materials & Electro-Optics Research Division, National Chung-Shan Inst. of Science and Technology, Taiwan.* This work theoretically and experimentally demonstrates one hundred-watt and near single-mode of the 1018 nm ytterbium-doped fiber laser (YDFL). Amplified spontaneous emission effect in YDFL can be suppressed, which agrees with the simulations.

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

FiO

13:30–15:30
FTh4A • Postdeadline Papers

13:30–15:30
FTh4B • Postdeadline Papers

See Update Sheet for list of Post-Deadline Papers

LS

15:00–17:00
LTh4F • Novel Lasers III
Presider: Mark Raizen; University of Texas at Austin, USA

LTh4F.1 • 15:00 Invited
Random Lasers in the Mid-infrared and Terahertz, Qijie Wang[1], Yongquan Zeng[1]; [1]*Nanyang Technological Univ., Singapore*. Random lasers were demonstrated in the mid-infrared and terahertz regimes in quantum cascade lasers with electrical pumping. Air-holes, dielectric pillars and metallic pillars were employed as efficient scatters to achieve multi-mode lasing.

LTh4F.2 • 15:30
Spatiotemporal Characterization of Ultrashort Pulses from the near- to mid-IR, Sina Zahedpour Anaraki[1], Jared K. Wahlstrand[2]; [1]*Univ. of Maryland at College Park, USA;* [2]*National Inst. of Standards and Technology, USA*. We use 2D spectral interferometry to characterize the full spatiotemporal profile of laser pulses. An intense pump imprints upon a weak broadband visible probe its spatial and temporal profile, which can be recovered using silicon based detectors.

LTh4F.3 • 15:45
Multiple-Beam Generation from a Single-Cavity Titanium-Sapphire Thin-Disk Laser, Austin W. Steinforth[1], José A. Rivera[1], J. G. Eden[1]; [1]*Univ. of Illinois, USA*. We demonstrate a laser array generated by a Ti:Al_2O_3 thin disk inside a Fabry-Pérot resonator stabilized by microlenses. More than 1,000 beams were produced from a single cavity.

LTh4F.4 • 16:00 Invited
Dual-comb Spectroscopy with One Unstabilized Semiconductor Laser, Ursula Keller[1]; [1]*ETH Zurich, Switzerland*. We present dual-comb spectroscopy on water vapor with a free-running modelocked semiconductor laser. The simple and compact laser emits simultaneously two gigahertz pulse trains with slightly different pulse repetition rates from a single cavity.

LTh4F.5 • 16:30
Directional random lasing mediated by transverse Anderson localization, Behnam Abaie[1], Thomas Hawkins[2], John Ballato[2], Arash Mafi[1]; [1]*Univ. of New Mexico, USA;* [2]*Clemson Univ., USA*. Anderson localized modes of a dye-filled disordered optical fiber are exploited for directional random lasing. Strong transverse localization reduces the spatial overlap of the lasing modes and results in a spectrally stable random laser emission.

LTh4F.6 • 16:45
Optofluidic droplet lasers on polycarbonate chip, Han Zhang[1], Yuze Sun[1]; [1]*Univ. of Texas at Arlington, USA*. We demonstrated optofluidic droplet lasers using micro-nozzle structures. Easy fabrication, reproducible generation and manipulation of microdroplets provide a promising platform to achieve integrated laser system on chip.

Key to Authors and Presiders

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