Nonlinear Optics (NLO) 2015
Meeting Program

26—31 July 2015
Kaua‘i Marriott Resort on Kalapaki Beach
Kauai, Hawaii, USA

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Aloha! We are happy that you have joined us in Kaua’i, Hawaii to share your latest research results at the Nonlinear Optics (NLO) topical meeting.

This is the 12th time the Nonlinear Optics (NLO) Topical Meeting is visiting the Hawaiian Islands. This meeting brings together a diverse group of presenters from around the world sharing an interest in the frontiers of research in nonlinear optics. Over the next 5 days, there will be 169 presentations including 1 keynote, 28 invited, 96 oral and over 40 poster presentations. This exceptional program includes a keynote speaker, W.E. Moerner, Nobel Laureate in Chemistry in 2014 from Stanford University, USA who will be discussing “Light Paves the Way to Single-Molecule Detection and Photocontrol: Foundations of Super-Resolution Microscopy.”

Nonlinear optical phenomena play a key role in several important applications. Such effects are now studied and applied over a wide range of energies and powers, from single-photons to zettawatts and above, and over broad spectral regimes, from THz to Gamma-ray frequencies. The NLO meeting provides an international forum for discussion of all aspects of nonlinear optics, including new phenomena, advanced materials, novel device concepts, as well as applications in various fields of science and technology.

As always, a key aspect of the NLO meeting is providing the opportunity to network with colleagues from around the world in a relaxed and beautiful setting, driven by the very latest technical advances in the field. This year’s meeting is structured to provide ample opportunities for such interactions—and of course the traditional Wednesday evening luau!

We are very interested in your opinions on how the meeting can be improved in the future. Please say hello to the General and Program Chairs of the meeting and let us know your thoughts.

We hope that you enjoy your time at the meeting and this opportunity to explore the amazing island of Kaua’i.

Sincerely,

Martti Kauranen, Tampere University of Technology, Finland, General Chair
Wayne Knox, University of Rochester, USA, General Chair
Barry Luther-Davies, Australian National University, Australia, Program Chair
Herbert Winful, University of Michigan, USA, Program Chair
COMMITTEE

General Chairs

Martti Kauranen, Tampere University of Technology, Finland
Wayne Knox, University of Rochester, USA

Program Chairs

Barry Luther-Davies, Australian National University, Australia
Herbert Winful, University of Michigan, USA

Program Committee

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Kodo Kawase, Nagoya University, Japan
Paul Lett, National Inst of Standards & Technology, USA
Natalia Litchinitser, State University of New York at Buffalo, USA
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Lung-Han Peng, National Taiwan University, Taiwan
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Andrey Sukhorukov, Australian National University, Australia
Sergei Turitsyn, Aston University, UK
Wenjie Wan, Shanghai JiaoTong University, China
Nikolay Zheludev, University of Southampton, UK
Lei Zhou, Fudan University, China

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The Optical Society

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GENERAL INFORMATION

About the Kaua’i Marriott Resort on Kalapaki Beach

This resort is uniquely located on Kalapaki Bay and offers a variety of recreational activities including family friendly pools and a renowned championship golf course. Attendees can enjoy the five open air restaurants and unique oceanfront dining options or the full-service spa as well as the spectacular views.

Registration
Kaua’i Court

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<td>Sunday, 26 July</td>
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Coffee Breaks
Kaua’i Court

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Online Access to the Technical Digest and Postdeadline Papers

Full Technical Attendees have both EARLY and FREE continuous access to the digest papers through OSA Publishing’s Digital Library. Presented papers can be downloaded individually or by downloading the .zip files (.zip files are available for 60 days after the meeting).

1. Go to www.osa.org/NLO.
2. Select the “Access digest papers” essential link on the right hand navigation.
3. Log in using your email address and password used for registration. You will be directed to the meeting page where you will see the .zip file link at the top of the page. Please note: if you are logged in successfully, you will see your name in the upper right-hand corner.

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

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 two weeks after the meeting. While accessing the papers in OSA Publishing’s Digital Library look for the multimedia symbol (above).

Update Sheet and Postdeadline Papers

All technical program changes will be communicated in the onsite Program Update Sheet. All attendees receive this information with registration materials, and we encourage you to review it carefully to stay informed to changes in the program. Postdeadline papers will also be announced on the update sheet.

About OSA Publishing’s Digital Library

Registrants and current subscribers can access all of the meeting papers, posters and postdeadline papers on OSA Publishing’s Digital Library. The OSA Publishing’s Digital Library is a cutting-edge repository that contains OSA Publishing’s content, including 16 flagship, partnered and co-published peer-reviewed journals and 1 magazine. With more than 240,000 articles including papers from over 450 conferences, OSA Publishing’s Digital Library is the largest peer-reviewed collection of optics and photonics.
Keynote Speaker
Wednesday, 29 July, 08:00—08:45
Ko’olau Salon

W.E. Moerner; Stanford University, USA
Nobel Laureate in Chemistry 2014

NW1A.1 • Light Paves the Way to Single-Molecule Detection and Photocontrol: Foundations of Super-Resolution Microscopy

More than 25 years ago, low-temperature experiments aimed at establishing the ultimate limits to optical storage in solids led to the first optical detection and spectroscopy of a single molecule in the condensed phase. At this unexplored ultimate limit, many surprises occurred where single molecules showed both spontaneous changes (blinking) and light-driven control of emission, properties that were also observed in 1997 at room temperature with single green fluorescent protein variants. In 2006, PALM and subsequent approaches showed that the optical diffraction limit of ~200 nm can be circumvented to achieve super-resolution fluorescence microscopy, or nanoscopy, with relatively nonperturbative visible light. Essential to this is the combination of single-molecule fluorescence imaging with active control of the emitting concentration and sequential localization of single fluorophores decorating a structure. Super-resolution microscopy has opened up a new frontier in which biological structures and behavior can be observed in live cells with resolutions down to 20-40 nm and below. Examples range from protein superstructures in bacteria to bands in actin filaments to details of the shapes of amyloid fibrils and much more. Current methods development research addresses ways to extract more information from each single molecule such as 3D position and orientation.

W. E. Moerner, the Harry S. Mosher Professor of Chemistry and Professor, by courtesy, of Applied Physics at Stanford University, conducts research in physical chemistry and chemical physics of single molecules, single-molecule biophysics, super-resolution imaging and tracking in cells, and trapping of single molecules in solution. His interests span methods of precise quantitation of single-molecule properties, to strategies for three-dimensional imaging and tracking of single molecules, to applications of single-molecule measurements to understand biological processes in cells, to observations of the photodynamics of single photosynthetic proteins and enzymes. He has been elected Fellow/Member of the NAS, American Academy of Arts and Sciences, AAAS, ACS, APS, and The Optical Society. Major awards include the Earle K. Plyler Prize for Molecular Spectroscopy, the Irving Langmuir Prize in Chemical Physics, the Pittsburgh Spectroscopy Award, the Peter Debye Award in Physical Chemistry, the Wolf Prize in Chemistry, and the 2014 Nobel Prize in Chemistry.

Hawaiian Cultural Workshop
Wednesday, 29 July, 09:00—10:30
Kipu Meeting Room (D)

Kumu Ka’iulani will teach a modern hula dance and traditional Hawaiian chant/song. Workshop is open to: OSA Members, family and friends. (Children 12 years old and under must have a parent present at all times.)

For this Workshop you’ll need to bring:
- Tank top or T-shirt
- Shorts or sarong
- Bare feet
- Notepad and pencil
- ALOHA & FUN!!

Cost: $35 USD per person for adults and children (Cost is not included in registration fee).

Luau Concert - There will be an opportunity to perform what you have learned in the Workshop at the Conference Luau during Kimo & Ka’iulani’s Cocktail Hour Concert.**

**Note: Luau admission tickets are required to participate in Luau Concert. Additional tickets may be purchased at Registration.

Poster Session
Wednesday, 29 July, 15:30—18:00
Kona Salon

Posters are an integral part of the technical program and offer a unique networking opportunity, where presenters can discuss their results one-on-one with interested parties.

Conference Reception and Luau
Wednesday, 29 July, 18:00—21:00
Luau Gardens

Join us for a reception and networking featuring traditional Hawaiian food and entertainment. This event is included in all NLO full technical registrations. Additional tickets are available for purchase from the registration desk for $99 USD.
EXPLANATION OF SESSION CODES

The first letter of the code designates the meeting. The second element denotes the day of the week (M = Monday, Tu = Tuesday, W = Wednesday, Th = Thursday, F = Friday). The third element indicates the session series in that day (for instance, 1 would denote the first sessions in that day). Each day begins with the letter A in the fourth element and continues alphabetically through the parallel session. 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 NM2A.4 indicates that this paper is being presented on Monday (M) in the second series of sessions (2) and is the first parallel session (A) in that series and the fourth paper (4) presented in that session.

Invited papers are noted with Invited

Keynote papers are noted with Keynote
AGENDA OF SESSIONS

Sunday, 26 July

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<tr>
<th>Time</th>
<th>Event</th>
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<tr>
<td>14:00—17:30</td>
<td>Registration, Kaua‘i Court</td>
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Monday, 27 July

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<th>Time</th>
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<tr>
<td>07:00—12:30</td>
<td>Registration, Kaua‘i Court</td>
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<tr>
<td>08:00—08:15</td>
<td>Opening Remarks, Ko‘olau Salon</td>
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<tr>
<td>08:15—10:00</td>
<td>NM1A • Frequency Combs I, Ko‘olau Salon</td>
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<td>10:00—10:30</td>
<td>Coffee Break, Kaua‘i Court</td>
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<tr>
<td>10:30—12:30</td>
<td>NM2A • Nonlinear Media and Applications I, NM2B • Ultrafast Optics and Applications</td>
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<tr>
<td>12:30—19:30</td>
<td>Free Afternoon</td>
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<td>18:30—21:30</td>
<td>Registration, Kaua‘i Court</td>
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<td>19:30—21:30</td>
<td>NM3A • Mid-Infrared and Terahertz, NM3B • Waveguides and Nanophotonics</td>
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Online Access to Technical Digest Now Available!

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### Tuesday, 28 July

<table>
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<tr>
<th>Time</th>
<th>Ko’olau Salon</th>
<th>Halele’a Salon</th>
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<tr>
<td>07:00—12:30</td>
<td>Registration, Kaua’i Court</td>
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<tr>
<td>08:00—10:00</td>
<td>NTu1A • Supercontinuum Generation and Solitons</td>
<td>NTu1B • Parametric Devices</td>
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<td>10:00—10:30</td>
<td>Coffee Break, Kaua’i Court</td>
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<td>10:30—12:30</td>
<td>NTu2A • Nonlinear Optics in Fibers</td>
<td>NTu2B • Nonlinear Plasmonics</td>
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<tr>
<td>19:30—21:30</td>
<td>NTu3A • Nonlinear Media and Applications II</td>
<td>NTu3B • Lasers</td>
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<td>08:00—10:00</td>
<td>NW1A • Nonlinear Microscopy I, Ko’olau Salon</td>
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<td>Featuring Keynote Speaker: W.E. Moerner, Stanford University, USA</td>
<td>Nobel Laureate in Chemistry 2014</td>
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<td>10:30—12:30</td>
<td>NW2A • Quantum Nonlinear Optics, Ko’olau Salon</td>
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<td>12:30—14:00</td>
<td>Lunch Break (on your own)</td>
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<tr>
<td>14:00—15:30</td>
<td>NW3A • Quantum and Coherent Effects</td>
<td>NW3B • Nonlinear Microscopy II</td>
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<tr>
<td>15:30—18:00</td>
<td>NW4A • Poster Session, Kona Salon</td>
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<tr>
<td>18:00—21:00</td>
<td>Conference Reception and Luau, Luau Gardens</td>
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## AGENDA OF SESSIONS

### Thursday, 30 July

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<tr>
<td>08:00—10:00</td>
<td>NTh1A • High-Field Nonlinear Optics, Ko’olau Salon</td>
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<td>10:30—12:30</td>
<td>NTh2A • Frequency Combs II</td>
<td>NTh2B • Metals and Nonlinear Plasmonics</td>
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<td>12:30—19:30</td>
<td>Free Afternoon</td>
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<td>19:30—21:30</td>
<td>NTh3A • Postdeadline Papers, Ko’olau Salon</td>
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### Friday, 31 July

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<td>Registration, Kaua’i Court</td>
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<tr>
<td>08:00—10:00</td>
<td>NF1A • Stimulated Scattering and Optomechanics, Ko’olau Salon</td>
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<tr>
<td>10:30—12:30</td>
<td>NF2A • Transverse Nonlinear Optics, Ko’olau Salon</td>
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07:00 -- 12:30 • Registration, Kaua‘i Court

08:00 -- 08:15 • Opening Remarks, Ko‘olau Salon

08:15 -- 10:00
NM1A • Frequency Combs I, Ko‘olau Salon
Presider: Steven Cundiff; Univ. of Michigan, USA

**NM1A.1 • 08:15**
Extreme Ultraviolet Frequency Combs, Jun Ye; 'Univ. of Colorado at Boulder JILA, USA. We report the latest progress on extreme ultraviolet frequency combs and their applications, including the recent demonstration of long coherence time in XUV and on molecular alignment at 100 MHz repetition frequency for high harmonic generations.

**NM1A.2 • 08:45**
Guided-wave half-harmonic generation of frequency combs with \( \sim 75 \)-fold spectral broadening, Alireza Marandi; Carsten Langrock; Martin M. Fejer; Robert L. Byer; 'Stanford Univ., USA. We demonstrate a guided-wave degenerate OPO comprising a PPLN waveguide and a polarization-maintaining optical fiber. The output frequency comb centered at 1548 nm is \( \sim 75 \)-times broader than the pump and is phase locked to it.

**NM1A.3 • 09:00**
Widely Wavelength-Tunable Ultra-Flat Frequency Comb Generation from a Harmonically Mode-Locked Laser Using a Bismuth-Based Highly Nonlinear Erbium-Doped Fiber, Yutaka Fukuchi; Masaru Yamamoto; 'Tokyo Univ. of Science, Japan. We generate frequency combs from a bismuth-based harmonically mode-locked fiber laser. The center wavelength of the output can be tuned from 1540nm to 1620nm. A 10GHz-spaced comb with a 3dB bandwidth of 210GHz is obtained.

**NM1A.4 • 09:15**
Electro-optical frequency division and stable microwave synthesis, Jiang Li; Xu Yi; Hansuek Lee; Scott Diddams; Kerry Vahala; 'California Institute of Technology, USA; 2Time and Frequency Division, National Institute of Standards and Technology, USA. A new method of optical frequency division is demonstrated using a tunable electrical oscillator to create combs through phase modulation of a dual Brillouin laser frequency reference. The method is used to generate stable microwaves.

**NM1A.5 • 09:30**
Photonic Chip Based Optical Frequency Comb Using Soliton Induced Cherenkov Radiation, Victor Brasch; Michael Geiselmann; Tobias Herr; Grigory Lihachev; Martin H. Pfeiffer; Michael L. Gorodetsky; Tobias Kippenberg; 'EPFL, Switzerland; 2CSEM, Switzerland; 3Physics, Lomonosov State Univ., Russian Federation. We show for the first time a fully coherent frequency comb generated in a SiN photonic chip which spans 2/3 of an octave using solitons and soliton induced Cherenkov radiation. Additionally we stabilize the spectrum.

10:00 -- 10:30 • Coffee Break, Kaua‘i Court
Third Harmonic Generation: A Unique Probe for Symmetry Analysis of Isotropic Media under Strain, Benoît Boulangert,2, Adrien Bornew, Corinne Félix2, Patricia Segonds1,2, Veronique Boutu2, Kamel Bencheikh3, Juan Ariel Levenson3, Université Joseph Fourier (Grenoble I), France; 2Institut Neel Centre National de la Recherche Scientifique, France; 3LPN Centre National de la Recherche Scientifique, France. Using third-harmonic generation around 516 nm, we were able to quantify precisely the anisotropy of both the refractive index and the third order electric susceptibility tensor of a germanium-doped silica optical fiber.

Cubic and Quadratic Nonlinear Susceptibilities in Waveguides, Roland Schiek1,2, Frank Setzpfandt1, Alexander Solntsev4, Dragomir N. Neshev4, Fachhochschule Regensburg, Germany; 2Ei Technik, Ostbayerische Technische Hochschule, Germany; 3IAF, Friedrich Schiller Universität, Jena, Germany; 4Nonlinear Physics Center, Australian National University, Australia. Cubic and quadratic nonlinear susceptibility tensor elements in lithium niobate waveguides and optical fibers were determined from measurements of pulse envelopes and power-dependent phase-changes due to self-phase modulation.

Nondegenerate Three-Photon Absorption in GaAs, Matthew Reichert1, David J. Hagan1, Eric W. Van Stryland1, Univ. of Central Florida, CREOL, USA. We present theoretical calculations and experimental measurements of the nondegenerate three-photon absorption coefficient of GaAs, which is enhanced by >3 orders of magnitude over the degenerate case.

The role of ferroelectric domain wall in nonlinear Cerenkov frequency up-conversion in 1D nonlinear crystal, Ning An1, Shanghai Institute of Laser Plasma, China. We reveal a variety of nonlinear Cerenkov radiation patterns that occurs in a single photonic crystal modulated by domain walls, which manifest themselves as normal, degenerated and anomalous-dispersion-like nonlinear Cerenkov radiation type sum-frequency generation.

Full bandwidth frequency doubling of a high-power CW fiber laser using a bulk aperiodically poled LN, Ameneh Bostani1, Mathieu Gagné1, Amirhossein Tehranchi1, Raman Kashyap1, École Polytechnique de Montréal, Canada. Temperature- and pump-frequency-shift-insensitive, full-bandwidth frequency doubling of a high-power CW fiber laser is realized using a bulk step-chirped PPLN. Quadratic second harmonic generation with respect to the pump has been demonstrated.
Nonlinear Diamond Photonics, Marko Loncar; Harvard Univ., USA. Owing to its wide bandgap, large linear and nonlinear refractive index, diamond is well suited for applications in nonlinear and high-power photonics. I will present our work on on-chip diamond frequency combs and Raman lasers.

Sideband Generation at a Frequency of larger than 10 THz Based on Molecular Modulation of a Continuous-wave Laser, Shin-ichi Zaitsu; Department of Applied Chemistry, Graduate School of Engineering, Kyushu Univ., Japan; PRESTO, Japan Science and Technology Agency, Japan; Division of Optoelectronics and Photonics, Center for Future Chemistry, Kyushu Univ., Japan. We have demonstrated an optical modulator for a continuous-wave laser at a modulation frequency of 17.6 THz. This is based on coherent molecular modulation in a dispersion-controlled high-finesse optical cavity.

Two-Photon Absorption Induced Single-Event Effects: Satellite Radiation Survivability through Nonlinear Optics, Dale McMorrow; Ani Khachatryan; Nicolas J. Roche; Joel M. Hales; Stephen Buchner; Jeffrey H. Warner; Joseph Melinger; US Naval Research Laboratory, USA; Sotera Defense Solutions, USA; George Washington Univ., USA. Experimental and theoretical approaches for developing a quantitative description of single-event effects (SEE’s) induced by two-photon absorption (2PA) are developed and demonstrated. Recent advances and the present status of 2PA SEE are described.

12:30 -- 19:30 • Free Afternoon

OSA Incubators

Collaborate. Innovate. Discover.

OSA Incubators provide unique, focused experiences that connect innovators, deliver insights and spark explorations at the cutting edge of optoelectronics. Researchers, engineers and business leaders discuss new and burgeoning fields in a way that cannot be achieved through traditional meetings.

Topics for future OSA Incubators come from accomplished members of the optics and photonics community. Have an idea? Contact us today!

osa.org/incubator
NM3A.1 • 19:30
Mid-wave Infrared Generation by Difference Frequency Mixing of Continuous Wave Lasers in Orientation-Patterned Gallium Phosphide, Jacob O. Barnes1,2, Shekhar Guha1, Peter G. Schunemann1; 1US Air Force Research Laboratory, USA; 2UES, Inc, USA; 3BAE Systems, Inc., USA. Continuous wave frequency generation was observed for the first time in orientation patterned gallium phosphide (OP-GaP). DFWM of 1064-nm and 1550-nm CW fiber lasers produced 3390 nm output.

NM3A.2 • 19:45
Raman lasers with Germania-core and silica-cladding fibers, Xinyong Dong1; 1China Jiliang Univ., China; 2Nanyang Technological Univ., Singapore. Mid-infrared Raman laser sources based on Germania-core and silica-cladding fibers pumped at ~2.0 μm pulsed/cw lasers are studied experimentally. Cascaded Raman laser with emission wavelength up to 2.53 μm and supercontinuum generation with maximum wavelength up to 3.1 μm are achieved, respectively.

NM3A.3 • 20:00
Mid-IR Pulse Shaping by Adiabatic Difference Frequency Conversion, Peter Kroegen1, Haim Suchowski2, Houkun Liang1,3, Franz X. Kärntner1,3; 1Hewlett Packard Labs, USA; 2Hermes Tech USA, Israel; 3Center for Free-Electron Laser Science and Physics Department, DESY and Univ. of Hamburg, Germany; 4School of Applied and Engineering Physics, Cornell Univ., USA. We demonstrate spectral phase and amplitude shaping at mid-IR spanning 2.5-5 mm, based on down-conversion of a shaped near-IR source, using chirped-pulse adiabatic difference frequency generation. The technique can be extended to multi-octave bandwidths.

NM3A.4 • 20:15
Upconversion applied for mid-IR hyperspectral image acquisition, Peter Tidemand-Lichtenberg1, Louis M. Kehlet2, Nicolai H. Sanders3, Jeppe S. Dam1, Christian Pedersen1; 1DTU Fotonik, Danmarks Tekniske Universitet, Denmark; 2Haldor Topsoe A/S, Denmark; 3DTU Nutech, Danmarks Tekniske Universitet, Denmark. Different schemes for upconversion mid-IR hyperspectral imaging is implemented and compared in terms of spectral coverage, spectral resolution, speed and noise. Phasematch scanning and scanning of the object within the field of view is considered.

NM3A.5 • 20:30
Suppressed Terahertz Generation in LiNbO3 via Optical Rectification by Three-Photon Absorption (3PA) under Intense Femtosecond Laser Excitation, Li-Guo Zhu1; 1China Academy of Engineering Physics, China. We'll demonstrate 3PA induced by intense laser is the main limit of THz generation in LiNbO3. A 3D model will be proposed. Optimized setups (pump fluence, duration, geometry, etc) for tilted-pulse-front experiments will be given.

NM3A.6 • 20:45
Measuring plasma density along femtosecond laser filament via THz spectroscopy, Tie-Jun Wang1,2; 1SIOM, Chinese Academy of Science, China. We report on a longitudinally resolved measurement of plasma density along femtosecond laser filament in air via needlelike high-voltage DC electric field enhanced THz spectroscopy. Longitudinal distribution of plasma density of ~1015 cm-3 along laser filament has been successfully recorded.
Direct Detection of Vacuum Fluctuations of the Multi-Terahertz Electric Field, Alfred Leitenstorfer¹, Claudius Riek¹, Denis V. Seletskiy¹;¹Univers. of Konstanz, Germany. We show that ultrabroadband electrooptic sampling in free space is able to directly detect the vacuum fluctuations of the electric field, opening up a time-domain approach to quantum statistics that operates on the sub-cycle scale.

Nonlinear Nearest-Neighbor Coupling in Quadratic Waveguide Arrays, Frank Setzpfandt¹, Roland Schiek², Wolfgang Sohler³, Thomas Pertsch¹;¹Friedrich-Schiller-Universität Jena, Germany; ²Ostbayerische Technische Hochschule Regensburg, Germany; ³Universität Paderborn, Germany. We investigate nonlinear coupling between neighboring waveguides in waveguide arrays with second-order nonlinearity. Using mode symmetries to suppress local nonlinearities, we experimentally show the profound effect of such nonlinear nearest-neighbor interactions on second-harmonic generation.

Discrete vortex propagation in three-dimensional twisted waveguide arrays, Alessandro Zannotti¹, Falko Diebel¹, Martin Boguslawski¹, Cornelia Denz¹;¹Institut für Angewandte Physik, Germany. Twisted waveguide arrays are realized as refractive index structures using tailored three-dimensionally modulated light fields. Probed with discrete vortices of opposed topological charges, this system provides distinctive output states, additionally controllable by the writing power.
Large nonlinear parameter of 550W⁻¹/m, 500 times larger than that in from two-photon absorption at 1.55μm. The SRN waveguides have a band gap of 1.85eV, and do not suffer from two-photon absorption at 1.55μm. The SRN waveguides have a large nonlinear parameter of 550W⁻¹/m, 500 times larger than that in silicon nitride waveguides.

NTu1A.2 • 08:15
Real-time comparison of anomalous- and all-normal dispersion supercontinuum generated in soft-glass PCFs, Mariusz Klimczak⁴, Grzegorz J. Sobon⁴, Rafał Kasztelanic⁴, Krzysztof M. Abramski⁴, Ryszard Buczynski⁴; ¹Inst of Electronic Materials Technology, Poland; ²Wroclaw Univ. of Technology, Poland; ³Univ. of Warsaw, Poland. We experimentally assess supercontinuum shot noise performance for anomalous and all-normal dispersion regimes. Double-clad photonic lattice design of fiber is postulated to enable a stabilizing self-seeding of Raman scattering-dominated, sub-picosecond pumped all-normal dispersion supercontinuum.

NTu1A.3 • 08:30
Intense Supercontinuum Generation in Condensed Media, Andrew H. Kung¹, Shu-Heng Lu¹, Mu-Chen Cheng¹; ¹Academia Sinica, Taiwan; ²National Tsing Hua Univ., Taiwan. Employing multiple thin plates instead of a bulk material mitigates large material dispersion and suppresses destructive effects to permit using peak powers up to 1000 times the self-focusing critical power in high-power supercontinuum generation.

NTu1A.4 • 09:00
Mid infrared supercontinuum generation from chalcogenide glass waveguides and fibers, Barry Luther-Davies¹, Yi Yu¹, Bin Zhang¹, Xin Gai¹, Chengcheng Zhai¹, Sisheng Qi¹, Wei Guo¹, Zhiyong Yang², Wang Jiang²; ¹Australian National Univ., Australia; ²School of Physics and Electronic Engineering, Jiangsu Normal Univ., China. We report work on mid-infrared super-continuum generation in chalcogenide fibers and waveguides pumped by 320fsec pulses at 21MHz in the 3-4.6μm range. Average powers of ≈20mW were produced with spectral coverage from <2μm to >11μm.

NTu1B.1 • 08:00
Optical Parametric Oscillators: Towards Longest Mid-IR Wavelengths and Shortest Few-Cycle Pulses, Majid Ebrahim-Zadeh¹,²; ¹ICFO -The Institute of Photonic Sciences, Spain; ²Instituto Catalana de Recerca i Estudis Avancats (ICREA), Spain. The latest advances in femtosecond optical parametric oscillators delivering tunable mid-IR radiation at wavelengths as far as 8 μm, with average powers exceeding 100 mW, and pulse durations down to 3.7 optical cycles are described.

NTu1B.2 • 08:30
Wider tunability of an injection-seeded THz parametric generator, Kosuke Murate¹, Kazuki Imayama¹, Shin’ichiro Hayashi¹, Kodo Kawase¹, Nagoya Univ., Japan; ²RIKEN, Japan. We report the improvement of the is-TPG tuning range. Suppression of THz-wave absorption in the crystal increased the upper limit of the tunable range from 3.0 to 4.7 THz.

NTu1B.3 • 09:00
GaN-Diode-Laser-Pumped Optical Parametric Generation in Nonlinear Waveguide, Hwanhong Lim¹, Surano Kurimura¹, Kazufumi Fuji¹, Masayuki Okano¹, Shigeki Takeuchi¹,²; ¹National Institute for Materials Science, Japan; ²Kyoto Univ., Japan; ³Osaka Univ., Japan. We demonstrated optical parametric generation (OPG) pumped by GaN diode laser in nonlinear optical waveguide. Mg:SLT-based slab waveguide emits visible photons with RGB spectrum and degenerate photon pairs in 800 nm region with controlled bandwidth.

NTu1B.4 • 09:30
Gain Measurement of MgO:LiNbO₃ Crystal in Injection-Seeded Terahertz-Wave Parametric Generation, Yuma Takida¹, Takashi Notake¹, Kouji Nawata¹, Yu Tokizane¹, Zhengli Han¹, Shin’ichiro Hayashi¹, Hiroaki Minamide¹; ¹RIKEN, Japan. We present a direct measurement for parametric gain characterization of MgO:LiNbO₃ crystal in injection-seeded terahertz (THz)-wave parametric generation pumped by 0.59-ns microchip Nd:YAG laser. We experimentally determined the gain coefficient and threshold length by measuring THz-wave output as a function of crystal length.
Pure-Quartic Solitons: the Interaction of Fourth Order Dispersion and Self Phase Modulation, Andrea Blanco-Redondo¹, Thomas F. Krauss², Benjamin J. Eggleton¹, Chad Husko¹; ¹Physics, The Univ. of Sydney, Australia; ²Univ. of York, UK. We experimentally demonstrate the existence of bright solitons arising from the interaction of anomalous fourth order dispersion with self-phase modulation. These pure-quartic solitons can exist in the normal group velocity dispersion regime.

120-mJ Mid-Infrared ZnGeP₂ FIRE OPO, Marc Eichhorn¹, Martin Schellhorn¹, Magnus W. Haakestad², Helge Fonnum², Espen Lippert²; ¹Inst Franco-Allemand Recherches St Louis, France; ²FFI, Norway. A high-energy mid-infrared ZnGeP₂ OPO based on the non-planar FIRE resonator is presented, achieving up to 120 mJ of pulse energy in the 3-5 μm wavelength range and up to 78% slope efficiency.

Polarization Instability of Vector Raman Solitons in Supercontinuum Generation, Qing Chao¹, Kelvin H. Wagner¹; ¹Department of Electrical, Energy and Computer Engineering, Univ. of Colorado at Boulder, USA. We numerically investigate polarization instability of Raman solitons in supercontinuum generation as a function of input polarization and fiber birefringence. Polarization dynamics and separatrices are observed on the Poincaré sphere and depend on fiber birefringence.

Resonant Phase Matching of Josephson Junction Traveling Wave Parametric Amplifiers, Kevin O’Brien¹, Chris Macklin¹, Irfan Siddiqi¹, Xiang Zhang¹; ¹UC Berkeley, USA. We propose a technique to phase-matching Josephson-junction traveling wave parametric amplifiers to achieve high gain (over twenty decibels) over a broad bandwidth (multiple GHz) for applications such as the multiplexed readout of quantum coherent circuits.

The eigenvalue based analysis of rogue wave phenomena in the framework of integrable higher-order nonlinear Schrödinger equation, Gihan Weerasekara¹, Akihiro Maruta¹; ¹Osaka Univ., Japan. Rogue wave phenomenon in the framework of integrable higher-order nonlinear Schrödinger equation (HNLSE) is studied by evaluating the eigenvalue of the associated eigenvalue equation in the inverse scattering transform. Our results reveal that soliton collision is one of the mechanisms for generating rogue waves.

We successfully simulated a one-dimensional Ising model composed of >10,000 spins using optically-coupled time-division-multiplexed degenerate optical parametric oscillators, Takahiro Inagaki¹, Kyo Inoue², Yoshihisa Yamamoto², Hiroki Takesue²; ¹NTT Basic Research Laboratories, Japan; ²Osaka Univ., Japan; ³Stanford Univ., USA. We successfully simulated a one-dimensional Ising model composed of >10,000 spins using optically-coupled time-division multiplexed degenerate optical parametric oscillators, paving a way towards the realization of a large-scale coherent Ising machine.
**Nonlinear Optics (NLO) • 26 — 31 July 2015**

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**Nonlinear Optics in Fibers**

10:30 -- 12:30

**NTu2A • Nonlinear Optics in Fibers**

*President: Ravinder K. Jain; Univ. of New Mexico, USA*

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**NTu2A.1 • 10:30**

**Gradient Index Nanostructured Core Fiber: a New Radical Approach for Dispersion Management**, Ryszard Buczynski1, Mariusz Klimczak2, Rafal Kazetelniak1, Bartlomiej Siwicki2, Grzegorz Stepniecki2, Jaroslaw Cimek2, Dariusz Pysz2, Ryszard Stepie2; 1Faculty of Physics, University of Warsaw, Poland; 2Glass Department, Institute of Electronic Materials Technology, Poland. Nanostructured core photonic crystal fibers comprising a solid cladding and sub-wavelength layout of solid rods in the core are presented as a concept for radically new method for dispersion engineering in nonlinear fiber optics.

**NTu2A.2 • 10:45**

**Intensity amplification by Talbot-based coherent addition of repetitive waveforms using fiber-optics XPM**, Reza Maram1, José Azaña1; 1INRS-Energie Materiaux et Telecom, Canada. We numerically demonstrate intensity amplification of repetitive pulse trains using a nonlinear time lens followed by a linear dispersive medium. The nonlinear time lens is realized by cross-phase modulation (XPM) of the input pulse train with periodic parabolic pump pulses.

**NTu2A.3 • 11:00**

**Nonlinear Capacity Limit to Optical Communications**, Rene-Jean Essiambre1, 2Bell Laboratories, Alcatel-Lucent, USA. An introduction to the measurement of information of a signal is presented. Challenges specific to calculating a nonlinear Shannon fiber capacity are highlighted.

**NTu2A.4 • 11:30**

**All-optical generation of frequency-shift keying radio-frequency signal based on nonlinear polarization rotation in a highly nonlinear fiber**, Wei Li1; 1Inst Semiconductor, CAS, China. An optical approach to generate frequency-shift keying (FSK) RF signal using nonlinear polarization rotation in highly nonlinear fiber is reported. FSK RF signals with 10 GHz carrier at 1.25 and 2.5 Gb/s are generated.

**NTu2A.5 • 11:45**

**Role of Nonlinear Intracavity Spectral Broadening on Optimization of Fiber Raman Laser Reflector Bandwidths**, Mike Klopfer1, Leanne Henry2, Ravinder Jain1; 1Center for High Technology Materials, Univ. of New Mexico, USA; 2Directed Energy Directorate, Air Force Research Laboratory, USA. We study intracavity nonlinearity-induced spectral broadening and optimization of the performance of high power FRPs by varying the bandwidth of the resonator FBGs.

**NTu2A.6 • 12:00**

**Supersymmetric Photonics: Mode Conversion, Scattering and Transformation Optics**, Matthias Heinrich1, Mohammad-Ali Miri2, Simon Stützer1, Stefan Nolte1, Alexander Szameit1, Demetrios N. Christodoulides2; 1Friedrich-Schiller-Universität Jena, Germany; 2CREOL The College of Optics & Photonics, Univ. of Central Florida, USA. We provide a brief introduction to supersymmetric photonics and present our newest theoretical findings and experimental results on SU$\text{Su}$Y mode conversion, the scattering dynamics in supersymmetric optical structures, and a SU$\text{Su}$Y-inspired extension of transformation optics.

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**Nonlinear Plasmonics**

10:30 -- 12:30

**NTu2B • Nonlinear Plasmonics**

*President: Dawn Tan; Singapore Univ. of Technology and Design, Singapore*

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**NTu2B.1 • 10:30 Invited**

**Plasmonic Stopped-Light Lasing: From Cavity-Free Nanolasing to Nonlinear-Self-Structuring in Surface-Plasmon Polariton Condensation**, Ortwin Hess1, 2Imperial College London, UK. Designed stopped-light singularities in the density of optical states of a planar gain-enhanced nanoplasmic waveguide structure provide a new stopped-light feedback mechanism that allows for cavity-free nanolasing and nonlinear self-structuring in surface-plasmon polariton condensation.

**NTu2B.2 • 11:00**

**Nonlinear Metal/Dielectric Plasmonic Interfaces**, Alexandre Baron1, Thang B. Hoang1, Chao Fang1, Stéphane Larouche1, Daniel J. Gauthier1, Maiken H. Mikkelsen1, David Smith1; 1Bell Laboratories, Alcatel-Lucent, USA. We investigate theoretically and experimentally the optical nonlinearity of metal/dielectric interfaces, which provides a metric that predicts the scaling of self-action as well as a means to measure $X^{(3)}$ of gold using surface plasmon polaritons.

**NTu2B.3 • 11:15**

**Withdrawn**

**NTu2B.4 • 11:30**

**Control of Nonlinear Optics at a Gold Tapered Tip Excited by Ultrafast Surface Plasmon Polariton Pulses**, Fumihiko Kannari1, Yuta Masaki2, Kazunori Toma1; 1Keio Univ., Japan. Nanofocusing of ultrafast surface plasmon polariton pulses excited on an Au tapered tip, and the nonlinear radiation such as second harmonics and coherent anti-stokes Raman scattering are deterministically controlled based on a measured plasmon response function.

**NTu2B.5 • 11:45**

**Nonlinear Conversion Using Fano-Resonant All-Dielectric Metasurfaces**, Yuanmu Yang1, Abdelaziz Boulesbaa2, Ivan Kravchenko2, Dayrl Briggs2, Alexander Puretzky2, David Geoghegan2, Jason G. Valentine1; 1Vanderbilt Univ., USA; 2Oak Ridge National Laboratory, USA. We present an experimental demonstration of third harmonic generation from Fano-resonant all-dielectric metasurfaces. The metasurfaces have a conversion enhancement factor of $1.5\times10^4$ and an absolute conversion efficiency on the order of $10^{-4}$.

**NTu2B.6 • 12:00**

**Photoinduced Nonlinear Mixing of Terahertz Dipole Resonances in Graphene Metadevices**, Chihun In1, Hyeon-Don Kim2, Bumki Min2, Hyunyong Choi1; 1Yonsei Univ., South Korea; 2Korea Institute of Science and Technology, South Korea. We demonstrate nonlinear mixing of terahertz dipole resonances in graphene metadevice. Ultrafast terahertz spectroscopy corroborates that the characteristic difference-frequency resonance indeed originates from the coupled interaction between graphene and meta-atoms.
Nonlinear Optical Signatures of Electronic Quantum Tunneling Effects in Nanoplasmonic Systems, Joseph W. Haus¹, Michael Scalora², Domenico de Ceglia², Antonietta M. Vincenti²; ¹Univ. of Dayton, USA; ²AMRDEC, US Army RDECOM, USA. We present a quantum theory for electron tunneling applied to nanoplasmonic materials in the regime with electromagnetic fields are confined in sub-micron gaps. The theory predicts quantum-based nonlinear effects: two-photon absorption, second- and third-harmonic generation and optical rectification.
NTu3A.1 • 19:30 Invited
Nonlinear Optical Propagation in Zero Index Materials, Kevin O’Brien1, Haim Suchowski1, Zj Jing Wong1, Alessandro Salandrino2, Xiaoao Yin1, Xiang Zhang1; ‘UNSF Nano-scale Science and Engineering Center (NSEC), University of California Berkeley, USA. Phase-matching is critical for coherent nonlinear optical processes, allowing nonlinear sources to combine constructively, resulting in more efficient emission. We experimentally demonstrate phase mismatch-free nonlinear propagation in a bulk zero index metamaterial.

NTu3A.2 • 20:00 Invited
Unity-Order Intensity-Dependent Change in Refractive Index in Indium-Tin Oxide at its Epsilon-Near-Zero Wavelength, Zahirul Alam1, Israel De Leon1, Robert W. Boyd1; ‘Univ. of Ottawa, Canada. We report that the nonlinear contribution to the refractive index of a sample of indium-tin oxide can be much larger than the linear contribution when the optical wavelength is close to the material’s bulk plasma wavelength, where the material exhibits epsilon-near-zero behavior.

NTu3A.3 • 20:30
SiO2-Al2O3-La2O3 Glass - a Superior Medium for Optical Kerr Gating at Moderate Pump Intensity, Christian Karras1, Wolfgang Paa1, Doris Sobon1, Jaroslaw Sotor1, Karol Krzempek1, Iwona Pasternak2, Aleksandra Krajewska2, Wlodek Strupinski2, Krysztof Abramski1; ‘Wroclaw Univ. of Technology, Poland; 2Institute of Electronic Materials Technology, Poland. We present an experimental study on materials technology, Germany.

Temporal dynamics of nonlinear absorption and refraction in crystalline and hydrogenated amorphous silicon, Akbar Ali Syed1, Matthew Reichert1, Trenton R. Ensley1, Jason Pelc1, David J. Hagan1, Eric W. Van Stryland1; ‘College of Optics and Photonics (CREOL), Univ. of Central Florida, USA; 2Hewlett-Packard Laboratories, USA. We measure the temporal dynamics of nonlinear absorption (NLA) and refraction (NLR) in crystalline and hydrogenated-amorphous silicon at 1550 nm. The effect of relative polarization on NLA and NLR are also reported.

New Nonlinear Optics Possibilities with Blue Phase Liquid Crystals, lam-Choon Khoo1; ‘Pennsylvania State Univ., USA. We provide a critical analysis and new observations of nonlinear optical properties of liquid crystals in a new phase that exhibits 3-D photonic crystal properties, and demonstrate new possibilities for fundamental and applied studies.

Organic and Bio-mimetic Random Lasers, Neda Ghofraniha1, Claudio Conti1; 2 ‘Institute of Complex Systems (ISC), National Council of Research, Italy; 2 ‘Physics Department, La Sapienza Univ., Italy. We report on different novel types of Random Lasers in which the optical cavity is merely represented by a random assembly of micro- and nano- metric scattering structures: paper sheets, solid organic dye and biotemplated materials.
NTu3A.6 • 21:15
Second harmonic generation from CMOS compatible suboxide amorphous thin films grown by sputtering, Kenji Imakita, Ibuki Kawamura, Minoru Fuji; Kobe Univ., Japan. Strong second harmonic generation (SHG) was observed from amorphous Ge doped SiO$_2$ and Si rich SiO$_2$ thin films. The observed maximum value of $d_{33}$ was 8.2 pm/V, which is 4 times larger than $d_{22}$ of $\beta$-BaB$_2$O$_4$ crystal.

NTu3B.7 • 21:15
A coherent polariton laser, Seonghoon Kim, Bo Zhang, Sebastian Brodbeck, Zhaorong Wang, Christian Schneider, Martin Kamp, Sven Hoefling, Univ. of Wuerzburg, Germany; Univ. of St Andrews, UK. We demonstrate a polariton laser with Poisson intensity noise using an unconventional cavity. Qualitative changes in the phase coherence was also observed, due to the matter-wave origin of the polariton laser.

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NW1A.1 • 08:00  Keynote
Light Paves the Way to Single-Molecule Detection and Photocontrol: Foundations of Super-Resolution Microscopy, W.E. Moerner; 1Stanford Univ., USA. More than 25 years ago, low temperature experiments aimed at establishing the ultimate limits to optical storage in solids led to the first optical detection and spectroscopy of a single molecule in the condensed phase. At this unexplored ultimate limit, many surprises occurred where single molecules showed both spontaneous changes (blinking) and light-driven control of emission, properties that were also observed in 1997 at room temperature with single green fluorescent protein variants. In 2006, PALM and subsequent approaches showed that the optical diffraction limit of ~200 nm can be circumvented to achieve super-resolution fluorescence microscopy, or nanoscopy, with relatively nonperturbative visible light. Essential to this is the combination of single-molecule fluorescence imaging with active control of the emitting concentration and sequential localization of single fluorophores decorating a structure. Super-resolution microscopy has opened up a new frontier in which biological structures and behavior can be observed in live cells with resolutions down to 20-40 nm and below. Examples range from protein superstructures in bacteria to bands in actin filaments to details of the shapes of amyloid fibrils and much more. Current methods development research addresses ways to extract more information from each single molecule such as 3D position and orientation.

NW1A.2 • 08:45  Limited
Nonlinear Deep Tissue Imaging with Advanced Soliton Sources, Chris Xu; ‘Cornell Univ., USA. Deep tissue multiphoton microscopy (MPM) using solitons generated from optical fibers are reviewed. The main characteristics of the excitation source for deep tissue MPM, such as wavelength, pulse energy, and repetition rate, are discussed.

NW1A.3 • 09:15
Nonlinear Optical Molecular Imaging Assesses Living Engineered Tissue Local Viability, Leng-Chun Chen; William Lloyd, Shiuhyang Kuo, Hyungjin Kim, Cynthia Marcello, Stephen Feinberg, Mary-Ann Mycek; ‘Univ. of Michigan, USA. Nonlinear optical microscopy methods were developed for quantitative, noninvasive, and label-free assessment of living engineered tissues fabricated from primary human cells. Clinical applications in tissue engineering and regenerative medicine will be discussed.

NW1A.4 • 09:30
Nonlinear photothermal microscopy for biological imaging, Takayoshi Kobayashi, Jinping H, Nan Wang, Jun Miyazaki; ‘Univ. of Electro-Communications, Japan. Nonlinear photothermal microscopy has been applied in the imaging of different biological tissues. The resolution is higher compared with the linear mechanism.

NW1A.5 • 09:45
Background-Free Second-Harmonic Generation Microscopy of Individual Carbon Nanotubes, Godofredo S. Bautista, Andreas Johansson, Nikhil Parappurath, Pasi Myllyperkiö, Hua Jiang, Esko Kauppinen, Mika Pettersson, Martti Kauranen; ‘Department of Physics, Tampere Univ. of Technology, Finland; ‘Department of Physics, Nanoscience Center, Univ. of Jyväskylä, Finland; ‘Department of Applied Physics and Center for New Materials, Aalto Univ., Finland. We use polarized second-harmonic generation (SHG) microscopy to investigate pristine air-suspended carbon nanotubes (CNT). We show that SHG originates from CNT chirality, allowing also different response for the two circular polarizations of fundamental light.

10:00 -- 10:30 • Coffee Break, Kaua‘i Court
**NW2A.1 • 10:30**  
**Invited**  
**Demonstration of Deterministic Photon-photon Interactions with a Single Atom**, Serge Rosenblum¹, Itay Shomroni¹, Orel Bechler¹, Yulia Lovsky¹, Gabriel Guendelman¹, Barak Dayan¹; ¹Weizmann Institute of Science, Israel. We demonstrate deterministic photon-atom and photon-photon interactions with a single atom coupled to a high-Q fiber-coupled microresonator. Based on Deterministic One Photon Raman Interaction (DOPRI), this scheme can form the basis for all-optical quantum information processing.

**NW2A.2 • 11:00**  
**Nonlinear Pi Phase Shift for Single Fiber-guided Photons Interacting with a Resonator-enhanced Atom**, Juergen Volz¹, Michael Scheucher¹, Christian Junge¹, Arno Rauschenbeutel¹; ¹Atomistitut, TU Wien, Vienna Center for Quantum Science and Technology, Austria. We demonstrate a fiber-integrated optical Kerr-nonlinearity where a single atom imprints the maximum nonlinear phase shift of pi between the one and two photon case. We employ this to generate entanglement between previously independent photons.

**NW2A.3 • 11:30**  
**Nearly-background-free, phase-preserving parametric up-conversion at the single-photon level**, Sergey V. Polyakov¹, Yu-Hsiang Cheng², Tim Thomay², Glenn Solomon², Alan Migdall²; ¹National Inst of Standards & Technology, USA; ²Joint Quantum Institute, UMD and NIST, USA. We demonstrate a background-free (to within experimental uncertainty) frequency up-converter. In addition, high fringe contrast at a single-photon-level in an up-converting interferometer is demonstrated, an enabling step towards faithful up-conversion of entangled photon pairs.

**NW2A.4 • 11:45**  
**Optically Tunable Entangled Photon State Generation in a Nonlinear Directional Coupler**, Frank Setzpfandt¹,², Alexander Solntsev¹, James Titchener¹, Che W. Wu¹, Chunle Xiong³, Thomas Pertsch², Roland Schiek³, Dragomir N. Neshev¹, Andrey A. Sukhorukov¹; ¹Centre for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS) and Nonlinear Physics Centre, Research School of Physics and Engineering, Australian National Univ., Australia; ²Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Germany; ³Centre for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS), the Institute of Photonics and Optical Science (IPOS), School of Physics, Univ. of Sydney, Australia; ⁴Univ. of Applied Sciences Regensburg, Germany. We propose and experimentally demonstrate an all-optically tunable biphoton quantum light source using a nonlinear directional coupler. The source can generate high-fidelity N00N states, completely split states, and states with variable degrees of entanglement.

**NW2A.5 • 12:00**  
**Nonlinear Quantum Optics in a Millimeter Size Whispering Gallery Mode Resonator**, Gerd Leuchs¹,², Christoph Marquardt¹,², Harald G. Schwefel¹,²; ¹Department Physik, Universität Erlangen-Nürnberg, Germany; ²Max Planck Institute for the Science of Light, Germany. Whispering gallery resonators made from nonlinear crystals offer high quality factors combined with small mode volumes leading to an enhanced effective \(\chi^{(2)}\) nonlinearity. These properties facilitate studying quantum optical effects in the nonlinear regime with interacting fields differing in frequency by up to four orders of magnitude. Furthermore, the small size results in a large mode spacing allowing for heralded single photon generation in a single mode.

**12:30 -- 14:00 • Lunch Break (on your own)**
Observation of the Excitation Ladder in a Microcavity Diode Using Multi-quantum Coherent Optical Photocurrent Spectroscopy, Steven T. Cundiff1, Travis Autry1,2, Gaël Nardin1, Daniele Bajoni1, Aristide Lemaître5, Sophie Bouchoule1, Jacqueline Bloch1; 1JILA, Univ. of Colorado & NIST, USA; 2Physics Department, Univ. of Michigan, USA; 3Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State Univ., Russian Federation; 5NRS-Laboratoire de Photonique et Nanostructures, France. We show that basic quantum gates can be realized with simple two-level quantum nodes connected through actively, optically controlled waveguides. This allows to simplify nodes and drastically reduce nonlinearities required for quantum gates, while improving scalability and versatility.

Quantum information processing with chip-based optically-controlled gates, Ivan A. Burenkov1, Olga V. Tikhonova1, Sergey V. Polyakov1, 1National Inst of Standards & Technology, USA; 2Department of Physics, Lomonosov Moscow State Univ., Russian Federation; 3Institute of Nuclear Physics, Lomonosov Moscow State Univ., Russian Federation. We study fluorescence of emitters coupled to radiation fields allowing for arbitrary interatomic spacing, dipole orientations, and spatial dimension, including the first complete solution in two dimensions. Light-matter coupling in a cavity results in a ladder of states with splittings determined by the coupling strength. We observe the higher ladder rungs in a semiconductor microcavity using multiquantum coherent optical photocurrent spectroscopy.

Nonlinear Terahertz Spectroscopy of Higgs Mode in Superconductors, Ryo Shimano1,2; 1Cryogenic Research Center, Univ. of Tokyo, Japan; 2Department of Physics, Univ. of Tokyo, Japan. By using terahertz-pump and terahertz-probe spectroscopy, we observed the oscillation of superconducting order parameter, namely the Higgs amplitude mode, in s-wave superconductors. We revealed the nonlinear coupling between the Higgs mode and radiation field.

Observing grain boundaries in monolayer molybdenum disulphide by multiphoton microscopy, Lasse Karvonen1, Antti Säynätjoki1,2, Babak Amirsolaimani3, Shisheng Li4, Sorosh Mehravar5, Nasser Peyghambarian1, Harri Lipisnen1, Goki Eda5, Khaneh Kieu5, Zhipei Sun5; 1Micro and Nanosciences, Aalto Univ., Finland; 2Institute of Photonics, Univ. of Eastern Finland, Finland; 3College of Optical Sciences, Univ. of Arizona, USA; 4Department of Physics, National Univ. of Singapore, Singapore. Multiphoton microscopy is used to characterize the crystal orientations and grain boundaries of chemical vapor deposited monolayer molybdenum disulphide flakes. Third-harmonic generation is shown to be sensitive for grain boundaries regardless of the crystal mis-orientations.

Correlated First, Second and Third Order Nonlinear Optical Microscopy of Metallic Nanostructures, Emeric Bergmann1, Christian Jonin1, Emmanuel Benichou1, Pierre F. Brevet1; 1Univ. Claude Bernard Lyon 1, France. We report the combined first, second and third order responses from gold metallic nanostructures. The different features observed are spatially correlated and discussed in light of the origin of the different orders observed.

Advanced Semiconductor-laser Light Pulse Sources for Multiphoton Microscopy, Hiroyuki Yokoyama1, Yi-Cheng Fang1; 1New Industry Creation Hatchery Center (NICHe), Tohoku Univ., Japan. We have developed novel light pulse sources based on the picosecond-pulse semiconductor laser technology. The light pulses are amplified to 100-kW peak power, and this enables the deep-site in vivo imaging of mouse brain tissues.

Subtraction threshold for fluorescence difference microscopy, Takayoshi Kobayashi1, Nan Wang1; 1Univ. of Electro-Communications, Japan. The selection criterion of subtraction factors used in subtraction microscopy is numerically investigated. The fluorescence peak intensity after subtraction and resolution derivative are proposed as essential parameters for evaluating the subtraction threshold.
NW4A.1
A Theoretical Observation of Novel Power Play in the Supercontinuum Spectra of Exponential Saturable Nonlinear Media, Nithyanandan K; 1Pondicherry Univ., India. The supercontinuum generation is observed to behave in a unique in saturable nonlinearity, such that the broadband is observed at shortest distance for pumping at saturation power, in comparison to all other pump power configurations.

NW4A.2
Angular noncritical phase-matching second harmonic generation in BaGa4Se7, Benoit Boulanger1, Elodie Boursier1, Jerome Debray2, Patricia Inacio3, Vladimir Panyutin1, Valentin Petrov1; 1Université Joseph Fourier (Grenoble I), France; 2Institut Neel Centre National de la Recherche Scientifique, France; 3Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy, Germany. We performed a complete study of angular noncritical phase-matched Second Harmonic Generation in the monoclinic BaGa4Se7 (BGSe). We determined the corresponding phase-matching wavelengths, conversion efficiencies and acceptances, as well as the excited nonlinear coefficients.

NW4A.3
Withdrawn

NW4A.4
Oscillons of Matter Waves, Nikolay Rosanov1, Nina Vysotina1, Leonid A. Nesterov1, Sergey V. Fedorov1, Nikolay A. Veretennikov1, Anatoly N. Shatsev1, S.I. Vavilov State Optical Institute, Russian Federation; 2Chair of Laser Optics, ITMO Univ., Russian Federation. Presented and discussed are localized structures of the Bose-Einstein condensate permanently exchanging energy with oscillating walls of the trap. Dynamics of oscillons is compared with that in the Fermi–Ulam and Fermi–Pasta–Ulam problems.

NW4A.5
Ultrafast Saturable Absorption in a-as2s3/Au Heterostructures, Rituraj Sharma1, Aneesha J.1, Rajesh K. Yadav1, Sam E. George1, Adarsh K. V.; 1Indian Institute of Science Education and Research (IISER), India. In this paper, we report that the non linear behavior of amorphous As2S3 can be drastically altered from two photon absorption (TPA) to saturable absorption (SA) when it form heterostructures with Au nanoparticles (ANPs).

NW4A.6
Withdrawn

NW4A.7
Withdrawn

NW4A.8
Enhanced Dynamical Casimir Effect for Surface Plasmon Polaritons and Guided Dielectric Waves, Vladimir Hizhnyakov1, Ardi Loot1, Chatraee Shahabedin Azzabad1, Helle Kaasik1; 1Univ. of Tartu, Estonia. Dynamical Casimir effect – emission of surface waves due to oscillations of optical length of resonator under laser excitation is considered. If amplitude of oscillations coincides with wavelength of emission then its strong enhancement takes place.

NW4A.9
Second Harmonic Generation in Scleral Collagen as a Non-Invasive Probe for Tissue Optical Properties, Michael Haines1, Gideon Billings1, Blake Charlebois1, Larry Batch1, Mary-Anne Mycek1, Agnapi G. Mordovanakis1, 2; 1Biomedical Engineering Department, Univ. of Michigan, USA; 2Center for Ultrafast Optical Science, Univ. of Michigan, USA; 2Refocus Group Inc, USA. Second harmonic generation in scleral tissues is used to infer local tissue scattering and nonlinear susceptibility. Measurements from ex vivo porcine samples suggest that the femtosecond-laser threshold for subsurface photodisruption depends on both these properties.

NW4A.10
Stability Analysis of Quantum-Cascade Lasers with Intracavity Nonlinearity and Group-Velocity Dispersion, Jing Bai1, Debao Zhou1; 1Univ. of Minnesota Duluth, USA. Both amplitude and phase instabilities of mid-infrared quantum-cascade lasers were analyzed in the presence of group-velocity dispersion and a background saturable absorber in the lasing medium. The effect of group-velocity dispersion is found to be more significant at lower pumping level and with a weaker saturable absorber.

NW4A.11
Stability of vortices and spiraling waves in non-equilibrium polariton condensates, Oleg Egorov1, Timothy Liew1, Xuekai Ma1, Michal Matuszewski1, Oleksandr Kyriienko1, Elena Ostrovskaya1; 1Friedrich-Schiller-Universität Jena, Germany; 2Nanyang Technological Univ., Singapore; 3Instytut Fizyki Polskiej Akademii Nauk, Poland; 4Australian National Univ., Australia. We study non-equilibrium dynamics of phase dislocations and vortices in the vicinity of modulational instability of an incoherently pumped polariton condensate. In particular we discuss the mechanism of vortex destabilization and formation of spiraling waves.

NW4A.12
Two-Photon Polymerization of a 3D Structure Using Focus Engineering, Yan Li1; 1Peking Univ., China. Using focus engineering, we have successfully fabricated a 3D microstructure with high resolution by two-photon polymerization with a single exposure. The polymerized array of double-helix structures demonstrates optical chirality.

NW4A.13
High-power frequency-doubling of ultrafast Yb-fiber laser in LBO crystal, Mukesh K. Shukla1, Samir Kumar1, Ritwick Das1; 1Biomedical Engineering Department, Univ. of Minnesota Duluth, USA. We report generation of 1.8W ultrashort-green pulses (≈ 140fs) by frequency-doubling of ultrafast Yb-fiber laser by optimally-focused second-harmonic-generation in LBO crystal. With efficiency 42%, we obtain excellent beam-quality (M2 ≤1.22) for frequency-doubled output.

NW4A.14
Parity-Time Anti-Symmetric Parametric Amplifier with Ultrafast All-Optical Switching, Diana Antonosyan1, Alexander Solntsev1, Andrey A. Sukhorukov1; 1Nonlinear Physics Centre, RSPE, Australian National Univ., Australia. We predict that directional coupler of nonlinear and lossy waveguides can perform ultrafast signal switching and parametric amplification, using the pump-controlled breaking of the parity-time anti-symmetry associated with nonlinear wave mixing.

NW4A.15
All-Optical Retiming Switches Using the Cascaded Second-Order Nonlinear Effect in Periodically Poled Lithium Niobate Devices: Effects of Domain Length Errors, Yutaka Fukuchi1, Kouji Hirata1; 1Tokyo Univ. of Science, Japan. We investigate characteristics of all-optical retiming switches employing periodically poled lithium niobate waveguides with consideration for domain length errors. While the retiming function is independent of random duty-cycle error, random period error causes output degradation.
Enhancement of optical echoes by using ultralow light, Byoung S. Ham 1; 2School of Information and Communications, Gwangju Institute of Science and Technology, South Korea. In conventional optical echoes, ultralow retrieval efficiency has been a major obstacle in potential applications such as all-optical associative memories. Here, we present a nearly unity optical-echo retrieval efficiency by using ultralow light phenomenon.

Tailoring the effective second-order nonlinear coefficients in random media, Mousa Ayoub 1, Joerg Imbrock 1, Markus Passlick 1, Cornelia Denz 1; 1Institute of Applied Physics, Univ. of Muenster, Germany. We study experimentally and theoretically the relative relationship between the non-zero components of the $\chi^{(2)}$-tensor in dependence of different degrees of ferroelectric domain disorder in quadratic media for frequency doubling and cascaded third harmonic generation.

ZnO nanowire array grown on a fiber tip as a new platform for sensor and UV-laser application, Igor V. Melnikov 1, Dmitry G. Gromov 1, Andrey A. Machnev 1, Mikhail Y. Nazarkin 1, Alexei S. Shuliatyev 1; 1National Research Univ. of Electronic Technology, Russian Federation; 2Univ. of Illinois, USA. The excitation of both surface polaritons and deep-level photoluminescence are observed and characterized in an array of ZnO nanowires with 40- to 50-nm diameter and 800-nm length that is being deposited on the end facet of a standard single-mode fiber.

Low-threshold supercontinuum generation for a gain-switched 1126-nm fiber laser, Igor V. Melnikov 1, Andrey A. Machnev 1, J G. Eden 1, Viktor Trushin 1; 1National Research Univ. of Electronic Technology, Russian Federation; 2Univ. of Illinois, USA. We present supercontinuum (SC) generated through a photonic band-gap fiber by a sub-µs pulse from a gain-switched 1126-nm fiber laser that spans over a half-octave (~1.0-1.6 µm) and is attainable yet at fairly moderate fiber length.

Spectral compression of chirped Gaussian pulse in nonlinear optical fibers with exponentially increasing dispersion, Mingfeng Li 1, Qian Li 1; 1Peking Univ. Shenzhen Graduate School, China. Efficient spectral compression of 200 fs chirped Gaussian pulse in a nonlinear optical fiber with exponentially increasing dispersion is demonstrated. A high spectral compression factor of about 38 is achieved.

Influence of an incoherent CW trigger on picosecond supercontinuum generation, Dongfei Zhang 1, Qian Li 1; 1Peking Univ. Shenzhen Graduate School, China. We numerically study the effect of an incoherent continuous-wave (CW) trigger on picosecond supercontinuum (SC) generation.

Nonlinear Kerr effect in a hybrid polymer/chalcogenide photonic crystal fiber, Christos Markos 1, Irnis Kubat 1, Ole Bang 1; 1DTU Fotonik, Technical Univ. of Denmark, Denmark. We fabricated and characterized a hybrid As$_2$S$_3$/PMMA photonic crystal fiber. The high index chalcogenide glass films provide the possibility to red-shift the transmission windows as much as ~ 17 nm with power.

Five-energy level computer model for fitting Z-scan measurements in disubstituted chalcogenodiphenylphosphino bithiophenes, Yuanti Zhang 1, Jianwei Wang 1, Qun Zhao 1, Gary M. Gray 1, Christopher M. Lawson 1; 1Univ. of Alabama at Birmingham, USA. We explicitly describe in detail a five-energy level computer model for analysis of ps and ns 2-scan measurements of novel chalcogenodiphenylphosphino and phosphonato-substituted oligothiophenes exhibiting strong nonlinear optical absorption in the violet-blue spectrum.

SHG techniques to investigate the Surface and the Bulk of Aqueous Solutions, Anthony Maurice 1, Qianli Ma 1, Fabrice Canto 1, Laurent Cousot 1, Olivier Diet 1, Emmanuel Benichou 1, Pierre-Francois Brevet 1; 1Universite Claude Bernard Lyon 1, France; 2CEA, DEN, France; 3ICSM, CEA, France. To investigate interface and bulk of liquids interface, we have developed a method based on coherent and incoherent second harmonic generation, which allows a high contrast between the two contributions.

Quantum correlations of three polar molecules in pendant states, Jin-Ming Liu 1, Yan-Jie Li 1; 1East China Normal Univ., China. We investigate the properties of tripartite quantum correlations for three polar molecules in pendant states and numerically analyze the relations of tripartite negativity, measurement-induced disturbance, and tripartite quantum discord to external field strength, dipole moment, rotational constant, dipole-dipole coupling, and temperature.

Optical properties of M-plane GaN thin films, Der-Jun Jang 1, Mousa Ayoub 1, Joerg Imbrock 1, Markus Passlick 1, Cornelia Denz 1, Ole Bang 1; 1DTU Fotonik, Technical Univ. of Denmark, Denmark. The excitation of both surface polaritons and deep-level photoluminescence are observed and characterized in an array of ZnO nanowires with 40- to 50-nm diameter and 800-nm length that is being deposited on the end facet of a standard single-mode fiber.

Light-graphene interactions at visible to near-infrared wavelengths enabled by Fano-like geometric resonance, Feng Liu 1, Luyi Chen 1, Qiushi Guo 1, Junwei Chen 1, Wangzhou Shi 1; 1Shanghai Normal Univ., China; 2Yale Univ., USA. Within the framework of temporal coupled mode theory for Fano resonance, we investigate the light-graphene interactions at visible to near-infrared wavelengths enabled by geometric resonance sustained in SiN$_x$ nanorod arrays.
NW4A.29
Spectroscopic Study on the Visible Region of the Second Harmonic Generation in LiNbO₃ nanocrystals, Oswaldo Sanchez-Dena¹, Emma-Vianey Garcia-Ramirez¹, Enrique Viguera-Santiago², Cesar Fierro-Ruiz², Runik Farias³, Jorge-Alejandro Reyes-Esqueda¹; ¹Physics Institute, UNAM, Mexico; ²Universidad Autónoma de Ciudad Juárez, Mexico; ³Universidad Autónoma del Estado de México, Mexico. Second-harmonic generation, at fundamental wavelengths of 800-1300 nm, in mechanochemically synthesized LiNbO₃ nanocrystals is reported. For a small, constant energy, a doubled-frequency converted signal has been detected for all this range, with an incident-wavelength-dependent intensity.

NW4A.30
Nonlinear Optical Properties of Au Colloidal Nanorod Systems, Emma-Vianey Garcia-Ramirez¹, Servando Almaguer-Valenzuela², Oswaldo Sanchez-Dena¹, Oscar Baldovino-Pantaleon², Jorge-Alejandro Reyes-Esqueda¹; ¹Physics Institute, UNAM, Mexico; 2Universidad Autónoma de Tamaulipas, Mexico. Colloidal Au nanorods systems obtained by SMG were studied. Their third order nonlinear response was studied using the x-scan technique at 532 nm and 1064 nm with 26 ps pulses for high and low irradiances.

NW4A.31
Nonlinear wave dynamics in a media with anomalous laser-induced group velocity dispersion, YuanYao Lin¹; ¹Department of Photonics, National Sun Yat-Sen Univ., Taiwan. A nonlinear system with chirp and intensity depending dispersion is modelled and nonlinear wave dynamics therein is investigated. A self-dispersion managed pulse with a tunable critical length is discovered in the proposed model.

NW4A.32
Flexible Four-Wave Mixing Based Wavelength Conversion in a Tellurite Microstructured Fiber, Lei Zhang¹, Hoang Tuan Tong¹, Daikue Sega¹, Harutaka Kawamura¹, Dinghuan Deng¹, Takenobu Suzuki¹, Yasutake Ohishi¹; ¹Toyota Technological Institute, Japan. Based on the four-wave mixing generated in a tellurite microstructured optical fiber, the signal at 1494 nm can be converted to any wavelength in the band from 1598 nm to 1641.5 nm.

NW4A.33
Soliton Self-frequency Shift and Supercontinuum Generation in a Tellurite Microstructured Optical Fiber, Tonglei Cheng¹, Hoang Tuan Tong¹, Xiaojie Xue¹, Dinghuan Deng¹, Kenshiro Nagasaka¹, Takenobu Suzuki¹, Yasutake Ohishi¹; ¹ofmlab, Japan. Soliton self-frequency shift in a tellurite microstructured optical fiber is demonstrated. And broadband supercontinuum spectrum is obtained pumped by nanosecond SC light.

NW4A.34
Spatial shock wave formation by diffraction effect in a photorefractive medium, Jose A. Andrade-Lucio¹, David F. Ortega-Tamayo¹; ¹Universidad de Guanajuato, Mexico. We show experimental results for the propagation of a diffracted beam by a straight edge like initial condition in a photorefractive crystal under drift nonlinearity. We have observed that the diffracted pattern and propagation is enhanced in the form of multiple waveguides.

NW4A.35
Hyper-Rayleigh Scattering as a Probe of Molecular Orientation Correlation in Isotropic Liquids, David P. Shelton¹; ¹Univ. of Nevada, Las Vegas, USA. Polarization and angle-dependent hyper-Rayleigh scattering measurements are presented for liquid nitrobenzene, which show that the molecular dipole orientation distribution for nitrobenzene is a transverse vector field.

NW4A.36
Signal Power Symmetry Optimization for Optical Phase Conjugation Using Raman Amplification, Pawel Rosa¹, Giuseppe Rizzelli¹, Juan Diego Ania-Castañón¹; ¹Instituto de Óptica, IO-CSIC, CSIC, Spain. We compare three Raman distributed amplification schemes and numerically optimize performance for OPC by minimizing signal power asymmetry. We show that a power asymmetry of 3% can be achieved in a 63 km span with random DFB Raman-based amplification.

NW4A.37
Measurement of Second Hyperpolarizability and Nuclear Rotational Response of Gas-phase Carbon Disulfide, Peng Zhao¹, Matthew Reichert¹, David J. Hagin¹, Eric W. Van Stryland¹; ¹CREOL Univ. of Central Florida, USA. We use nonlinear beam deflection to separate the bound-electronic and nuclear-rotational responses in gas-phase CS₂. This allows a direct comparison of the second hyperpolarizability to our liquid CS₂ measurements considering local-field effects.

NW4A.38
Extremely Nondegenerate Two-photon Absorption Enhancement in Quantum Well (QW) Semiconductors, Himansu S. Pattanaik¹, Matthew Reichert¹, Jacob B. Khurgin¹, David J. Hagin¹, Eric W. Van Stryland¹; ¹Univ. of Central Florida, CREOL, USA; ²Department of Electrical and Computer Engineering, The Johns Hopkins Univ., USA. We present a theoretical study of extremely nondegenerate two-photon absorption in direct-gap quantum well semiconductors. We predict large enhancement in nondegenerate two-photon absorption for TM-TM polarized light over bulk semiconductors.

NW4A.39
Large Enhancement of Nonlinear Goos-Hänchen Shifts and Optical Bistability due to Surface Plasmon Excitations, Kihong Kim¹; ¹Ajou Univ., South Korea. The Goos-Hänchen shift of p waves incident on a metal-nonlinear dielectric bilayer in the Kretschmann configuration is studied theoretically. There appear very strong bistability and hysteresis phenomena due to surface plasmon excitations.

NW4A.40
Temporal Silicon Photonic Integrator Using Raman-Gain Assisted -phase-shifted Bragg GRATINGS, Ye Deng¹, Shuqian Sun¹, Ninghua Zhu¹, Ming Li¹; ¹Institute of Semiconductor, CAS, China. A temporal silicon photonic integrator based on a -phase-shifted Bragg grating using Raman gain for loss compensation is proposed and theoretically demonstrated. This scheme shows an excellent integral performance and has potential for optical integration.

NW4A.41
Data Driven Control of Complex Optical Systems, Steven Brunton², J. N. Kutz², Xing Fu³, Mikala Johnson³; ²Applied Mathematics, Univ of Washington, USA; ³Mechanical Engineering, Univ. of Washington, USA; ⁴Kymeta Corporation, USA. Advances in data science are revolutionizing the characterization and control of complex optical systems, including the ultra-fast laser and the reconfigurable holographic metamaterial antenna. Methods from data science include machine learning, dimensionality reduction, and compressive sensing. We present these techniques on two optical systems.

NW4A.42
Super/subradiant second harmonics generation, Reuben Shuker¹; ¹Physics, Ben Gurion Univ., Israel. We show that three-level ladder system, driven by resonant laser field, can generate second harmonic of the pumping field in both superadiant and subadiant regime. Transition between these regimes may occur in a phase-transition-like manner.
### NW4A.43
**Rate-Equation Model of Light-Induced Heating in LiNbO$_3$-type Crystals under High-Average-Power Laser Irradiation**, Susumu Kato$^1$, Sunao Kurimura$^2$, Norikatsu Mio$^3$; $^1$AIST, Japan; $^2$NIMS, Japan; $^3$Univ. of Tokyo, Japan. Light-induced heating under high-average-power laser is investigated in LiNbO$_3$-type crystals in green second-harmonic generation. The accumulation effect of polaron causes catastrophic breakdown of crystals. A rate-equation model is proposed to evaluate the threshold intensity.

### NW4A.44
**The role of mean-field theory and pump mechanisms in the nonlinear emission of a quantum dot laser**, José David Hernández Rivero$^1$, Andrés Urquijo$^2$, Herbert Vinck-Posada$^2$; $^1$Universidade Federal de Minas Gerais, Brazil; $^2$Universidad Nacional de Colombia, Colombia. Nonlinear phenomena of quantum-dot lasers under the mean-field approximation are well-known, but pump mechanisms actually seem to determine this behavior. Here is discussed the emission spectrum and dynamics by considering either incoherent or coherent pumping.

18:00 -- 21:00 • Conference Reception and Luau, Luau Garden
NTh1A.1 • 08:00
The Extreme Nonlinear Optics of Coherent X-Ray Beams and Applications in Imaging and Nanometrology, Margaret M. Murnane\textsuperscript{1}, Henry Kapteyn\textsuperscript{1}; \textsuperscript{1}JILA, Univ. of Colorado at Boulder, USA. It is now possible to control the spectral, temporal and polarization of high harmonic x-ray beams for a wide range of applications in imaging and spectroscopy.

NTh1A.2 • 08:30
Circularly Polarized Soft X-Ray High Harmonics and XMCD on a Tabletop, Henry Kapteyn\textsuperscript{1}; \textsuperscript{1}JILA, Univ. of Colorado at Boulder, USA. We present the first circularly-polarized soft X-ray harmonics to photon energies >160eV. Bright phase matched beams are used to characterize important materials with intrinsic perpendicular magnetic anisotropy for the first time using tabletop sources.

NTh1A.3 • 08:45
Bright Attosecond Pulse Generation under Transient Phase-matching in Two-color High-order Harmonic Generation, Bernd Schütte\textsuperscript{1}, Paul Weber\textsuperscript{1}, Katalin Kovács\textsuperscript{2,3}, Emeric Balogh\textsuperscript{2,4}, Balázs Major\textsuperscript{1}, Valer Tosa\textsuperscript{1,4}, Songhee Han\textsuperscript{1}, Marc Vrakking\textsuperscript{1}, Katalin Varjú\textsuperscript{2,4}, Arnaud Rouzée\textsuperscript{1}; \textsuperscript{1}Max-Born-Institut, Germany; \textsuperscript{2}Department of Optics and Quantum Electronics, Univ. of Szeged, Hungary; \textsuperscript{3}National Institute for R&D of Isotopic and Molecular Technologies, Romania; \textsuperscript{4}ELI-HU Nonprofit Kft., Hungary. Experimental and theoretical study of two-color HHG is presented. We show efficient continuum generation up to 160 eV, and calculations suggest the generation of single attosecond pulse isolated by hybrid optical and transient phase-matching gating.

NTh1A.4 • 09:00
Investigation of Non-adiabatic Molecular Dynamics with Attosecond Transient Absorption, Chen-Ting Liao\textsuperscript{1}, Xuan Li\textsuperscript{2}, Daniel Haxton\textsuperscript{2}, William McCurdy\textsuperscript{2}, Arvinder S. Sandhu\textsuperscript{1}; \textsuperscript{1}Univ. of Arizona, USA; \textsuperscript{2}Lawrence Berkeley Lab, USA. We investigate superexcited molecules with attosecond transient absorption. Spectral lineshape evolution helps resolve the autoionization and predissociation dynamics. Strong-field control is explored and the symmetry of electronic states is found to play an important role.

NTh1A.5 • 09:15
Transient Nonlinear Optics of Solids in Extremely High Fields, Mark Stockman\textsuperscript{1}; \textsuperscript{1}Georgia State Univ., USA. We discuss latest developments in theory and recent experimental results for a new class of phenomena in condensed matter optics when a strong optical pulse field \~1-3 V/Å reversibly changes the solid within an optical cycle. A dielectric undergoes a reversible transition to a semimetallic state. Such a pulse drives ampere-scale currents in dielectrics and controls their properties in a non-perturbative manner on a 100-as temporal scale.

NTh1A.6 • 09:45
Picosecond Laser Filamentation in Air, Pavel G. Polynkin\textsuperscript{1}, Andreas Schmitt-Sody\textsuperscript{2}, Heiko Kurz\textsuperscript{1}, Luc Berge\textsuperscript{1}, Stefan Skupin\textsuperscript{2}; \textsuperscript{1}Univ. of Arizona, USA; \textsuperscript{2}Air Force Research Laboratory, USA; \textsuperscript{3}Leibniz Universitat Hannover, Germany; \textsuperscript{4}CEA, DAM, DIF, France; \textsuperscript{5}CNRS - CEA, Univ. of Bordeaux, France. We show that in picosecond laser filamentation in air, impact ionization mechanism facilitates the formation of dense yet continuous plasma channels. Picosecond filamentation may combine the advantages of femtosecond filamentation and nanosecond optical breakdown regimes.

10:00 -- 10:30 • Coffee Break, Kaua‘i Court
beyond 1 Tbit/s. Different comb generation schemes for transmission at data rates optical transceivers. We investigated and demonstrate the viability of comb sources are likely to become key elements of future terabit/s fiber-based frequency comb is explored.

Chieh Huang 1, Tsong-dong Wang 2, Po-Chen Wang 1; 1National Tsing Hua Univ., Taiwan; 2Chung-San institute of Science and Technology, Australia; 3Macquarie Univ., Australia.

Comb Sources, Christian Koos 1, Tobias Kippenberg 2, Liam P. Barry 3, Larry Dalton 4, Abderrahim Ramdane 5, Francois Lelarge 6, Regan Watts 3, Delwin Elder 1, 1Karlsruhe Institute of Technology (KIT), Germany; 2Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland; 3Dublin City Univ., Ireland; 4Univ. of Washington, USA; 5Laboratoire de Photonique et Nanostructures, France; 6ILL-V Labs, France. Chip-scale frequency comb sources are likely to become key elements of future terabit/s optical transceivers. We investigated and demonstrate the viability of different comb generation schemes for transmission at data rates beyond 1 Tbit/s.

A Mid-Infrared Mode-locked Fiber Laser for Frequency Combs, Darren D. Hudson 1, Tomonori Hu 1, Stuart Jackson 2; 1Univ. of Sydney, Australia; 2Macquarie Univ., Australia. We demonstrate a fiber laser emitting 497fs pulses near 3μm using a mid-IR transparent fluoride fiber doped with Erbium. The potential of this laser as a source for a mid-IR Kerr comb generation is explored.

Generation of High-power THz Frequency Comb from Off-axis THz Parametric Oscillator at Room Temperature, Yu-Chung Chu 1, Yenchie Huang 1, Tsong-dong Wang 2, Po-Chen Wang 3; 1National Tsing Hua Univ., Taiwan; 2Chung-San institute of Science and Technology, Taiwan. We generated two high-power frequency combs centered at 1.8 and 4.2 THz from an off-axis lithium-niobate parametric oscillator at room temperature. Stimulated polariton scattering peaked at 4.2 THz is also observed in lithium niobate for the first time.
Program Update Sheet

All technical program changes and Postdeadline Papers will be communicated in the onsite Program Update Sheet. All attendees receive this information with registration materials, and we encourage you to review it carefully to stay informed to changes in the program.
NF1A • Stimulated Scattering and Optomechanics, Ko’olau Salon
Presider: Tal Carmon; Technion Israel Institute of Technology, USA

08:00 — 10:00

NF1A.1 • 08:00
Enhancing and Inhibiting Stimulated Brillouin Scattering in Photonic Integrated Circuits, Benjamin J. Eggleton1; 1Univ. of Sydney, Australia. On-chip Stimulated Brillouin scattering offers potential for integration of a variety of important photon functionalities. Here, we demonstrate selectively enhancing and inhibiting nonlinear interactions on a chip by exploiting the frequency dependence of the optical density-of-states near the edge of a photonic-bandgap.

NF1A.2 • 08:30
Control of Coherent Information via Traveling-wave Photon-phonon Interactions, Peter T. Rakich1; 1Department of Applied Physics, Yale Univ., USA. Through a new class hybrid photonic-phononic waveguide structures we show that artificial Brillouin nonlinearities can be created and manipulated in silicon. Exploiting the nonlocal nature of such hybrid interactions, we demonstrate sophisticated phonon emit-receive functionalities.

NF1A.3 • 09:00
Area dependence of chirped-pulse stimulated Brillouin scattering, Mark Dong1, Herbert G. Winful1; 1Univ. of Michigan, USA. We show that chirped pulses can enhance the formation of Brillouin dynamic gratings as well as the storage and retrieval of information. The process is analogous to adiabatic rapid passage in two-level systems.

NF1A.4 • 09:15
Optomechanics of random and nonlinear media, Silvia Gentilini1, Claudio Conti1; 1Institute for Complex Systems (ISC-CNR), Italy. We give a review of our numerical results on the effect of randomness and nonlinearity on optical forces. For random media we find that disorder induced localization enhance the light induced mechanical effects; for nonlinear media we show that an ultra-fast nonlinear polarization may give a negative contribution to the optical pressure.

NF1A.5 • 09:30
Single Crystal Diamond Cantilevers for Mechanical Control of Quantum Systems, Kumaravelu Ganesan2, Afaq Piracha2, Olga Freidin2, Marcus Doherty1, Neil Manson1, Steven Prawer2; 1Research School of Physics and Engineering, Australian National Univ., Australia; 2School of Physics, Univ. of Melbourne, Australia. We demonstrate a simple technique to fabricate cantilevers from bulk CVD single crystal diamond as well as from single crystal diamond membrane windows fabricated in a novel technique. Mechanical quality factors of cantilevers were measured. A mechanical Q-factor of as high as 500 was achieved.

NF1A.6 • 09:45
Secure transmission and retrieval of images in conjunction with steganography using chaos in nonlinear acousto-optic feedback, Monish R. Chatterjee1, Fares S. Almehmadi1; 1Univ. of Dayton, USA. Digital images are encrypted onto a chaotic carrier in a Bragg cell under hybrid nonlinear feedback and secure data is embedded into the system via steganography. System robustness (with and without channel noise) is analyzed vis-a-vis information security.
NF2A.1 • 10:30
Quantum Gravity Simulation and Irreversibility in Nonlinear Optics, Maria Chiara Braidotti¹, Silvia Gentilini¹, Claudio Conti¹; ‘Institute for Complex Systems (ISC-CNR), Italy. We show that non-paraxial nonlinear optics can be described in terms of a generalized quantum mechanics that is nowadays studied in the field of quantum gravity. The key point is the so-called generalized uncertainty principle (GUP) that describes particle localization on a scale comparable with the Planck length. The GUP has one-to-one correspondence to the resolution limit of non-paraxial propagation.

NF2A.2 • 11:00
Transverse strong to weak localization in nonlinearly induced photonic random structures, Cornelia Denz¹, Sebastian Brake¹, Martin Boguslawski¹, Daniel Leykam², Anton Desyatnikov³; ‘Univ. of Muenster, Germany; ²Australian National Univ., Australia. We present observation and analysis of universal wave localization effects – Anderson localization and, for the first time, coherent backscattering in photonic random potential ensembles where naturally particular constructive interference contributions survive against statistical speckle background.

NF2A.3 • 11:15
Autofocusing of cylindrical caustics self-generated in a defocusing nonlinear medium, Michael Karpov¹, Yonatan Sivan², Victor Fleurov¹, Thibault Congy³, Nicolas Pavloff³, Shimshon Barad¹; ‘Tel-Aviv Univ., Israel; ²Ben Gurion Univ., Israel; ³LPTMS, CNRS and Univ. Paris Sud, France. We describe a simple method for generating an autofocusing, radially-symmetric Airy wave, relying on optical caustics which form in a defocusing, nonlocal thermal nonlinear medium with a cylindrical reflective boundary.

NF2A.4 • 11:30
Metal-Free Optical-Controllable Lens by Nonlinear Negative Refraction, Jianjun Cao¹, Yuanlin Zheng¹, Xianfeng Chen¹, Yaming Feng¹, Wenjie Wan¹; ‘Shanghai Jiao Tong Univ., China. We demonstrated a metal-free flat lens using negative refraction by degenerate four-wave mixing with a thin glass slide [1] and further realize a magnifying lens by introduction additional transformation optics [2], achieving an all-optical controllable lensing effect.

NF2A.5 • 11:45
Influence of a Second-order Kerr Lens in the SHG Crystal on the THG Efficiency and Beam Quality, Peter Koch¹, Juergen Bartschke², Johannes A. L’huillier³; ‘Photonik-Zentrum Kaiserslautern, Germany; ²Xiton Photonics GmbH, Germany. By detuning the phase-matching temperature of the SHG crystal, cascaded Chi(2)-processes play an important role in the optimization of a two crystal frequency tripling setup. Self-action of the fundamental is beneficial for the THG efficiency and beam quality.

NF2A.6 • 12:00
Nonlinear combining of laser beams, Pavel M. Lushnikov¹; ‘Univ. of New Mexico, USA. Multiple laser beams are combined into a diffraction-limited beam by beam self-focusing (collapse) in Kerr medium. Beams with total power above critical are combined in near field and propagated through optical fiber. Random fluctuations during propagation trigger strong self-focusing event producing diffraction-limited beam with the critical power.

NF2A.7 • 12:15
Interaction between Airy beams in nonlinear media, Nicolas Marsal¹, Noemi Wiersma¹, Marc Sciamanna¹, Delphine Wolfersberger¹; ‘CentraleSupélec-MOPS, France. We analyse numerically the dynamics and interaction schemes of two counter-propagating Airy beams in a photorefractive crystal. Interestingly, the system evolves from a steady to time-dependent stable and turbulent states where spatiotemporal chaos is identified.