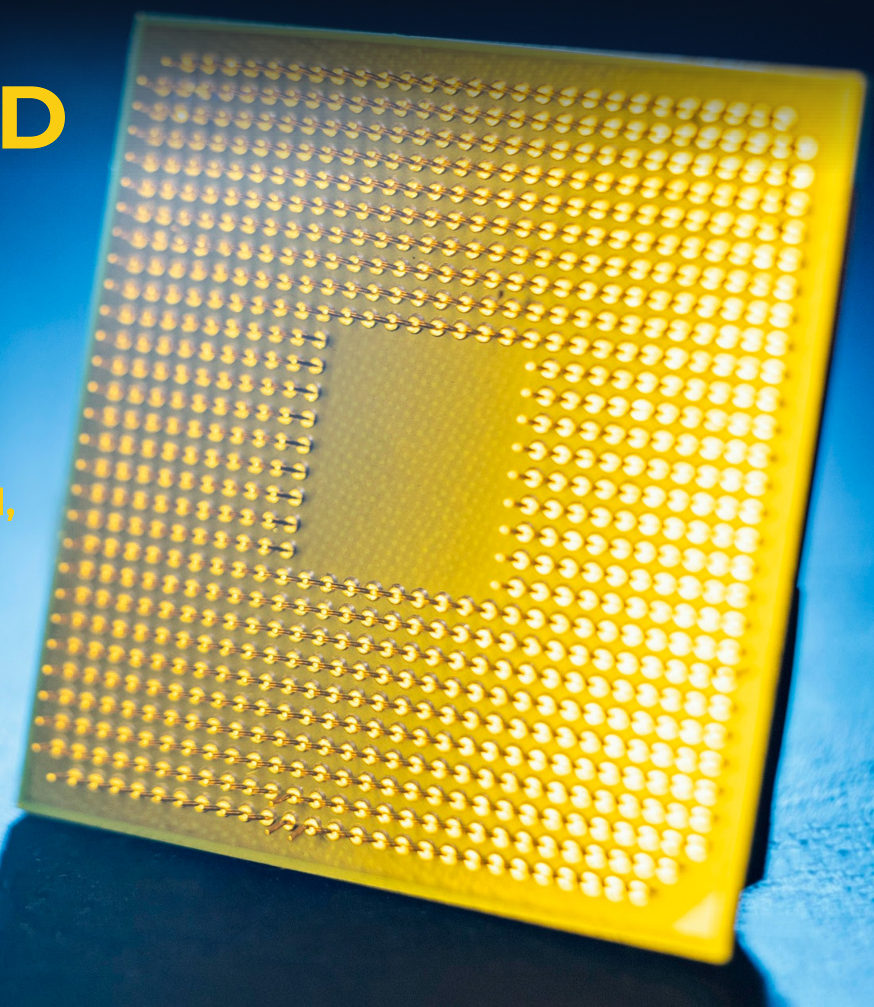
LOPS Annual Conferences®

LOPS 2024

4th EDITION OF ANNUAL CONFERENCE ON

LASERS, OPTICS, PHOTONICS SENSORS, BIO PHOTONICS, ULTRAFAST NONLINEAR OPTICS & STRUCTURED LIGHT

JUNE 07-10, 2024
(EDITION 4)



DoubleTree Resort by Hilton Hollywood Beach, Hollywood, FL, USA

SPONSORS & SUPPORTERS

OPTICA

UC San Diego
JACOBS SCHOOL OF ENGINEERING
Shu Chien-Gene Lay Department of Bioengineering

CCNY
INSTITUTE FOR ULTRAFAST SPECTROSCOPY AND LASERS

University of Central Florida

HAMAMATSU

PHOTOTHERMAL SPECTROSCOPY CORP
IR+Raman

DRS DAYLIGHT SOLUTIONS

SMART BIOPHOTONICS

CREOL
THE COLLEGE OF OPTICS AND PHOTONICS

CYTEK®
TRANSCEND THE CONVENTIONAL

ASSOCIATION OF ITALIAN AMERICAN EDUCATORS
AIAE
WWW.AIAE.NET

ORGANIZING COMMITTEE MEMBERS

Robert Alfano, Chief Executive

Alex Kazemi, Chairman

Brock Koren, Co-Chair

Lingyan Shi, Co-Chair

Peter Delfett, Co-Chair

Bing Yu, Co-Chair

Keerthi Rajana, Director of the Conference

Day 1 | Friday | June 07, 2024

Start of Session | 09:00 | All Virtual attendees can join the Conference through Zoom

---

Coffee: 08:30-09:00 AM

Session Chairs: Dr. Alex Kazemi

Welcoming Remark	09:00-09:10	**Dr. Alex Kazemi/Chairman of Conference**
Keynote Speaker	09:10-09:40	**Lasers on Silicon** Douglas Dykaar, DifTek Lasers Inc., Canada
Plenary Speaker	09:40-10:20	**Update on Ultrafast optical physics for the generation of HHG and supercontinuum** Robert R. Alfano, The City College of New York, USA

Coffee Break @ 10:20-11:00 (40 minutes)

Plenary Speaker/Virtual	11:00-11:40	**Recent advances in tabletop attosecond X-ray sources** Zenghu Chang, University of Central Florida, USA
Keynote Speaker	11:40-12:10	**Diffuse Optics in the Clinic: Recent Results** Arjun G. Yodh, University of Pennsylvania, USA
Keynote Speaker	12:10-12:40	**Multimodal In vivo Imaging Guided Stem Cell Retinal Therapy** Yannis Paulus, University of Michigan, USA

Lunch Break @ 12:40-14:10 (90 minutes)

Session Chair: Peter J. Delfyett

Panel Discussion	14:10-15:10	**Industrial Panel Discussion** Moderator: Dr. Jose Pozo, CTO, OPTICA, USA **Introduction** : Peter J. Delfyett University of Central Florida, USA Alex Kazemi, The Boeing Company,USA Brock Koren, DRS Daylight Solutions, USA Ming Yan, Cytek Biosciences, USA Lu Ping, OFS Fitel LLC, USA
Keynote Speaker	15:10-15:40	**LiDAR Enhancement using non-Classical Light** Amr S. Helmy, University of Toronto, Canada
Invited Speaker	15:40-16:00	**Recent progresses on deep-learning enabled, deep-ultraviolet scanning microscopy for tumor margin assessment** Bing Yu, Marquette University and Medical College of Wisconsin, USA

Coffee Break @ 16:00-16:40 (40 minutes)

Plenary Speaker	16:40-17:20	**Vibrational photothermal microscopy: new window for biology and medicine** Ji-Xin Cheng, Moustakas Chair Professor of photonics and optoelectronics, Boston University Photonics Center, USA
Invited Speaker	17:20-17:40	**From Technology to Discovery: Deeper, Faster, and Colorful Photoacoustic Imaging in Life Sciences** Junjie Yao, Duke University, USA
Keynote Speaker	17:40-18:10	**Toward Fully Stabilized Chip Scale Optical Frequency Combs Sources and Applications - Sources and Applications.** Peter J. Delfyett, University of Central Florida, USA

Day 1 | End of the Session

Day 2 | Saturday | June 08, 2024

Coffee: 08:30-09:00 AM

Session Chairs: Brock Koren

Plenary Speaker	09:00-09:40	**Attosecond Clocking and Control of Strong Field Quantum Trajectories** Louis F. DiMauro, The Ohio State University, USA
Keynote Speaker	09:40-10:10	**Lateral heterostructures with arbitrary shape and material composition in two-dimensional materials** Ali Adibi, Georgia Institute of Technology, USA

Coffee Break @ 10:10-10:50 (40 minutes)

Plenary Speaker/Virtual	10:50-11:30	**Singularity Engineering by Meta-optics** Federico Capasso, Harvard University, USA
Keynote Speaker	11:30-12:00	**NeuralRTE: A new photon transport simulation algorithm for assessment of light propagation in biological tissues'** Alexander Doronin, Victoria University of Wellington, New Zealand
Invited Speaker	12:00-12:20	**New Generation Photoacoustic Imaging: From benchtop wholebody imagers to wearable sensors** Lei Li, Rice University, USA
Keynote Speaker	12:20-12:50	**Modeling and compensating polarization aberrations in optical systems** Boris Gramatikov, Wilmer Eye Institute, Johns Hopkins University, USA

Lunch Break @ 12:50-14:50 (120 minutes) | Conference Lunch at Banquet Hall

Session Chair: Alexander Doronin

Keynote Speaker	14:50-15:20	**Ionizing radiation acoustic imaging (iRAI) for mapping the dose deep in the patient during radiation thera** Xueding Wang, University of Michigan, USA
Invited Speaker	15:20-15:40	**Synergistic Anticancer Potential of Green Synthesized Nanoparticles and Pheophorbide a-Mediated Photodynamic Therapy in lung cancer** Blassan P George, University of Johannesburg, South Africa
Keynote Speaker	15:40-16:10	Peter Hesketh, Georgia Institute of Technology, USA

Coffee Break @ 16:10-16:50 (40 minutes)

Keynote Speaker	16:50-17:20	**Gas Analysis Methods Based on Stimulated Raman Scattering and Collision Enhanced Raman Scattering in Hollow Core Photonic Crystal Fiber with Potential for Human Breath Analysis for Lung Cancer Detection** Haishan Zeng, University of British Columbia, Canada
Keynote Speaker	17:20-17:50	**Neuron Counting and Optical Characteristics in Human Brain Tissues: A Noninvasive Study in Visible and Near-Infrared Spectra** Jamal H. Ali, CUNY, USA
Keynote Speaker	17:50-18:20	**Unveiling the Depths of Cell Biology Using Multi-Laser Spectral Flow Cytometry** Ming Yan, Cytek Biosciences, USA
Keynote Speaker	18:20-18:50	**Multicomponent Photochemotherapeutic drugs for Photodynamic diagnosis and Photodynamic therapy in cancer** Heidi Abrahamse, University of Johannesburg, South Africa

Day 3 | Sunday | June 09, 2024

Coffee: 08:30-09:00 AM

Session Chairs: Angela B Seddon

Plenary Speaker (Virtual)	09:00-09:40	**Longitudinally-Structured Light Fields for Sensing and Dynamic Behavior** Alan E. Willner, University of Southern California, USA
Keynote Speaker	09:40-10:10	**The past, present, and future of Quantum Cascade Lasers Technology (QCL-IR)** Brock Koren, DRS Daylight Solutions, USA

Coffee Break @ 10:10-10:50 (40 minutes)

Invited Speaker	10:50-11:10	**Altering the optical properties of aromatic amino acid lattices in the microtubule cytoskeleton with small aromatic molecules.** Travis J. A. Craddock, Nova Southeastern University, USA
Invited Speaker	11:10-11:30	**Emerging Fiber Technologies for Distributed Optical Fiber Sensing** Lu, Ping, OFS Fitel LLC, USA
Invited Speaker	11:30-11:50	**Which wavelength of light for photo-biomodulation therapy can penetrate deeper into the spinal canal?** Piao, Daching, Oklahoma State University, USA
Invited Speaker	11:50-12:10	**Correlations between intraocular pressure regulation and the biomechanical behaviors of distal aqueous outflow vasculature** Guan (Gary) Xu, Univeristy of Michigan, USA

Luncheon: 12:10-14:10 @ Banquet Hall (120 minutes)

Session Chair: Lingyan Shi

Invited Speaker	14:10-14:30	**Paradigm shift in the operations and applications of volume Bragg gratings** Ivan Divliansky, CREOL, USA
Keynote Speaker	14:30-15:00	**Raman-based Noninvasive Continuous Glucose Monitoring (CGM)** Jeon Woong Kang, MIT, USA
Invited Speaker	15:00-15:20	**Non- and Minimally-Invasive Optical Monitoring of the Central Nervous System During Critical Care** David R. Busch, University of Texas Southwestern, USA
Keynote Speaker	15:20-15:50	**Metabolic Nanoscopy for Studying Aging and Diseases** Lingyan Shi, UCSD Bioengineering, USA

Coffee Break @ 15:50-16:30 (40 minutes)

Keynote Speaker	16:30-17:00	**Advanced Fiber optic Sensing Systems for Aviation and Aerospace Applications** Dr. Alex Kazemi, The Boeing Company Fiber Optic Architect PD Advanced Concept, Chairman, LOPS2024
Keynote Speaker	17:00-17:30	**Mid-infrared (MIR) continuous wave, room temperature, first time fibre lasing beyond 5 µµm.** Angela B Seddon, University of Nottingham, UK

Keynote Speaker	17:30-18:00	**The emergence of Super Resolution Optical Photothermal Infrared Spectroscopy and Imaging** Mustafa Kansiz and Craig Prater, Photothermal Spectroscopy Corp., USA
Invited Speaker	18:00-18:20	**Talk : Challenges of and developments towards off-contact diffuse reflectance spectroscopy** Piao, Daching, Oklahoma State University, USA

Conference Closing Remarks by Alex Kazemi

Day 4 | Monday | June 10, 2024

VIRTUAL SESSION | Please download Zoom Meeting Application (Free Download)

Session Chairs: Bing Yu | Keerthi Rajana

Plenary Talk	09:00-09:40	Paul Corkum, University of Ottawa, Canada
Invited Speaker	09:40-10:00	**Visible Resonance Raman Scattering in Brains** Binlin Wu, Southern Connecticut State University, USA
Keynote Speaker	10:00-10:30	**Spatially Stable Constellations of Polarization Singularities in the Optical Wavefronts** Andrei Afanasev, The George Washington University, USA
Keynote Speaker	10:30-11:00	**Machine-Learning-based Opening Object Recognition** Yang Yue, Xi’an Jiaotong University, China
Student Speaker Talk	11:00-11:20	**Kidney Cancer Classification Model Using Deep Learning** Joseph Neumann, Southern Connecticut State University, USA

Closing Remarks Bing Yu & Keerthi Rajana

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

DoubleTree Resort by Hilton Hollywood Beach,
4000 South Ocean Dr., Hollywood, FL 33019

DAY 1

PRESENTATIONS

LASERS ON SILICON

Douglas Dykaar
Founder, DifTek Lasers Inc., Canada

Growing lasers on silicon has eluded scientists for decades and has been referred to as the Holy Grail of photonics [1]. The fundamental issue preventing the integration of III-V based laser diodes on silicon (or other) substrates is the lattice mismatch between the material systems. This mismatch results in dislocations in the grown III-V material which degrades the performance and lifetime of the resulting laser diodes. There is however an exception to this limitation: Nanorods. In this case, dimensions are < 1 μm, which allows the dislocations to relax, allowing the growth of high quality Quantum Wells. Nanorod LEDs [2], vertically emitting lasers [3] and cleaved edge emitting geometries [4] have all been fabricated.

Compared to previous geometries of nanorod lasers the approach presented here lases in the plane of the substrate, doesn't require cleaved end facets, can be scaled to useful output powers and allows for integration with other components or Photonic Integrated Circuits generally.

I present a straightforward design and simulation results for fabricating III-V laser diodes on silicon substrates: A linear array of Bragg-spaced Quantum-Well Nanorods.

1. V. Venugopal, "Silicon Lasers: the Final Frontier", (https://spie.org/news/photonics-focus/julaug-2020/silicon-lasers_the-final-frontier?SSO=1), (2020).
2. Y. Wu, Y. Xiao, I. Navid, K. Sun, Y. Malhotra, .Wang, D.Wang, Y. Xu, A. Pandey, M. Reddeppa, W. Shin, J. Liu, J. Min and Z. Mi, "InGaN micro-light-emitting diodes monolithically grown on Si: achieving ultra-stable operation through polarization and strain engineering", Light: Science & Applications,11:294 (2022).
3. S. Arafin, X. Liu, Z. Mi, "Review of recent progress of III-nitride nanowire lasers", Journal of Nanophotonics, 074599-1, Vol. 7, (2013).
4. E. Stark, T. Frost, S. Jahangir, S. Deshpande and P. Bhattacharya, "A monolithic electrically injected InGaN/GaN disk-in-nanowire (λ=533nm) laser on (001) silicon," 2014 IEEE Photonics Conference, San Diego, CA, USA, 2014, pp. 591-592, doi: 10.1109/IPCon.2014.6995279.

Biography

Dr. Doug Dykaar is the founder of DifTek Lasers, Inc. He received the PhD in Electrical Engineering from the University of Rochester in 1987 in Gerard Mourou's Ultrafast Science group. He was a member of technical staff at AT&T Bell Labs Murray Hill, Research manager at DALSA, and Research Scientist at Thalmic/North. Doug also taught at Conestoga College in their 4-year Bachelor of Engineering Program. At last count, he had over 100 patent applications and 60 publications. His research interests span lasers to superconductivity to materials science to composite electronics.

UPDATE ON ULTRAFAST OPTICAL PHYSICS FOR THE GENERATION OF HHG AND SUPERCONTINUUM

Professor Robert R. Alfano
The City College of New York, USA

The focus will be on Higher harmonic Generation (HHG) and Supercontinuum (SC) which are Nonlinear optical effects. These can be described by electromagnetic theory arising from Kerr index n 2. This HHG is relevant to the outcome of Attosecond laser pulse generation which was awarded the 2023 Nobel prize and possibly relevant for Zeptosecond laser pulses.

Biography

In 2019, Robert Alfano received SPIE (Society of Photo-Optical Instrumentation Engineers) Gold Medal Award, the highest honor bestowed by the society. Robert Alfano is an Italian-American experimental physicist. He is a Distinguished Professor of Science and Engineering at the City College and Graduate School of New York of the City University of New York, where he is also the founding Director of the Institute for Ultrafast Spectroscopy and Lasers (1982). He is a pioneer in the fields of Biomedical Imaging and Spectroscopy, Ultrafast lasers and optics, tunable lasers, semiconductor materials and devices, optical materials, biophysics, nonlinear optics and photonics; he has also worked extensively in nanotechnology and coherent backscattering. His discovery of the white-light supercontinuum laser is at the root of optical coherence tomography, which is breaking barriers in ophthalmology, cardiology, and oral cancer detection (see "Better resolution with multibeam OCT," page 28) among other applications. He initiated the field known now as Optical Biopsy. He recently calculated he has brought in $62 million worth of funding to CUNY during his career, averaging $1.7 million per year. He states that he has accomplished this feat by "hitting the pavement"; he developed a habit of aggressively reaching out to funding partners and getting them interested in his work. Alfano has made discoveries that have furthered biomedical optics, in addition to fields such as optical communications, solid-state physics, and metrology. Alfano has an outstanding track record for achievements regarding the development of biomedical instruments. His contributions to photonics are documented in more than 700 research articles, 102 patents, several edited volumes and conference proceedings, and well over 10,000 citations. He holds 45 patents and published over 230 articles in the biomedical optics area alone. His discovery of the white-light supercontinuum laser is at the root of optical coherence tomography, which is breaking barriers in ophthalmology, cardiology, and oral cancer detection (see "Better resolution with multibeam OCT," page 28) among other applications. Alfano has trained and mentored over 52 PhD candidates and 50 post-doctoral students. For the past ten years, he has trained innumerable high school students in hands on photonics.

Areas of Expertise/Research:

Bonding of Tissues with Light Biomedical Optics and Detection of Cancer with Light Spectroscopy Expertise in Properties of Light and Photonics Ultrafast Spectroscopy and Lasers Physics and Electrical Engineering Science and Engineering Find more information at : https://en.wikipedia.org/wiki/Robert_Alfano#

AWARDS

Michael S. Feld Biophotonics Award

Charles Hard Townes Medal

Plenary Speaker, Chief Planning Committee member, LOPSTM # SPIE Gold Medal (2019)

Founding Director of the Institute for Ultrafast Spectroscopy and Lasers (1982)

Pioneer, Biomedical Imaging, Spectroscopy, Ultrafast lasers, Optics, Tunable Lasers semiconductor materials devices, optical materials, biophysics, nonlinear optics and photonics

Discoverer, white-light Supercontinuum laser | # 700 research articles, 102 patents # 10,000 citations

45 patents and 230 articles: Biomedical optics area | # SPIE Gold Medal 2019

American Physical Society Arthur Schawlow Award 2013

OSA Charles Townes Award 2008

Britton Chance Biomedical Optics Award 2012

Coherent Lifetime Achievement Award in Biomedical Optics 2002

Fellow, the American Physical Society (APS) | # Fellow, Optical Society (OSA)

Fellow, New York Academy of Sciences

Fellow, Institute of Electrical and Electronics Engineers (IEEE)

Fellow, the International Society for Optics and Photonics (SPIE)

Eastern New York Intellectual Property Law Association (ENYIPLA) Inventor of Year award (2018) |

OSA Michael S. Field Biophotonics Award (2016)
APS Arthur L Schawlow Prize in Laser Science (2013)
CCNY President's Inaugural Award for Excellence (2013)
Association of Italian American Educators "Lifetime Achievement Award" (2012)
SPIE Britton Chance Biomedical Optics Award (2012
Optical Society of America Charles Hard Townes Award (2008)
Coherent Award for Lifetime Achievement in Biophotonics (2002)
Fellow of IEEE – January 1, 2001 to present. Fellow of New York Academy of Sciences (1999-present)
Leonardo Da Vinci Award (1991) | # Fellow of Optical Society of America (1989 to date)
Outstanding Italian-American Award for Science (1983)
Research Corporation Award Fellow of American Physical Society (1976 to date) A. P. Sloan Fellow 1975-80

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

RECENT ADVANCES IN TABLETOP ATTOSECOND X-RAY SOURCES

Zenghu Chang
University of Central Florida, Orlando, FL 32816, USA

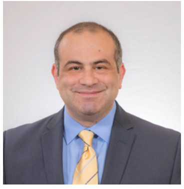
Biography

Zenghu Chang is a University Trustee Chair, Pegasus, and Distinguished Professor at the University of Central Florida (UCF), where he directs the Institute for the Frontier of Attosecond Science and Technology. He is a fellow of the American Physics Society and the Optical Society of America. Chang earned a master's and a doctorate at the Xi'an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences, in 1985 and 1988 respectively. He joined UCF in 2010. His group first demonstrated high-order harmonic cutoff extension using long wavelength driving lasers in 2001. He is the author of the book "Fundamentals of Attosecond Optics."

Attosecond extreme ultraviolet sources based on high-order harmonic generation (HHG) driven by Ti:Sapphire lasers centered at 800-nm have been the workhorse for studying electron dynamics since 2001. However, the photon energy range with sufficient flux for time-resolved experiments is limited <130 eV. Theories predicted that the extension of the high harmonic spectrum to higher photon energy favors long laser wavelengths, which has been validated by experiments [1]. In recently years, significant progress has been made in developing few-cycle, carrier-envelope phase stabilized, high peak-power lasers in the 1.6 to 2 μm that has laid the foundation for attosecond X-ray sources in the water window (282 – 533 eV), which covers the atomic K-shell excitation of carbon, nitrogen, and oxygen [2]. Even longer wavelength high-peak-power lasers are becoming available. We will first review the recent progress on Chirped Pulse Amplification lasers centered at 2.5 μm and 4.1 μm based on the Cr:ZnSe and Fe:ZnSe gain media [3, 4], which are able to output >3-mJ femtosecond pulses at >500 Hz repetition rate. We then describe recent breakthroughs in Chirped Pulsed Optical Parametric Amplifiers based on the ZnGeP2 nonlinear crystals pumped by Ho:YLF CPA lasers at 2 μm. Sub-100 fs pulses with mJ energy can be generated at 1 kHz [5]. These new generation driving lasers paved the way to push the tabletop attosecond sources to the tender X-ray range (1 to 5 keV).

References:

1. Chang Zenghu et al, 2022 Advances in Optics and Photonics 14, 652
2. Saito Nariyki et al, 2019 Optica 6, 1542
3. Wu Yi et al, 2020 Scientific Reports 10, 7775
4. Marra Z. Alphonse et al, 2023 Optics Express 31, 13447
5. Zhou Fangjie et al, 2022 Optics Letters 47, 6057



LIDAR ENHANCEMENT USING NON-CLASSICAL LIGHT

Amr S. Helmy
Edward S. Rogers Sr. Department of Electrical and Computer Engineering, University of Toronto, 10 King's College Road, Toronto, Ontario, Canada M5S 3G4 a.helmy@utoronto.ca

The detection of objects in the presence of significant background noise is a problem of fundamental interest in sensing. In this talk I aim to demonstrate theoretically and experimentally how one can exploit non-classical light generated in monolithic semiconductor light sources in conjunction with non-local effects to enhance the performance of optical target detection and model LiDAR system.

Our protocols utilize quantum time-correlation which are obtained from a spontaneous parametric down-conversion sources. The protocols only requires time-resolved photon-counting detection, which is phase-insensitive and therefore suitable for practical target detection. As a representative comparison to such a detection protocol, we also consider a classical phase-insensitive target detection protocol based on intensity detection. Unlike classical target detection and ranging protocols, the probe photons in our detection protocol are completely indistinguishable from the background noise and therefore useful for covert ranging applications.

The experimental results agree very well with the theoretical prediction. In particular, we find that in a high-level environment noise and loss, our detection protocol can achieve performance comparable to that of the classical protocol that is practical in the optical regime.

Biography

I joined the department of Electrical and Computer engineering of the University of Toronto with a mixed experience in academic as well as industrial environments. I received both my M.Sc. (9/1995) and Ph.D. (11/1998) degrees from the University of Glasgow, Scotland, in the field of photonics. I was a European Union-sponsored research fellow on project to study difference frequency generation in III-V heterostructures using Quantum well intermixing in 1999. Between 2000 and 2004 I joined Agilent Technologies, where I was involved in developing different Photonic devices ranging form high reliability high power submarine-class 980 nm lasers, to DFBs for un-cooled high temperature operation, to integrated laser/modulator/amplifier devices. My Research Interests include; Photonic device physics and characterization techniques, non-linear optics in III-V semiconductors, applied optical spectroscopy for III-V optoelectronic devices and materials, III-V fabrication and monolithic integration techniques.

DIFFUSE OPTICS IN THE CLINIC: RECENT RESULTS

Arjun G. Yodh
Department of Physics and Astronomy
University of Pennsylvania
Philadelphia, PA 19104-6396

Diffuse optical techniques probe physiology in tissues located far below the surface (e.g., centimeters), as well as demonstrated sensitivity to deep tissue hemodynamic biomarkers such as blood flow, blood oxygenation, and oxygen metabolism, as well as other classes of biomarkers such as molecular cytochrome-C oxidase, water, and intracranial pressure. I will discuss recent clinical examples from work carried out with colleagues in the hospital at the University of Pennsylvania and at the Children's Hospital of Philadelphia. The talk will coherently review clinical results from human brain during mechanical thrombectomy [1], intracranial pressure in neonates with hydrocephalus [2] and adults during ventricular arrhythmia [3], placental blood oxygenation during maternal hyperoxia [4], as well as the metabolic responses of swine models during cardiac surgery/arrest and upon exposure to CO.

References

1. Forti, R.M., Favilla, C.G., Cochran, J.M., Baker, W.B., Detre, Kasner, S.E., Mullen, M.T., Messé, S.R., Kofke, A., Balu, R., Kung, D., Pukenas, B.A, Sedora-Roman, N.I., Hurst, R.W., Choudhri, O.A., Mesquita, R.C., and Yodh, A.G., Journal of Stroke and Cerebrovascular Diseases 28, 1483-1495 (2019). DOI: 10.1016/j.jstrokecerebrovasdis.2019.03.019
2. Flanders, T.M., Lang S, Ko, T.S., Andersen, K.N, Jahnavi, J., Flibotte, J.N., Licht, D.L., Tasian, G.E., Sotardi, S.T., Yodh, A.G., Lynch, J.M., Kennedy, B.C., Storm, P.B., White B.R., Heuer, PG., Baker, W.B., Journal of Pediatrics. 236, 54-61 (2021). https://doi.org/10.1016/j.jpeds.2021.05.024
3. Lafontant, A., Gabrielli, E.M., Bergonzi, K., Forti, R., Ko, T., Shah, R., Arkles, J., Licht, D., Yodh, A.G., Kofke, W.A., White, B., and Baker, W., Neurophotonics 9, 035004-1-035004-11 (2022). PMID: 36039170, PMCID: PMC9407009. DOI: 10.1117/1.NPh.9.3.035004
4. Wang, L., Cochran, J.M., Ko, T., Baker, W.B., Abramson, K., He, L., Busch, D.R., Kavuri, V., Linn, R.L., Parry, S, Yodh, A.G., and Schwartz, N., Nature Biomedical Engineering (2022)

Biography

Arjun Yodh received his B.Sc. degree from Cornell, and his Ph.D. degree from Harvard in Atomic Physics under the guidance of Tom Mossberg. He carried out postdoctoral research at AT&T Bell Laboratories, working with Steven Chu and Harry Tom. Yodh joined the Department of Physics and Astronomy at the University of Pennsylvania as an Assistant Professor in 1988. Today, he is the James M. Skinner Professor of Science at Penn. He has taken on various leadership roles during this time. Notably, he was Director of Penn's Laboratory for Research on the Structure of Matter (LRSM) and its NSF-funded Materials Science and Engineering Research Center (MRSEC) for 11 years from 2009-2020. Currently, he is the Chair of Penn's Department of Physics and Astronomy. Yodh's research is multi-faceted. He is a pioneer in the field of biomedical optics. He was recently recognized by the Optical Society in 2021 with the Feld Prize in Biophotonics for his contributions to the development of the theoretical framework and clinical translation of diffuse optical spectroscopy and tomography technologies. He and his group were among the first to predict and experimentally demonstrate wave-like propagation properties of diffuse photon density waves, and to develop the image reconstruction algorithms needed to generate 3D tomographic images based on diffuse optical and diffuse correlation measurements. His more recent work includes demonstrating and clinically translating light diffusion concepts for noninvasive imaging and monitoring of tissue blood flow, hemodynamics, metabolic responses, and therapeutics in cancer and brain. Finally, Yodh is a dedicated mentor, advising and having advised more than 100 Ph.D. students and postdoctoral associates, and playing an influential role in several educational outreach programs that promote STEM activities at all levels.

Director, Laboratory for Research on Structure of Matter (LRSM) and NSF-MRSEC (2009-2020), James M. Skinner Professor of Science, University of Pennsylvania (2000-present), Professor of Physics and Astronomy, University of Pennsylvania (1997 – present), Associate Professor of Physics, University of Pennsylvania (1993-97), Assistant Professor of Physics, University of Pennsylvania (1988-93), Postdoctoral Research Associate with Harry W. K. Tom, AT&T Bell Labs (1987-88), Postdoctoral Research Associate with Steven Chu, AT&T Bell Labs (1986-87).

RECENT PROGRESSES ON DEEP-LEARNING ENABLED, DEEP-ULTRAVIOLETSCANNING MICROSCOPY FOR TUMOR MARGIN ASSESSMENT

Bing Yu, PhD

Joint Department of Biomedical Engineering, Marquette University and Medical College of Wisconsin, Milwaukee, WI

Cancer surgery remains the major treatment option for early-stage tumors and its goal is complete tumor removal. Patients with positive margins after cancer surgery are at increased risk of recurrence and are recommended to undergo additional surgery, or more toxic treatment (e.g., chemoradiation for oral cancers). Due to an inability to accurately determine margin status during surgery in a timely fashion, a substantial number of patients require additional surgery or treatment, which is associated with emotional, cosmetic, morbidity, and financial burdens. Current intraoperative pathological methods, such as frozen section and touch prep, are time- and labor- intensive and require pathology or cytopathology expertise, and thus are not routinely available or utilized, particularly in community hospitals settings. While 2D and 3D radiographic examination are available for intraoperative margin assessment, their accuracies and resolutions are low. Emerging technologies are either point (e.g., spectroscopy devices) or high resolution devices with a very small field-of-view (e.g., OCT and confocal microscopes) that require excessive time to scan a specimen, or wide-field devices (e.g., fluorescence and SFDI) with low resolution and poor sensitivity. None has demonstrated the capability of analyzing an entire tumor specimen with both adequate resolution and time efficiency in a clinical setting. At the 2023 LOPS, we reported a first generation (GEN-1) deep-learning enabled, deep ultraviolet scanning microscope (DDSM) as an intraoperative tool to evaluate the margins of freshly resected tumor specimens from breast cancer surgery at subcellular resolution. In this presentation, we report our new progresses on development of a GEN-2 DDSM system and new findings in imaging normal and malignant surgical tissues from multiple organ sites, including breast, oral cavity, lung, et

Biography

Dr. Bing Yu received his Ph.D. from Virginia Tech in 2005 and postdoctoral training from Duke University between 2005-08. Dr. Yu is currently an Associate Professor of Biomedical Engineering at Marquette University and Medical College of Wisconsin. His prior experience includes a Senior Research Scientist and Research Assistant Professor at Duke University and tenure-track Assistant Professor at the University of Akron. His current research focuses on light-tissue interaction, optical imaging and spectroscopy for cancer detection and treatment monitoring, and optical sensors. Dr. Yu is an ASLMS Fellow, senior member of SPIE, and member of Optica (OSA) and BMES.

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

VIBRATIONALPHOTOTHERMAL MICROSCOPY: NEW WINDOW FOR BIOLOGY AND MEDICINE

Ji-Xin Cheng
Moustakas Chair Professor of photonics and optoelectronics,
Boston University Photonics Center, jxcheng@bu.edu

Chemical-bond imaging opens a window for life science and materials science by providing chemical information with minimal perturbation to molecules. Infrared and Raman microscopies are widely used, yet limited by poor spatial resolution or very slow imaging speed. Recently developed coherent anti-Stokes Raman scattering and stimulated Raman scattering microscopy enabled high-speed chemical imaging, whereas their performance is limited by a non-resonant background or a cross phase modulation. Vibrational excitation and subsequent relaxation efficiently generates heat, making photothermal detection a natural and sensitive means of imaging chemical bonds. AFM-IR has allowed nanoscale infrared imaging, but not applicable to live cells. This presentation will introduce a novel optically detected chemical microscopy called vibrational photothermal (VIP) microscopy. Modalities include mid-infrared photothermal (MIP), simulated Raman photothermal (SRP), and short-wave infrared photothermal (SWIP) microscopy. Principle, instrumentation, and applications to life science will be discussed.

Biography

Photothermal Spectroscopy Corp, which licenses all my photothermal imaging IP, is a sponsor of LOPS. My biosketch is attached here. Thanks! Ji-Xin Cheng is currently the Inaugural Theodore Moustakas Chair Professor in Photonics and Optoelectronics at Boston University. Authored in 320+ peer-reviewed articles with an h-index of 98 (Google Scholar) and holder of >30 patents, Cheng and his team has been constantly at the most forefront of the chemical imaging field in development, discovery, and delivery. Commercial chemical microscopes based on his innovations, including coherent Raman scattering and mid-infrared photothermal microscopes, are installed and used in many countries worldwide. Ji-Xin Cheng, Moustakas Chair Professor of Photonics and Optoelectornics. Professor of ECE, BME, PHYS and CHEM. Chair of Photonics Center Education Committee. Boston University. Office PHO827; Lab PHO801; Email jxcheng@bu.edu; Group website: https://sites.bu.edu/cheng-group/

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

MULTIMODAL IN VIVO IMAGING GUIDED STEM CELL RETINAL THERAPY

Yannis M. Paulus,[1,2] Van Phuc Nguyen,[1] Wei Qian,[3] Abigail Fahim,[1] Xueding Wang[2]

[1]Department of Ophthalmology and Visual Sciences, University of Michigan, Ann Arbor, MI, 48105

[2]Department of Biomedical Engineering, University of Michigan Ann Arbor, MI, 48109 USA

[3]IMRA America, Inc, Ann Arbor, MI 48105, USA

Purpose | Stem cell therapy offers a promising method for the treatment of currently incurable diseases such as geographic atrophy in age-related macular degeneration. However, a major challenge of stem cell therapy is to track the distribution of stem cells after transplantation. This study demonstrates an advanced, non-invasive, high resolution, multimodality platform technology for longitudinal visualization of cell-based regeneration of damaged retinal pigment epithelium (RPE) using photoacoustic microscopy (PAM), optical coherence tomography (OCT), and fluorescence microscopy (FM) imaging in living rabbits.

Methods | Laser photocoagulation (power =800 mW, spot size =500 μm, pulse duration = 0.1 s, 12 spots/eye) was applied to twelve New Zealand white rabbits to create retinal pigment epithelium (RPE) damage. On day 4 post exposure to laser irradiation, each eye received a subretinal injection of 30 μL(3.3×106 cells/μL) human induced pluripotent stem cell differentiated to RPE (hiPSC-RPE) cells. These cells were labeled with ultrapure chain-like gold nanoparticle (CGNP) clusters, which were conjugated with both nuclear localization signal-containing peptides and indocyanine green (ICG) molecules. The cell labeling was done through overnight incubation of hiPSC-RPE cells with CGNP clusters having a mass concentration of 100 ug/mL. The CGNP clusters have a red-shifted optical absorption in the near-infrared window, and the size of 7-8 nm in diameter after disassembly enables renal excretion and optimal safety and biocompatibility. The location of hiPSC-RPE cells were followed up to 8 months after transplantation by color fundus photography, PAM, OCT, and fluorescence imaging (FI). All animal studies were performed after approval by the UM IACUC.

Results | TEM and confocal images demonstrated that CGNP clusters penetrated the nucleus of hiPSC-RPE cells without affecting the cell's morphology, pigmentation, or RPE differentiation or function. OCT demonstrated the morphology of the retinal layers. PAM images at 578 nm and 650 nm visualized the microvasculature and transplanted cells, respectively. PAM images obtained at 650 nm showed the distribution of the hiPSC-RPE cells with minimal background signal from blood vessels and demonstrated that the cells rapidly within 1 week localized to laser burns and remained at the laser burn sites with signal throughout the 8 months. After transplantation, the cells were observed by fluorescence imaging up to 28 days post-injection with significant reduction in fluorescence signal by 1 month. Co-registration PAM and OCT images validated the location of hiPSC-RPE cells to the injured RPE regions. Histological and immunofluorescence images confirmed the imaging results of grafted hiPSC-RPE cells in the subretinal space with the formation of melanin pigmentation, normal cell morphology, and normal cellular RPE differentiation.

Conclusion | This research presents an innovative technology for longitudinal imaging of transplanted cells within living animals through the use of PAM, OCT, and FI imaging techniques. The location of hiPSC-RPE cells can be observed and distinguished by employing chain-like gold nanoparticle clusters. Over a period of 8 months, labeled cells can be tracked within the subretinal space. This imaging platform holds promise as a valuable tool for investigating cell-based therapeutic interventions in various eye diseases.

Biography

Yannis M. Paulus, M.D., F.A.C.S, is an academic vitreoretinal surgeon and clinician scientist that loves applying biomedical engineering, optics, lasers, biodesign, and nanoparticles to develop novel retinal therapies. He is the Helmut F. Stern Career Development Professor and an Associate Professor with Tenure, Department of Ophthalmology and Visual Sciences and Department of Biomedical Engineering and Medical Director of the Grand Blanc ACU at the University of Michigan. He completed his undergraduate in chemistry and physics at Harvard, medical school with a bioengineering scholarly concentration and ophthalmology residency at Stanford University, and surgical/medical vitreoretinal fellowship at Johns Hopkins University. Dr. Paulus directs an active, multidisciplinary lab dedicated to improving the vision of patients by developing novel retinal imaging and treatment systems including multimodal cellular and molecular imaging systems, nanotechnologies, combination therapies, and minimally traumatic retinal laser therapies. He has published over 160 peer reviewed publications in leading journals including Nature Communications, Nature Nanotechnology, Science Advances, Advanced Materials, ACS Nano, and the Lancet, has started up 3 retinal start-ups, has 10 patent applications, and received numerous awards, including the Macula Society Gragoudas Award, Alcon Research Institute Young Investigator Award, and the ARVO/Alcon Early Career Clinician-Scientist Research Award.

FROM TECHNOLOGY TO DISCOVERY: DEEPER, FASTER, AND COLORFUL PHOTOACOUSTIC IMAGING IN LIFE SCIENCES

Junjie Yao
Department of Biomedical Engineering, Duke University, NC, USA
Department of Neurology, Duke University School of Medicine, NC, USA

Photoacoustic imaging (PAI) is an increasingly powerful technique for multi-scale anatomical, functional, and molecular imaging by acoustically detecting the optical absorption contrast in biological tissues. In PAI, a short-pulsed laser beam is used to illuminate the tissue, generating a tiny but rapid temperature rise and resulting in the emission of ultrasonic waves through thermoelastic expansion. The wideband ultrasonic waves are then detected to create high-resolution tomographic images that map the tissue's optical absorption.

In my talk, I will focus on several technological advancements in PAI that have collectively enabled fast, deep, and high-sensitivity biomedical applications and discoveries in life sciences, such as functional stroke imaging, drug testing, cancer detection, and interventional therapy. First, PAI has overcome the penetration limit by utilizing advanced internal light delivery techniques, allowing for super-deep (>10 cm) imaging. This breakthrough has extended the applicability of PAI to internal organ imaging in large animal models and humans. Second, innovative scanning technologies and deep-learning models have significantly accelerated PAI, enabling imaging speeds that are more than 1000 times faster while maintaining a large field of view and high spatial resolution. This enhancement facilitates the monitoring of highly dynamic biological processes at the microscopic scale, such as functional brain activities and glassfrog transparency. Third, through the use of novel fabrication technologies in optics and acoustics, miniaturized PAI systems have been developed. These handheld, wearable, and head-mounted imaging devices offer high spatial-temporal resolutions and high throughput, providing greater flexibility and accessibility in imaging applications. Lastly, PAI has greatly benefited from the genetically-encoded switchable or tunable near-infrared photoacoustic-specific probes. By incorporating these probes, the sensitivity and specificity of PAI have been improved by more than 1000 times, enabling highly sensitive detection of malignant cancer, tissue hypoxia, and neuronal activities.

By highlighting these technological advancements, my talk aims to update the recent progress made in PAI and its potential for a wide range of biomedical applications in life sciences.

Biography

Our mission at PI-Lab is to develop state-of-the-art photoacoustic tomography (PAT) technologies and translate PAT advances into diagnostic and therapeutic applications, especially in functional brain imaging and early cancer theranostics. PAT is the most sensitive modality for imaging rich optical absorption contrast over a wide range of spatial scales at high speed, and is one of the fastest growing biomedical imaging technologies. Using numerous endogenous and exogenous contrasts, PAT can provide high-resolution images at scales covering organelles, cells, tissues, organs, small-animal organisms, up to humans, and can reveal tissue's anatomical, functional, metabolic, and even histologic properties, with molecular and neuronal specificity.

At PI-Lab, we develop PAT technologies with novel and advanced imaging performance, in terms of spatial resolutions, imaging speed, penetration depth, detection sensitivity, and functionality. We are interested with all aspects of PAT technology innovations, including efficient light illumination, high-sensitivity ultrasonic detection, super-resolution PAT, high-speed imaging acquisition, novel PA genetic contrast, and precise image reconstruction. On top of the technological advancements, we are devoted to serve the broad life science and medical communities with matching PAT systems for various research and clinical needs. With its unique contrast mechanism, high scalability, and inherent functional and molecular imaging capabilities, PAT is well suited for a variety of pre-clinical applications, especially for studying tumor angiogenesis, cancer hypoxia, and brain disorders; it is also a promising tool for clinical applications in procedures such as cancer screening, melanoma staging, and endoscopic examination.

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

TOWARD FULLY STABILIZED CHIP SCALE OPTICAL FREQUENCY COMBS SOURCES AND APPLICATIONS

P. J. Delfyett, L. Trask, S. Pericherla
CREOL, The College of Optics and Photonics
Department of Physics, Dept, of ECE University of Central Florida
Orlando FL, 32816

We present novel, carrier-envelope stabilized optical frequency comb from a photonic architecture comprised of an opto-electronic oscillator driving a series of electro-optic modulators. The system is self-starting, self-stabilizing and self-referenced. These results identify a pathway towards chip scale electro-optic modulator based optical frequency combs.

Summary

Optical frequency combs are becoming increasingly important in optical communications, signal processing and sensing applications. Many desirable applications can benefit from these sources, but need sources that are chip-scale in nature, owing to their small size, light weight and low power consumption. In this work, we show a photonic system architecture that lays the ground work for a fully integratable, self-starting, self-stabilizing and self-reference optical frequency comb, operating at 1550 nm, with at 10.5 GHz comb spacing, with the potential for chip-scale integration. This wavelength regime is technically relevant for current optical communications standards. The 10.5 GHz spacing is also attractive, as the repetition rate is readily known, and the optical combs can be easily individually accessed for WDM based coherent communications and signal processing applications.

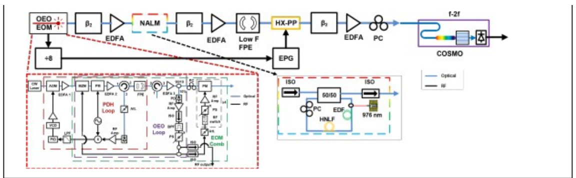


Fig. 1: Schematic diagram of the electro-optic modulator based optical frequency comb driven by an opto-electronic oscillator.

The system is comprised of a narrow linewidth (<10Hz) cw laser that is passed through a single intensity modulator, followed by 3 phase modulators. Each modulator is driven with the same RF signal and the frequency of this RF signal determines the optical frequency comb spacing. The cw laser is locked to a high finesse (100,000) finesse etalon comprised of ultralow expansion quartz (ULE), with a 1.5 GHz free spectral range. The portion of the output light from the etalon is detected by a photodetector. Since the etalon has pass bands separated by 1.5 GHz, the photo-detected signal will possess weak RF beat signals at 1.5 GHz and it harmonics. The photocurrent is passed through a filter that passes the 7th harmonic at 10.5 GHz. This RF signal is applied onto the modulators, which then create sidebands on the cw laser's carrier frequency. Since the 10.5 GHz sideband are resonant with the etalon, the sidebands are passed and detected by the photo-detector, creating a stronger photocurrent modulator at 10.5 GHz. This process continues and serves as an 'optoelectronic oscillator'. Because the optical pathlength between the modulators and photodetectors can be made long, using optical fiber, the Q factor of the optoelectronic loop can be made very high, and thus generate a very clean RF tone (Fig. 2a).

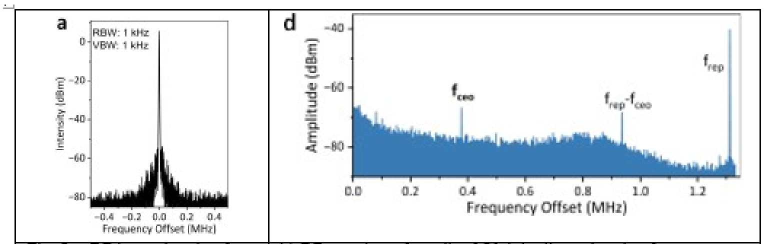


Fig. 2a: RF tone showing f_{rep} | b) RF spectrum from the f-2f detection, showing f_{ceo}

The output pulse is then sent to a nonlinear amplifying loop mirror, which spectrally broadens the pulse and reduces the optical pulse duration from the series of modulators is reduced in pulse repetition rate and amplified, to increase the peak power. Additional pulse train clean-up is employed, using a nonlinear loop mirror. The pulse is then dispersion managed, amplified and passed through a low finesse (500) cavity (FSR+10.5GHz) to provide additional spectral filtering on each combline. The pulse is then reduced in repetition rate through electro-optic gating, amplified and passed through a commercially available nonlinear interferometer for the detection of the carrier envelope signal.

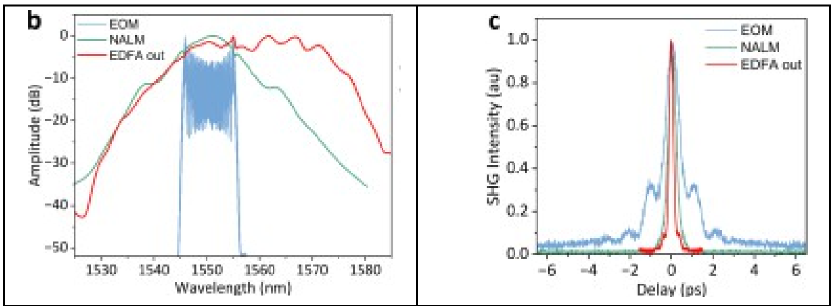


Fig. 3: Optical spectra at each stage | b) Intensity autocorrelation at each stage

In conclusion, we demonstrate the first ever, carrier-envelop stabilized optical frequency comb generated from electro-optic modulation driven by an opto-electronic oscillator. The resulting source produces fully stabilized optical frequency combs, with well defined repetition rate and carrier envelope offset.

References

1. S. A. Diddams, “The evolving optical frequency comb,” JOSA B, vol. 27, no. 11, pp. B51–B62, 2010.
2. K. Beha, et al., “Electronic synthesis of light,” Optica, vol. 4, no. 4, pp. 406–411, 2017.
3. M. Bagnell et al., “Millimeter-wave generation in an optoelectronic oscillator using an ultrahigh finesse etalon as a photonic filter,” Journal of lightwave technology, vol. 32, no. 6, pp. 1063–1067, 2013.
4. M. E. Plascak, et al., “Tunable broadband electro-optic comb generation using an optically filtered optoelectronic oscillator,” IEEE Photonics Technology Letters, vol. 30, no. 4, pp. 335–338, 2017.

Biography

Peter J. Delfyett received the B.E.(E.E.) degree from The City College of New York in 1981, the M.S. degree in EE from The University of Rochester in 1983, the M. Phil and Ph.D. degrees from The Graduate School & University Center of the City University of New York in 1987 and 1988, respectively. His Ph.D. thesis was focused on developing a real time ultrafast spectroscopic probe to study molecular and phonon dynamics in condensed matter using optical phase conjugation techniques. After obtaining the Ph.D. degree, he joined Bell Communication Research as a Member of the Technical Staff, where he concentrated his efforts towards generating ultrafast high power optical pulses from semiconductor diode lasers, for applications in applied photonic networks. Some of his technical accomplishments were the development of the world’s fastest, most powerful modelocked semiconductor laser diode, the demonstration of an optically distributed clocking network for high speed digital switches and supercomputer applications, and the first observation of the optical nonlinearity induced by the cooling of highly excited electron-hole pairs in semiconductor optical amplifiers. While at Bellcore, Dr. Delfyett received numerous awards for his technical achievements in these areas, including the Bellcore Synergy Award and the Bellcore Award of Appreciation. Dr. Delfyett joined the faculty at the College of Optics & Photonics and the Center for Research and Education in Optics and Lasers (CREOL) at the University of Central Florida in 1993, and currently holds the positions of University of Central Florida Trustee Chair Professor of Optics, ECE & Physics. Dr. Delfyett served as the Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics (2001-2006), and served on the Board of Directors of the Optical Society of America. He served as an Associate Editor of IEEE Photonics Technology Letters, was Executive Editor of IEEE LEOS Newsletter (1995-2000) and sits on the Presidential Science Advisory Council of the Orlando Science Center. He is a Fellow of the Optical Society of America, Fellow of IEEE/LEOS, was a member of the Board of Governors of IEEE-LEOS (2000-2002), and is also a member of Tau Beta Pi, Eta Kappa Nu, and Sigma Xi, and SPIE. Dr. Delfyett has been awarded the 1992 YMCA New Jersey Black Achievement Award, the 1993 National Black Engineer of the Year Award – Most Promising Engineer, the University Distinguished Research Award ’99, and highlighted in Design News’ “Engineering Achievement Awards”. In addition, Dr. Delfyett has been awarded the National Science Foundation’s Presidential Faculty Fellow Early Career Award for Scientists and Engineers, which is awarded to the Nation’s top 20 young scientists. Dr. Delfyett has published over 500 articles in refereed journals and conference proceedings, has been awarded 30 United States Patents, and has been highlighted on ‘C-SPAN’, “mainstreekweek.com” and in “Career Encounters”, a PBS Special on technical careers in the optics and photonics field. Dr. Delfyett was awarded the

1999 University Distinguished Researcher of the Year Award, the 2000 Black Engineer of the Year Award – Outstanding Alumnus Achievement, and the 2000 Excellence in Graduate Teaching Award. He was awarded the University of Central Florida's 2001 Pegasus Professor Award which is the highest honor awarded by the University. He is also a Founding Member in NSF's Scientists and Engineers in the School Program, which is a program to teach 8th graders about the benefits of science, engineering and technology in society. In 2003, Dr. Delfyett received the Technology Innovation Award from the Orlando Economic Development Commission. He was selected as one of the "50 Most Important Blacks in Research Science in 2004" and as a "Science Trailblazer in 2005 and 2006" by Career Communications Group and Science Spectrum Magazine. Dr. Delfyett has also endeavored to transfer technology to the private sector, and helped to found "Raydiance, Inc." which is a spin-off company developing high power, ultrafast laser systems, based on Dr. Delfyett's research, for applications in medicine, defense, material processing, biotech and other key technological markets. Dr. Delfyett was also elected to serve 2 terms as President of the National Society of Black Physicists (2008-2012). Most recently, he was awarded the APS Edward Bouchet Award for his significant scientific contributions in the area of ultrafast optical device physics and semiconductor diode based ultrafast lasers, and for his exemplary and continuing efforts in the career development of underrepresented minorities in science and engineering.

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

DoubleTree Resort by Hilton Hollywood Beach,
4000 South Ocean Dr., Hollywood, FL 33019

DAY 2
SEPEAKER PRESENTATIONS

ATTOSECOND CLOCKING AND CONTROL OF STRONG FIELD QUANTUM TRAJECTORIES

Andrew J. Piper, Qiaoyi Liu, Yaguo Tang, Abraham Camacho Garibay, Dietrich Kiesewetter, Vyacheslav Leshchenko, Pierre Agostini and Louis F. DiMauro

Department of Physics, The Ohio State University, USA Jens E. Bækhøj and Kenneth J. Schafer

Department of Physics & Astronomy, Louisiana State University, USA

Nearly thirty years ago, a simple and intuitive unified view of intense laser-atom interactions was introduced. The model is based on a semi-classical description where a bound electron is tunnel ionized by the strong optical field, followed by propagation under the influence of the strong field and finally driven back to interact with the core. This simple view has become known as the three-step or rescattering model and is responsible for the production of high energy electron & photons, multiple ionization and the formation of attosecond light pulses. The coherent process is defined by initial conditions set by tunnel ionization which defines the physical observables for the subsequent steps.

Feynman has taught us that the outcome of a quantum process is dictated by the sum over all the quantum trajectories that contribute to it. Naturally, when analyzing experiments, we often refer to these individual trajectories even though they have not been measured individually. In this talk, we introduce a Quantum Trajectory Selector (QTS) method capable of resolving individual quantum orbits responsible for strong-field phenomena in real time. Using an attosecond XUV pulse, we select the moment of ionization and measure the rate for both rescattered electron emission and double ionization driven by a phase locked near infrared field. We show that there is an intensity-dependent shift in the ionization time associated with double ionization, and we clock this shift as it varies by 250 as. The QTS provides a new attosecond paradigm for expanding our understanding of recollision-driven physics.

Biography

Louis F. DiMauro is Professor of Physics and Hagenlocker Chair at the Ohio State University. He received his BA (1975) from Hunter College, CUNY and his Ph.D. from University of Connecticut in 1980 and was a postdoctoral fellow at SUNY at Stony Brook before arriving at AT&T Bell Laboratories in 1981. He joined the staff at Brookhaven National Laboratory in 1988 rising to the rank of senior scientist. In 2004 he joined the faculty at The Ohio State University. He was awarded 2004 BNL/BSA Science & Technology Prize, 2012 OSU Distinguish Scholar Award, the 2013 OSA Meggers Prize and the 2017 APS Schawlow Prize in Laser Science. He is a Fellow of the American Physical Society, the Optical Society of American and the American Association for the Advancement of Science. He is currently the Director of the Institute for Optical Science and co-Director of the NSF NeXUS facility and the OSU Chemical Physics graduate program. He has served on numerous national and international committees, government panels, served as the 2010 APS DAMOP chair, vice-chair of the NAS CAMOS committee and currently serves on the NAS Board of Physics and Astronomy. His research interest is in experimental ultra-fast and strong-field physics. In 1993, he and his collaborators introduced the widely accepted semi-classical model in strong-field physics. His current work is focused on the generation, measurement, and application of attosecond x-ray pulses, study of fundamental scaling of strong field physics and application of x-ray free electron lasers.

LATERALHETEROSTRUCTURES WITH ARBITRARY SHAPE AND MATERIAL COMPOSITION IN TWO-DIMENSIONALMATERIALS

Hossein Taghinejad and Ali Adibi
School of Electrical and Computer Engineering,
Georgia Institute of Technology
ali.adibi@gatech.edu

A new approach for realization of lateral heterostructure with a high degree of control over the shape of the heterostructure and the material composition in two-dimensional transition metal chalcogenides is presented. It is shown that through highly controlled chalcogen exchange, sub-micron-sized lateral heterostructures with unprecedented flexibility in shape and material composition wih dimensions below 50 nm can be formed. Fabrication processes both at low temperatures and high temperatures will be explained, and their unique features will be discussed using detailed experimental characterization results. Potential use of these structures in forming quantum devices in atomically thin materials will also be discussed.

Biography

Ali Adibi is the director of Bio and Environmental Sensing Technologies (BEST) and a professor and Joseph M. Pettit chair in the School of Electrical and Computer Engineering, Georgia Institute of Technology. His research group has pioneered several structures in the field of integrated nanophotonics for both information processing and sensing. He is the author of more than 220 journal papers and 520 conference papers. He is the editor-in-chief of the Journal of Nanophotonics, and the nanophotonic program track chair of the Photonics West meeting. He is the recipient of several awards including Presidential Early Career Award for Scientists and Engineers, Packard Fellowship, NSF CAREER Award, and the SPIE Technology Achievement Award. He is also a fellow of OSA, SPIE, and AAAS.

SINGULARITY ENGINEERING BY META-OPTICS

Federico Capasso
John A. Paulson School of Engineering and Applied Sciences,
Harvard University, USA
capasso@seas.harvard.edu

Metaoptics offers fresh opportunities for structuring light as well as dark. The majority of research has so far mostly concentrated on one dimensional line singularities (optical vortices). Meta surfaces offer opportunities to engineer singularities in other dimensions as well. I will report on the realization of 2D phase and polarization singularities and the unique applications that they will open1, along with recent results on the realization of an equally spaced liner array of 0D phase singularities using inversed designed cylindrically symmetric phase only meta surfaces. 2 I will discuss complete, topologically protected polarization singularities; they are located in the 4D space spanned by the three spatial dimensions and the wavelength and are created in the focal region of a lens using a meta surface. 3 Our recent demonstration of a new kind of holography (Light sheet continuous depth)4 holography) has opened up the possibility of realizing volume singularities. Applications will be discussed.

1. Soon Wei Daniel Lim, Joon-Suh Park, Maryna L. Meretska, Ahmed H. Dorrah, & Federico Capasso Nature Communications, 12, 4190 (2021)
2. Soon Wei Daniel Lim, Joon-Suh Park, Dmitry Kazakov, Christina M Spaegele, Ahmed H Dorrah, Maryna L Meretska, and Federico Capasso, Nature Communications, 14, 3237 (2023)
3. Christina M. Spaegele, Michele Tamagnone, Soon Wei Daniel Lim, Marcus Ossiander, Maryna Meretska, Federico Capasso Science Advances, 9, 24 (2023)
4. A. H. Dorrah, P. Bordoloi, V. S. de Angelis, J. O. de Sarro, M. Zamboni-Rached, L. A. Ambrosio, and F. Capasso, Nature Photonics 17, 427, (2023).

Biography

Federico Capasso received the doctor of Physics degree, summa cum laude, from the University of Rome, Italy, in 1973 and after doing research in fiber optics at Fondazione Bordoni in Rome, joined Bell Labs in 1976. In 1984, he was made a Distinguished Member of Technical Staff and in 1997 a Bell Labs Fellow. In addition to his research activity Capasso has held several management positions at Bell Labs including Head of the Quantum Phenomena and Device Research Department and the Semiconductor Physics Research Department (1987–2000) and Vice President of Physical Research (2000–2002). He joined Harvard on January 1, 2003.

AWARDS:

Duddell Medal and Prize (2002)

Edison Medal (2004)

SPIE Gold Medal (2013)

Balzan Prize (2016)

Matteucci Medal (2019) Citations (Google Scholar): Over 100 000 H-index (Google Scholar): Over 150 Publications: Over 500 peer-reviewed journals Patents: Over 70 US patents Key achievements: Bandstructure Engineering.and Quantum Cascade Lasers (QCLs) Metasurfaces and Flat optics Casimir forces

NEW GENERATION PHOTOACOUSTIC IMAGING: FROM BENCHTOP WHOLEBODY IMAGERS TO WEARABLE SENSORS

Dr. Lei Li
California Institute of Technology, USA

Whole-body imaging has played an indispensable role in preclinical research by providing high-dimensional physiological, pathological, and phenotypic insights with clinical relevance. Yet, pure optical imaging suffers from either shallow penetration or a poor depth-to-resolution ratio, and non-optical techniques for whole-body imaging of small animals lack either spatiotemporal resolution or functional contrast. We have developed a dream machine, demonstrating that a stand-alone single-impulse panoramic photoacoustic computed tomography (SIP-PACT) mitigates these limitations by combining high spatiotemporal resolution, deep penetration, anatomical, dynamical and functional contrasts, and full-view fidelity. SIP-PACT has imaged in vivo whole-body dynamics of small animals in real time, mapped whole-brain functional connectivity, and tracked circulation tumor cells without labeling. It also has been scaled up for human breast cancer diagnosis. SIP-PACT opens a new window for medical researchers to test drugs and monitor longitudinal therapy without the harm from ionizing radiation associated with X-ray CT, PET, or SPECT. Genetically encoded photochromic proteins benefit photoacoustic computed tomography (PACT) in detection sensitivity and specificity, allowing monitoring of tumor growth and metastasis, multiplexed imaging of multiple tumor types at depths, and real-time visualization of protein-protein interactions in deep-seated tumors. Integrating the newly developed microrobotic system with PACT permits deep imaging and precise control of the micromotors in vivo and promises practical biomedical applications, such as drug delivery. In addition, to shape the benchtop PACT systems toward portable and wearable devices with low cost without compromising the imaging performance, we recently have developed photoacoustic topography through an ergodic relay, a high-throughput imaging system with significantly reduced system size, complexity, and cost, enabling wearable applications. As a rapidly evolving imaging technique, photoacoustic imaging promises preclinical applications and clinical translation.

Biography

Dr. Lei Li is an assistant professor of Electrical and Computer Engineering at Rice University. He obtained his Ph.D. from the Department of Electrical Engineering at California Institute of Technology in 2019. He received his MS at Washington University in St. Louis in 2016. His research focuses on developing next-generation medical imaging technology for understanding the brain better, diagnosing early-stage cancer, and wearable monitoring of human vital signs. He was selected as a TED fellow in 2021 and a rising star in Engineering in Health by Columbia University and Johns Hopkins University (2021). He received the Charles and Ellen Wilts Prize from Caltech in 2020 and was selected as one of the Innovators Under 35 by MIT Technology Review in 2019. He is also a two-time winner of the Seno Medical Best Paper Award granted by SPIE (2017 and 2020, San Francisco).

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

SYNERGISTIC ANTICANCER POTENTIAL OF GREEN SYNTHESIZEDNANOPARTICLES AND PHEOPHORBIDE A-MEDIATED PHOTODYNAMIC THERAPY IN LUNG CANCER

Blassan George, Alexander Chota and Heidi Abrahamse
Laser research Centre, Faculty of Health Sciences, University of Johannesburg, South Africa

Lung cancer is one of the most common cancers that affects both men and women and is regarded as the leading cause of cancer related deaths. It is characterized by the unregulated cell division of altered cells within the lung tissues. Green nanotechnology is a promising therapeutic option that is adopted in cancer research. Dicoma anomala (D. anomala) is an African medicinal plant used for the treatment of various medical conditions which includes cancer. In this study, silver nanoparticles (AgNPs) were synthesized using D. anomala MeOH root extract. We further evaluated the anticancer efficacy of the synthesized AgNPs as an individual treatment as well as in combination with pheophorbide a (PPBa) mediated photodynamic therapy (PDT). UV-VIS spectroscopy, high-resolution transmission electron microscopy (HR-TEM), Scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) was used to confirm the formation of D.A AgNPs. Post 24 h treatment, A549 cells were evaluated for ATP proliferation, morphological changes supported by LIVE/DEAD assay, and caspase activities. The results revealed a dose-dependent decrease in cell proliferation in both individual and combination therapy of PPBa mediated PDT and D.A AgNPs on A549 lung cancer cells with significant morphological changes. Additionally, the LIVE/DEAD assay displayed a significant increase in the number of dead cell population in individual treatments (i.e., IC50's treated A549 cells) as well as in combination therapy. In conclusion, the findings from this study demonstrated the anticancer efficacy of green synthesized AgNPs as a mono-therapeutic drug as well as in combination with a chlorophyll derivative PPBa in PDT. Taken together, the findings highlight the therapeutic potential of green nanotechnology in medicine.

Keywords: Lung cancer; green nanoparticles; silver nanoparticles; Dicoma anomala; photodynamic therapy; pheophorbide a

Biography

Blassan George is a Professor at the Laser Research Centre, Faculty of Health Sciences, University of Johannesburg, South Africa. His research focuses on the photodynamic therapy of cancer. He is an NRF Y1 rated scientist, and received funding from various external funding bodies including South Africa Medical Research Council, National Research Foundation, African Laser Centre etc. He has presented his research outcomes in more than 30 international conferences. He is supervising 2 masters, 4 PhD and 2 postdoc students and completed 3 PhD, and 10 masters. He has published 75 articles in peer-reviewed international journals, 16 book chapters and 8 conference proceedings with h-index (21-Scopus, 23-Google Scholar).

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

MODELING AND COMPENSATINGPOLARIZATION ABERRATIONS IN OPTICAL SYSTEMS

B. I. Gramatikov
Ophthalmic Instrumentation Development Laboratory
Wilmer Eye Institute
The Johns Hopkins University School of Medicine
Baltimore, Maryland, United States

When designing polarization-sensitive systems, it is important to keep track of the polarization state of light along all beam paths. This is best done by using polarization-relevant modeling. Either Jones or Mueller matrix formalism can be used to model the polarization-related behavior of optical elements, such as waveplates, mirrors (dielectric or metallic), dielectric plates, beamsplitters, etc. Polarization can additionally be affected by coatings, angle of incidence and other factors. Adequate modeling is badly needed, especially in folded designs. In many cases, polarization-changing optical components with retarder behavior need to be compensated for, i.e. the difference in phase retardation introduced by them needs to be nullified. This talk proposes a method of measuring and modeling polarization aberrations, and compensation by means of appropriate linear retarders, whenever possible. Further, the spatial inhomogeneity of the generalized global Mueller matrix is discussed and modeled, and ways of its equalization and/or compensation are suggested. Practical suggestions for laser scanning systems are formulated, in order to keep system-caused polarization changes low.

Biography

Boris Gramatikov obtained his Dipl.-Ing. degree in Biomedical Engineering in Germany, and his Ph.D. in Bulgaria. He has completed a number of postdoctoral studies in Germany, Italy and the United States. He joined the faculty of the Biomedical Engineering Department of The Johns Hopkins University in 1996, and has been working in the Laboratory of Ophthalmic Instrumentation Development at The Wilmer Eye Institute since 2000. His areas of expertise include electronics, optoelectronics, computers, computer modeling, signal/image processing, data analysis, instrumentation design, biophotonics, ophthalmic and biomedical optics, polarization optics, all applied to the development of diagnostic methods and devices for ophthalmology and vision research. His team has developed a series of pediatric vision screeners. He has 147 publications, 43 of which in high-impact peer-reviewed journals. He serves as a reviewer and editorial board member with a number of technical and medical journals. Boris is the Director for Continuous Electrical Engineering Education (CEEE) at the Baltimore Section of the IEEE. He is the inventor or co-inventor on six issued US patents.

IONIZING RADIATION ACOUSTIC IMAGING (IRAI) FOR MAPPING THE DOSE DEEP IN THE PATIENT DURING RADIATION THERAPY

Xueding Wang[1,5], Wei Zhang[1], Dale Litzenberg[2], Yaocai Huang[1], Kai-Wei Chang[1], Ibrahim Oraiqat[3] Scott Hadley[2], Eduardo G. Moros3, Man Zhang[5], Paul L. Carson[1,5], Kyle C. Cuneo[2], Issam El Naqa[2,3,4]

[1]Department of Biomedical Engineering, University of Michigan, Ann Arbor, Michigan

[2]Department of Radiation Oncology, University of Michigan, Ann Arbor, Michigan

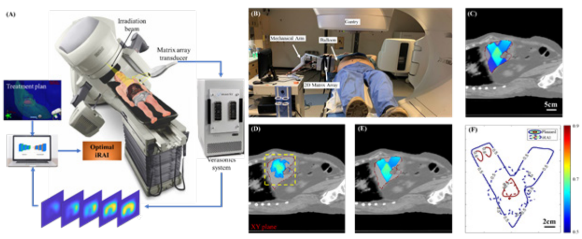
[3]Department of Machine Learning, Moffitt Cancer Center, Tampa, Florida

[4]Department of Radiation Oncology, Moffitt Cancer Center, Tampa, Florida

[5]Department of Radiology, University of Michigan, Ann Arbor, Michigan

Ironizing radiation acoustic imaging (iRAI) is a novel imaging concept with the potential to map the delivered radiation dose on anatomical structure in real time during external beam radiation therapy (RT) including conventional RT, FLASH mode RT and proton therapy. This technology offers unprecedented opportunities for online monitoring of radiation's interactions with tissues of interest, providing adaptive feedback for safe and personalized cancer treatment. Described here is the new development of iRAI volumetric imaging system in mapping the three-dimensional (3D) radiation dose deposition of complex clinical radiotherapy treatment plans with patients receiving radiation to liver tumor. The iRAI system consisted of a custom-designed two-dimensional (2D) matrix transducer array with integrated preamplifier array, driven by a clinic-ready ultrasound imaging platform. The real-time visualization of radiation dose delivery was archived in total 8 patients with liver tumor under a clinical linear accelerator. The feasibility of iRAI in real-time visualizing the radiation dose delivery were verified in advanced radiation therapy modalities, including FLASH mode RT and proton therapy. These studies demonstrate the potential of iRAI to monitor and quantify the radiation dose deposition in patient bodies during treatment. iRAI offers a cost-effective and practical solution for real-time visualization and quantification of 3D radiation dose delivery in both conventional RT and advance RT, potentially leading to personalized radiotherapy with optimal efficacy and safety.

Figure



The new development of volumetric iRAI system for mapping the radiation dose deep in patient body during the radiation therapy. (A) 3D schematic of the iRAI system for mapping the dose deposition in a patient during RT delivery; (B) A photograph of the iRAI imaging on a patient taken during RT. (C) The dose distribution of only the two static sagittal beams of the treatment plan with a liver mask fused onto the CT scan anatomy structure. Scale bar, 5 cm. (D) The iRAI measurement of dose with a liver mask fused onto the CT anatomy structure with the same position as b. The yellow dashed box indicates the field of view of the 2D matrix array. (E) Dose distribution (>50%) of the treatment plan with a liver mask fused on the CT anatomy structure. (F) The 50 and 90% isodose lines in the iRAI measurement and the treatment plan. Scale bar, 2 cm. The red line in (C-E) indicates the boundary of the liver.

Biography

Dr. Wang's research group, Optical Imaging Laboratory at the U-M School of Medicine, is focused on imaging system development, and adaptation of novel diagnostic and therapeutic technologies to laboratory research and clinical settings, especially those involving light and ultrasound. Major part of our research is focused on clinical applications of photoacoustic imaging, including those involving breast cancer, inflammatory arthritis, prostate cancer, liver conditions, bowel disease, eye conditions, and brain disorders. We are also interested in design and fabrication of multi-functional nanoparticle agents (e.g. metallic, hydrogel) for both diagnosis and therapy, as well as interactions between nanoparticles and cells.

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

SENSORS AND MICRO/NANO-ELECTRO-MECHANICAL SYSTEMS (MEMS/NEMS). MANY SENSORS ARE BUILT BY MICRO/NANOFABRICATION TECHNIQUES AND THIS PROVIDES A HOST OF ADVANTAGES INCLUDING LOWERPOWERCONSUMPTION, SMALL SIZE AND LIGHT WEIGHT." FOR SMALL SCALE BODY OPTICAL SENSORS

Peter Hesketh
Georgia Institute of Technology, USA

Biography

Dr. Hesketh's research interests are in Sensors and Micro/Nano-electro-mechanical Systems (MEMS/NEMS). Many sensors are built by micro/nanofabrication techniques and this provides a host of advantages including lower power consumption, small size and light weight. The issue of manipulation of the sample in addition to introduce it to the chemical sensor array is often achieved with microfluidics technology. Combining photolithographic processes to define three-dimensional structures can accomplish the necessary fluid handling, mixing, and separation through chromatography. For example, demonstration of miniature gas chromatography and liquid chromatography with micromachined separation columns demonstrates how miniaturization of chemical analytical methods reduces the separation time so that it is short enough, to consider the measurement equivalent to "read-time" sensing. A second focus area is biosensing. Professor Hesketh has worked on a number of biomedical sensors projects, including microdialysis for subcutaneous sampling, glucose sensors, and DNA sensors. Magnetic beads are being investigated as a means to transport and concentrate a target at a biosensor interface in a microfluidic format, in collaboration with scientists at the CDC. His research interests also include nanosensors, nanowire assembly by dielectrophoresis; impedance based sensors, miniature magnetic actuators; use of stereolithography for sensor packaging. He has published over sixty papers and edited fifteen books on microsensor systems.

GAS ANALYSIS METHODS BASED ON STIMULATED RAMAN SCATTERING AND COLLISION ENHANCED RAMAN SCATTERING IN HOLLOW CORE PHOTONIC CRYSTAL FIBER WITH POTENTIAL FOR HUMAN BREATH ANALYSIS FOR LUNG CANCER DETECTION

Haishan Zeng, PhD
Prism Award (Life Sciences & Biophotonics- 2013 SPIE, University of British Columbia, Canada

Biography

Dr. Haishan Zeng is a distinguished scientist with the Integrative Oncology Department (Imaging Unit) of the BC Cancer Research Centre and a professor of Dermatology, Pathology, and Physics at the University of British Columbia, Vancouver, Canada. For over 30 years, Dr. Zeng's research has been focused on the optical properties of biological tissues, light-tissue interaction, and nanomaterials enhanced light-tissue interaction as well as their applications in medical diagnosis and therapy. His group has pioneered the multiphoton absorption based laser therapy and is at the leading position in endoscopy imaging and Raman spectroscopy for in vivo early cancer detection, and silver/gold nanoparticles based surface enhanced Raman spectroscopy analysis of body fluids for cancer screening. He has published over 170 refereed journal papers, 17 book chapters, and 1 book ("Diagnostic Endoscopy", CRC Press Series in Medical Physics and Biomedical Engineering). Dr. Zeng serves as Editorial Board members for the Journal of Biomedical Optics and the recently launched Translational Biophotonics. He is an Executive Organizing Committee member of the annual SPIE International Symposium on Biomedical Optics. Dr. Zeng's research has generated 28 granted patents related to optical diagnosis and therapy. Several medical devices derived from these patents including fluorescence endoscopy (ONCO-LIFE™) and rapid Raman spectroscopy (Vita Imaging Aura™) have passed regulatory approvals and are currently in clinical uses around the world. The Aura™ device using Raman spectroscopy for non-invasive skin cancer detection was awarded the Prism Award in the Life Sciences and Biophotonics category in 2013 by SPIE - the International Society for Optics and Photonics.

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

NEURON COUNTING AND OPTICAL CHARACTERISTICS IN HUMAN BRAIN TISSUES: A NONINVASIVESTUDYINVISIBLE ANDNEAR-INFRAREDSPECTRA

Jamal H. Ali
Borough of Manhattan Community College,
The City University of New York, USA

Brain tissue optical properties, such as scattering coefficient, scattering length, and g value, are critical parameters for several biomedical applications and neuroscience research, including optical imaging and spectroscopy. However, measuring these properties accurately can be challenging due to the complex nature of brain tissue and the variety of measurement techniques available. However, there have been reports of discrepancies in optical property measurements obtained from different techniques. Specifically, we will examine the literature to identify the largest reported range of values for these optical properties and the used techniques. Understanding the sources of discrepancies in measuring optical properties in brain tissues and developing strategies to address them. This is crucial for advancing our knowledge of brain tissues through optical imaging techniques. This can help with brain-related disorders diagnosis and treatment. We aim to identify the main sources of variation and help researchers develop strategies to minimize these discrepancies. Such strategies could include optimizing sample preparation protocols, standardizing measurement techniques, and using multiple techniques to cross-validate results.

For the first time, we may be able to non-invasively measure the density of neurons in the cerebral cortex gray matter at different optical windows (700 to 2400 nm). Using tissue transmission or backscattering and the Mie model, structural properties, such as the density of neurons, in the gray matter of human brain tissue, will be explored for the first time. This is a significant step toward studying the state of neurons in a person with the potential for neurodegenerative diseases. This will allow appropriate intervention at an early stage of the disease.

Overall, in this paper we will be able to measure neurons density noninvasively in brain tissues. We also will provide a comprehensive understanding of the sources of discrepancy in measuring optical properties in brain tissues.

Biography

Jamal Ali received his B.S. in Physics from Yarmouk University in Jordan and an M.S. in Physics from the City College of New York (CCNY). He got his master's degree in Science Education from Queens College. He obtained his Ph.D. in Physics from the City University of New York (CUNY) working at the Institute for Ultrafast Spectroscopy and Lasers (IUSL) of the City University of New York (CUNY). He worked on "Light Propagation in Paint and Prostate Tissues Media Using Visible to Mid-IR Spectroscopy and Imaging Techniques" for his thesis.

Biography

Ming Yan, Ph.D. has served as our Chief Technology Officer and a member of our board of directors since 2015. Dr. Yan is also a co-founder of our company. Dr. Yan has over 20 years of experience in research and development. Prior to joining our company, Dr. Yan held research and development positions at AT&T Bell Laboratories, a research and development division of AT&T Communications, a telecommunication company, Lawrence Livermore National Labs, a federal research facility, and BD Biosciences, a biotechnology company. Dr. Yan has published several research papers relating to laser spectroscopy and cell analysis in top peer-reviewed journals. He has over a dozen patents and pending patent applications for his innovations. Dr. Yan holds a B.S. in Physics from Fudan University and a Ph.D. in Electrical Engineering from the City University of New York.

About Cytek Biosciences :

Cytek Biosciences is a leading cell analysis solutions company advancing the next generation of cell analysis tools by delivering high-resolution, high-content, and high-sensitivity cell analysis utilizing its patented Full Spectrum Profiling™ (FSP™) technology. Cytek's novel approach harnesses the power of information within the entire spectrum of a fluorescent signal to achieve a higher level of multiplexing with precision and sensitivity. Cytek's FSP platiorm includes its core instruments, the Aurora, and Northern Lights™ systems; its cell sorter, the Aurora CS; the flow cytometer and imaging products under the Amnis® and Guava® brands; and reagents, sotiware and services to provide a comprehensive and integrated suite of solutions for its customers. For more information about our products and solutions, please visit htps://cytekbio.com/.

UNVEILING THE DEPTHS OF CELL BIOLOGY USING MULTI-LASER SPECTRAL FLOW CYTOMETRY

Ming Yan
Co-Founder and CTO, Cytek Biosciences, USA

NEURALRTE: A NEW PHOTON TRANSPORT SIMULATION ALGORITHM FOR ASSESSMENT OF LIGHT PROPAGATION IN BIOLOGICAL TISSUES

Alexander Doronin
Victoria University of Wellington, New Zealand

Biography

Dr Alexander Doronin is an Assistant Professor in Computer Science at Victoria University of Wellington (New Zealand). His research interests are interdisciplinary and lie at the interface between Computer Graphics, Biomedical Optics and most recently Artificial Intelligence focusing on modelling of light transport in turbid media, development of novel optical diagnostics modalities, physically-based rendering, optical measurements/instrumentation, acquisition and building of realistic material models, colour perception, translucency, appearance and biomedical visualization. He has extensive recognized experience in the design of forward and inverse algorithms of light scattering in turbid tissue-like media simulations and created a generalized Monte Carlo model of photon migration which has found a widespread application as an open-access computational tool for the needs of light transport communities in Biophotonics, Biomedical Imaging and Graphics.

The development of optical diagnostic modalities necessitates accurate in silico simulation of light propagation in turbid media, including biological tissues, the atmosphere, and various fluids. Such task poses significant challenges due to the complexities of multiple scattering of light. Traditional methods, employing a range of analytical and stochastic techniques (e.g. Monte Carlo (MC) method), have achieved considerable maturity in simulating light transport phenomena in translucent materials. However, the MC method, known for its high accuracy and regarded as the gold standard in the field, requires substantial computational and energy resources. Its performance is heavily dependent on the medium's optical properties and the configuration of the optical probe. This is particularly evident in specialized applications like Laguerre-Gaussian beams and Raman scattering, where the challenges are more pronounced.

In this work, we introduce NeuralRTE, a novel approach that harnesses the power of Artificial Intelligence to learn and subsequently provide an efficient and detailed evaluation of photon transport behaviours. This new method stands out for its independence from the medium's optical properties/geometry and its ability to maintain consistent execution time, contrasting with traditional unbiased stochastic solvers that typically require increasing the number of photons to enhance accuracy, as dictated by the Central Limit theorem. Through rigorous testing and comparison with conventional analytical and computational models, NeuralRTE has proven to surpass existing solutions, while upholding the required accuracy standards. This advancement in photon transport simulations offers modern, efficient, versatile and open-source solution for a wide range of applications. We demonstrate through numerous test cases how this new method can be effectively utilized in sensing, 3D graphics, and inverse problem solving tasks on embedded systems, showcasing its broad potential and utility.

MULTICOMPONENT PHOTOCHEMOTHERAPEUTIC DRUGS FOR PHOTODYNAMIC DIAGNOSIS AND PHOTODYNAMIC THERAPY IN CANCER

Heidi Abrahamsea

[a]Laser Research Centre, DSI/NRF SARChI Chair, Faculty of Health Sciences, University of Johannesburg, Johannesburg, South Africa

Photodynamic therapy (PDT) and diagnosis (PDD) are highly topical research for the implementation of alternative and targeted cancer therapy. Central to efficient clinical application of PDT and PDD is the development of effective photochemotherapeutic drugs called photosensitizers (PS). PSs must not only provide sufficient killing capacity of cancer cells, but it must also easily and efficiently be absorbed by cancer cells (CC) more so than normal surrounding cells. Activation to produce significant ROS that would activate cell signaling pathways to induce apoptosis is another key characteristic of PSs. PSs with optimal activation and conjugation capabilities allowing both binding to nanoparticles (NP) and providing association with suitable, cancer specific antibodies (AB) were performed. Both CCs and cancer stem cells (CSCs) were targeted. In addition, synergistic effects of phytochemicals and phytochemicals with potential as PSs have also been studied. Metallophthalocyanine PSs conjugated to metal-based NPs and cell specific ABs have produced an array of highly effective and efficient multicomponent drugs (MCD) for PDT and PDD. In addition, these newly synthesized MCDs not only target CCs but also CSCs which often cause recurrence and metastasis. An array of highly efficient MCDs have been synthesized and demonstrated to be highly effective in targeting CCs and CSCs and inducing cell death.

Keywords: PDT; PDD; Photosensitizers; Nanoparticles; Targeted PDT

Biography

Prof. Abrahamse BSc (RAU), BSc Honours (Biochemistry; US and Psychology; UNISA), MSc (Medical Biochemistry; US), PhD (Molecularbiology/ Biochemistry; Wits University), Executive Leadership (Gibs, UP), Global Clinical Scholar Research Program (Harvard Medical School) is currently the Director of the Laser Research Centre, UJ and DST/NRF SARChI Chair for Laser Applications in Health (2016-2025). She is appointed as Adjunct Professor to the Manipal College of Health Professions, India. Her research interests include photobiology and photochemistry with specific reference to Photodynamic cancer therapy and Photobiomodulation. She was the recipient of the Faculty of Health Sciences highest research output for 2009 and the University of Johannesburg Vice-Chancellor's Distinguished Award for Outstanding Researcher of the Year, 2010 and again in 2020 and the NLC Rental pool grant-holder bestresearch output for 2008, most masters graduates 2013 and most IP produced 2013 and most doctorategraduates, 2014. She was runner up to the DST WISA Distinguished Scientist award in 2015 and placed second in the SAWiSA awards, 2023. She was granted a DST/NRF SARChI chair in 2016 which was renewed for another 5 years in 2020.In 2019 she received the International Photodynamic Association Humanitarian award recognize those who have made selfless efforts and personal sacrifices to enhance and promote the science of Photodynamic therapy and in 2022 she received the International Photodynamic Association for Basic PDT Research Excellence Award. She was also awarded the South African Higher Education Resources Services Lifetime Achiever award in 2023. According to Expertscape: The expertise of Heidi Abrahamse ranks in the Top 0.0044% of 44 977 published authors worldwide on Photosensitizing Agents from 2012 through 2023 based on contributions to 44 articles on the topic. https://expertscape.com/au/photosensitizing+agents/Abrahamse%2C+H She has supervised 63 masters, 38 doctorates and 26 post-doctorate fellows. She has acted as external examiner for masters and doctorate theses from several national and international universities and has an impressive record for external grant applications. Her international standing as a researcher of distinction is supported by the fact that she has hosted 6 international conferences including the World Association for Laser Therapy, Photodynamic therapy conference supported by the DST SA/ Germany year of science, a Phototherapy workshop, Biophotonics in Cancer symposium and Photobiomodulation:Trends in Disease Management in 2022. She has co-chaired 6 BRICS meetings in 2020, 2021 Brazil and2021, 2023 Russia and the International Commission for Optics, Optics & Photonics AFRICA 2023. She was the president of the international society, WALT for 2010 to 2012. She has been invited to present her research at several international conferences as invited, keynote or plenary presenter. Her society membership include: SASBMB; ASBMB; ASCB; ISO; WALT; OSA; WALA; EMLA; NAALT; and ISLA. She has acted as external and panel reviewer for external national and international funding bodiesand grants and played an instrumental role in negotiating memorandums of understanding with several international institutions. Her publication record is impressive with 298 peer reviewed accredited journal publications, 64 accredited full paper proceedings, 52 chapters and 2 books. She is currently a NRF B2 rated scientist with a Scopus H-index of 48, Google scholar H-index of 57 and a ResearchGate H-index of 51. She serves on international councils, executive committees and board of directors including the World Academy of Laser Applications, European Medical Laser Association and the African Laser Centreand serves on the editorial boards of 8 peer-reviewed internationally accredited journals while acting as reviewer for over 50 journals. She was appointed Co-Editor in Chief of the international accredited journal Photobiomodulation, Photomedicine and Laser Surgery and Associate Editor of Journal of photochemistry and photobiology A: Chemistry. Her academic career span more than 33 years and provide her with substantial experience in tertiary education, lecturing and research. She has lectured 6 different subjects from first year to fourth year level. She serves on several research-related university committees for both universities and science councils and World Health Organization International EMF Project – South Africa National Committee. She currently serves her second term on the University of Johannesburg Council as elected Senate representative and was appointed by the Minister of Health to serve on the National Health Research Committee of South Africa for 2020-2023. She is a member of the Academy of Science of South Africa

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

DoubleTree Resort by Hilton Hollywood Beach,
4000 South Ocean Dr., Hollywood, FL 33019

DAY 3 SEPEAKER PRESENTATIONS

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

LONGITUDINALLY-STRUCTURED LIGHT FIELDS FOR SENSING AND DYNAMIC BEHAVIOR

Alan E. Willner
Univ. of Southern California

Biography

A beam's spatial distribution can be structured in terms of its amplitude and phase, and the transverse and longitudinal distribution can be tailored by an appropriate transmission of orthogonal modes. This presentation will highlight longitudinally-structured light fields for: (a) Sensing: To mitigate atmospheric turbulence effects, knowledge of turbulence strength at various distances could be valuable. One approach for probing utilizes multiple sequentially transmitted longitudinally structured beams. Each beam is composed of Bessel-Gaussian modes with different longitudinal wavenumbers such that a distance-varying beam width is produced, which results in a distance- and turbulence-dependent power coupling to other spatial modes; and (b) Dynamic Behavior: Space-time wave packets (STWPs) can have spatiotemporal evolution that is arbitrarily engineered to occur at various distances along the longitudinal propagation path. This can be achieved by introducing a 2-D spectrum comprising both temporal and longitudinal wavenumbers associated with specific transverse Bessel-Gaussian fields, resulting in packets evolving in time and distance.

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

THE PAST, PRESENT, AND FUTUREOFQUANTUMCASCADE LASERS TECHNOLOGY (QCL-IR)

Brock Koren
DRS Daylight Solutions, USA

First realized in 1994 by Bell Labs, quantum cascade lasers (QCLs) enable rapid advancements in academic, industrial, and defense applications. QCLs are now available in a diverse range of commercial systems from high-power fixed wavelength sources to narrow-linewidth and rapidly, broadly tunable lasers. QCLs have now also been adopted in novel QCL instrumentation providing unique capabilities for liquid/gas analysis and chemical imaging microscopy.

Koren details the latest advancements in life sciences and materials sciences research enabled by today's solutions. He will cover the operating principles of quantum cascade lasers, the fundamentals of infrared vibrational spectroscopy, the advantages of QCLs in applications, novel research from 2023, and the next-generation applications and technology.

Biography

Brock Koren is an executive with over 25 years of experience in high-technology companies. He received Bachelor of Science degree in electrical engineering from California State University, Long Beach. He is currently the director of sales and business development for DRS Daylight Solutions, the world's leading provider of best-in-class mid-infrared, quantum cascade laser sources for the life sciences, research, industrial, and defense industries. Koren was most recently the vice president of sales and marketing and product management for Gamma Scientific, a manufacturer of light measurement instruments for display testing, LED testing, light meters, light sources, and spectrometers.

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

ALTERING THE OPTICAL PROPERTIES OF AROMATIC AMINO ACID LATTICES IN THE MICROTUBULE CYTOSKELETON WITH SMALL AROMATIC MOLECULES

Travis J. A. Craddock [a, b], *, **Tatum Hedrick** [b], **Caleb Siguenza** [b]

[a]Department of Biology, University of Waterloo, 200 University Ave W, Waterloo, ON, Canada N2L 3G1

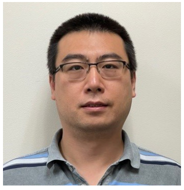
[b]Departments of Psychology & Neuroscience, Nova Southeastern University, 3300 S University Drive, Fort Lauderdale-Davie FL, USA 33328

Microtubules are self-assembling biological helical nanotubes made of the protein tubulin, vital for cell motility, architecture, cell division, molecular signaling, and intracellular trafficking. It has been hypothesized that these hollow molecular nanostructures may support optical transitions in photoexcited lattices of tryptophan, tyrosine, and/or phenylalanine amino acids, functioning as light harvesters like photosynthetic units. This capability, combined with their shape, makes them analogous to quantum wires. Recent experimental work supports this, demonstrating that electronic energy can diffuse across microtubules in a manner unexplained by conventional Förster theory, highlighting their effectiveness as light harvesters. Here, we present theoretical work on the interaction of small aromatic molecules with microtubules and their potential effect on energy transfer between amino acids in tubulin. Our results demonstrate the potential for manipulation of the optical properties of aromatic amino acid lattices by the addition of small aromatic molecules within microtubule protein structures.

Keywords: coherent energy transfer, excitonic transport, quantum biology, quantum optics, microtubule, psychedelics, structure-based simulation, optical biophysics

Biography

Travis J.A. Craddock, Ph.D. is an Associate Professor and Canada Research Chair in the Department of Biology at the University of Waterloo in Waterloo, Canada. Dr. Craddock received his Ph.D. in the field of biophysics at the University of Alberta where his graduate research activities focused on subneural biomolecular information processing, and nanoscale neuroscience descriptions of memory, consciousness, and cognitive dysfunction in neurodegenerative disorders. His current research activities are focused on applying computational biophysics and theoretical quantum biology methods towards the purpose of identifying novel treatments and diagnostics for complex chronic illness involving neuroinflammation.



EMERGING FIBER TECHNOLOGIES FOR DISTRIBUTED OPTICAL FIBER SENSING

Lu, Ping

Senior R&D scientist, OFS Fitel LLC, USA

Biography

Ping Lu is currently a senior R&D scientist at OFS Fitel LLC, where he develops specialty fibers and fiber sensors for industrial, aerospace, and medical applications. He obtained his Ph.D. in condensed matter physics from Memorial University of Newfoundland in 2012, where he researched the micro-structured optical fibers. Before joining OFS, he worked at the National Energy Technology Laboratory to establish one of the only optical fiber sensor interrogator programs among DOE national labs. His current research interests focus on developing advanced fiber-optic sensing systems for low-cost distributed multi-parameter environmental monitoring. He has authored or co-authored over 100 research papers in the field of fiber optics and laser physics.

WHICH WAVELENGTH OF LIGHT FOR PHOTO-BIOMODULATION THERAPY CAN PENETRATE DEEPER INTO THE SPINAL CANAL?

Daqing Piao, [1] Lara Sypniewski, [2] Kenneth E. Bartels [2]
[1]School of Electrical and Computer Engineering,
[2]Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Oklahoma State University, Stillwater, OK

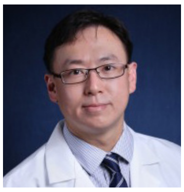
The therapeutic potential of photo-biomodulation therapy (PBMT) for spinal cord injury (SCI) by promoting neuronal regeneration and functional recovery has been recognized in the recent decade. Whereas there is increasing mechanistic evidence for PBMT-related effects on spinal cord injuries in rodent models, there are various reasons, such as difficulty defining appropriate dosage, regarding why these results have not been extensively explored for treatment of spinal cord diseases in humans.

One of the technical questions relevant to the clinical potential of PBMT for SCI that has not been answered is which wavelength of light known to be generative of PBMT responses can penetrate deeper into the spinal canal. This wavelength-suitability issue is especially important in consideration of the significant dose attenuation expected for the skin-to-spinal-canal transmission. The target dose at the level of the spinal canal must be adequate to produce the desired photobiomodulatory therapeutic response, however, the delivery of the target dose shall not be made at the cost of collateral thermal damage of the entrance tissue.

With the development of a flexible 9-channel dual-mode intra-spinal dosimetry probe and cadaver dog, we have measured the skin-to-spinal-canal transmission of lasers at 4 wavelengths including 808, 915, 975, and 1064nm. This talk presents the development of the 9-channel intra-spinal probe, the dose-calibration of the 9-channel probe at the four wavelengths, the experimental procedures on the cadaver dog, and the results of the skin-to-spinal penetration measured from 3 cadaver dogs. It has been shown that the 1064nm light resulted in significantly greater dose at the spinal cord level, in comparing to the other three wavelengths, under otherwise the same conditions determining the surface dose. The results will provide important insights into which wavelength of PBMT has the strongest therapeutic potential for SCI, should the maximum target-dose at safe surface-dose be the determining factor.

Biography

Daqing (Daching) Piao, PhD received BS in Physics (Applied Optics) in 1990 from Tsinghua University, Beijing, China. He earned MS and PhD, both in Biomedical Engineering, in 2001 and 2003, respectively, from the University of Connecticut (UCONN), Storrs, CT. After a total of two years of post-doctoral training in UCONN and Dartmouth College, he joined the faculty of the School of Electrical and Computer Engineering at Oklahoma State University in 2005. His research interest centers on applying light-tissue interaction principles for identifying and modulating tissue properties. Among the recognitions he has received, a New Investigator Award from the Prostate Cancer Research Program of DoD (Army Medical Research and Material Commaond) recognized his origination of transrectal diffuse optical tomography and the combination of it with transrectal ultrasound for prostate cancer research.



CORRELATIONS BETWEEN INTRAOCULAR PRESSURE REGULATION AND THE BIOMECHANICAL BEHAVIORS OF DISTAL AQUEOUS OUTFLOW VASCULATURE

Guan (Gary) Xu[1], Linyu Ni[1], Alexus Warchock[1], Wonsuk Kim[2], Sayoko E. Moroi[3], Alan Argento[2]

[1]Univeristy of Michigan, Ann Arbor

[2]University of Michigan, Dearborn

[3]The Ohio State University, Wexner Medical Center University of Central Florida, Orlando, Florida 32816, USA

Purpose: Glaucoma is a leading cause of blindness globally. The intraocular pressure (IOP) outcomes of newer glaucoma surgeries are unpredictable, in part due to a gap in knowledge of tissue biomechanics at the level of distal aqueous outflow vasculature and the surrounding perilimbal sclera (PLS). In our previous studies, we established a multispectral photoacoustic microscopy (PAM) and finite element analysis (FEA) method to quantify the strains in individual tissue components. PAM-FEA confirmed the perilimbal sclera's (PLS) role in restricting deformations of aqueous veins.

Methods: Distal vasculature was identified by perfusing suspension of microspheres in whole globes. The steady state IOP of the eye at constant flow rates and the IOP elevation rate at constantly increasing flow rates were measured. PAM-FEA resolved the average cross-sectional area change of the aqueous veins and the deformation of surrounding sclera using 800 nm and 1200 nm illuminations, respectively. The volumetric flow through the vasculature was also quantified. The correlations between the volumetric flow, the IOP measurements, and the biomechanical behaviors of the tissue components were calculated. We also attempted to predict the IOP outcomes of our perfusion procedure using the biomechanical behaviors of the tissue components quantified by PAM-FEA.

Results: The results show that the cross-sectional area change of the aqueous veins and deformation of PLS parallel to the globe surface and the volumetric outflow rate are strongly correlated with the steady-state IOP. The deformation of the sclera perpendicular to the eye surface is not significantly correlated with the IOP measurements. The linear regression shows that the PAM-FEA measurements of the deformation of the tissue components and the volumetric outflow rate can be used to predict the IOP outcomes in our perfusion procedures at approximately 10% error.

Conclusion: These findings support our hypothesis that the PLS and aqueous veins with less deformation are correlated with elevated steady state IOP and less adaptive behavior of eyes to increased aqueous outflow volume.

Biography

Dr. Xu received his PhD and postdoctoral training in optical and ultrasound imaging in biomedicine. He received a predoctoral award from Congressionally Directed Medical Research Programs, a postdoctoral fellowship from American Heart Association, a Career Development Award from American Gastroenterology Association, a Senior Research Award from Crohn's and Colitis Foundation and an R37 MERIT award from National Cancer Institute.

PARADIGM SHIFT IN THE OPERATIONS AND APPLICATIONS OF VOLUME BRAGG GRATINGS

Ivan Divliansky
CREOL, The College of Optics and Photonics, USA

The talk will introduce and discuss in details several new holographic optical elements with unique properties and broad spectrum of applications. These elements could revolutionize applications such as ultra-fast pulse modulation, compact spectrometers, laser beam combining and others. The foundation of these elements is a chirped volume Bragg grating incorporating additional phase information or operating at modified incoming angles. We see these HOEs as a major paradigm shift in the operations and applications of volume Bragg gratings.

Biography

Dr. Ivan Divliansky is a Research Associate Professor of Optics & Photonics at CREOL, The College of Optics and Photonics at UCF. Currently, his research interests include high-power laser beam combining, solid state and fiber laser systems development, design, and applications of holographic optical elements. His current projects also include the development of the next generation head-up displays.

Dr. Divliansky has more than 85 conference proceedings and more than 35 peer review publications in journals such as Nature Photonics, Light: Science & Applications, Advanced Materials, Applied Physics Letters, Optics Letters, and others with total citations by other authors of more than 1550 and h-index of 16. He has edited one book and authored two book chapters, co-authored two patents, and is an Associate Editor within the editorial board of Frontiers in Physics, specialty section Optics and Photonics. He is also frequent referee for Optics Express, Optics Letters, Applied Optics, and other peer review journals.

Dr. Divliansky serves as a chair of Optica's Holography and Diffractive optics technical group.

RAMAN-BASED NONINVASIVE CONTINUOUS GLUCOSE MONITORING (CGM)

Jeon Woong Kang
Research Scientist, MIT, USA

The importance of monitoring blood glucose cannot be overemphasized considering the increasing population of diabetics worldwide and the associated costs. However, the painful lancing process of obtaining blood drops by finger-stick hinders people from actively monitoring blood glucose levels. Recently, minimally invasive continuous glucose monitoring (CGM) sensors have become popular alone or in combination with close-loop insulin pump among type I diabetes (T1D) patients. However, subcutaneous insertion, skin irritation caused by imbedded wire, and adhesive are barriers. High operating cost also limits the adoption of these devices.

Noninvasive glucose monitoring has been a technology in high demand to provide people in need with pain-free, convenient, and continuous or as frequent measurements as necessary. Over the past decades, a variety of technologies have pursued this long quest. Among many, Raman spectroscopy has been recognized as a promising method. Raman spectra have distinctive spectral features, specific for target molecules. For in vivo transdermal Raman spectroscopy, acquired Raman spectra contain information on glucose molecules from the interstitial fluid. Although these reports have claimed the diagnostic capability of the Raman system, the absence of the characteristic Raman peaks and true prospective prediction have been criticized. Here, we present experimental data that may finalize the long debate. We present the results of direct observation of glucose-specific Raman peaks in swine glucose clamping experiments. From the measured spectra, we confirm the presence of the glucose signal and the linearity between intensities of the glucose Raman peaks and the reference glucose concentrations. Prospective prediction was achieved by simply tracking glucose Raman peak intensities.

Biography

Dr. Busch's work focuses on developing non-invasive and minimally invasive optical tools to monitor deep tissues in health and disease, as well as throughout therapy. He received a Ph.D. from the University of Pennsylvania (Physics) in 2011 and completed a postdoctoral fellowship in Neurology at the Children's Hospital of Philadelphia, prior to joining the faculty at the University of Texas Southwestern Medical Center. Dr. Busch is currently an assistant professor in the Departments of Anesthesiology and Pain Management, Neurology, and Biomedical Engineering at the University of Texas Southwestern Medical Center.

NON- AND MINIMALLY-INVASIVEOPTICALMONITORING OF THE CENTRAL NERVOUS SYSTEM DURING CRITICAL CARE

David R. Busch

University of Texas Southwestern, USA

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

METABOLIC NANOSCOPY FOR STUDYING AGING AND DISEASES

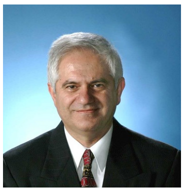
Lingyan Shi
Shu Chien-Gene Lay Department of Bioengineering,
University of California San Diego
9500 Gilman Drive, #0412, La Jolla, CA 92093-0412

Metabolism is a complex biochemical process in living organisms that involves different biomolecules and consists of various reaction steps. To understand the multi-step biochemical reactions involving various components, it is essential to elucidate in-situ dynamics and the correlations between different types of biomolecules at subcellular resolution. In this context, we have developed and integrated deuterium-probed picosecond stimulated Raman scattering (DO-SRS), multiphoton fluorescence (MPF), and second harmonic generation (SHG) into a single nanoscopy system to study metabolic changes in aging and diseases.

By developing A-PoD and PRM algorithms, our current metabolic nanoscopy provides super-resolution with hyperspectral volumetric imaging capability. Combined with deuterated molecules (glucose, amino acids, fatty acids, water molecules, etc.) as probes, the metabolic heterogeneity of the brain, adipose tissue, liver, muscle, retina, kidney, lung, and ovaries (in Human, Mouse, and Drosophila tissues) is quantitatively imaged. This metabolic nanoscopy dissects the molecular events and cellular machinery in living organisms during aging and disease progression, offering new tools potentially for disease detection, diagnosis, assessing therapeutic efficacy & resistance, as well as for mechanistic understanding of scientific fundamentals in neurodegenerative diseases, cancer, drug delivery, and aging processes.

Biography

Lingyan Shi is currently an Assistant Professor in the Shu Chien-Gene Lay Department of Bioengineering at UC San Diego. Her Lab's research focuses on developing high-resolution, high-speed metabolic nanoscopy for studying aging and diseases. She discovered the "Golden Window" for deep tissue imaging and developed metabolic imaging platforms including "DO-SRS" and "STRIDE". Shi group at UC San Diego transformed SRS into a super-resolution multiplex nanoscopy using A-PoD and PRM algorithms, uncovering lipid metabolic dynamics in various organ tissues during aging processes. Dr. Shi holds 8 awarded patents. She received the Blavatnik Regional Award for Young Scientist in 2018, the Hellman Fellowship Award in 2021-2022, the "Rising Star Award" from Nature Light Science & Applications in 2021, the "Advancing Bioimaging Scialog Fellow" by RCSA and CZI, the "David L. William Lecture & Scholarship" Award from the Kern Lipid Conference, and the "Sloan Research Fellow" Award in Chemistry in 2023, and the 2024 rising star award by BMES-Cell and Molecular Bioengineering (CMBE) society.



ADVANCED FIBER OPTIC SENSING SYSTEMS FOR AVIATION AND AEROSPACE APPLICATIONS

Dr. Alex Kazemi
Associate Technical Fellow
The Boeing Company Fiber Optic Architect
PD Advanced Concept
LOPS2024 Chairman

This presentation is an outline to fiber optic sensor systems and its understanding of the utilization of these systems for aviation, aerospace and space applications. It documents the current state of the art and provides references for users of this advanced technology for future of aerospace and track the rapid advances in leading edge technologies under development plus revolutionary progresses in fiber optic technology as applied to flight-test instrumentation that that has been achieved over the last two decades and are expected to continue at a rapid pace for the foreseeable future.

Optical fiber is well-known for its ability to carry information at high speeds over long distances. They have evolved a long way from the first low-loss fiber demonstrated in the late 1960s. Fiber optic technologies offer unique features that can be exploited in a variety of ways, such as carrying high optical powers in flexible light guides for welding stations, transfer ring images in endoscopes, distribute sensing along a large structure such as wing of the aircraft, and for low weight and high-transmission bandwidth in avionics.

The presentation also covers the state-of-the-art Fiber Bragg Grating (FBG) technology. One application for this technology is System Health Monitoring (SHM) to a wide range of aircraft systems in order to establish a comprehensive set of data for aging aircraft. Other future applications could entail embedding fiber optic systems in composite structures as they are manufactured, allowing extremely light-weight flexible structures to be actively controlled, and giving enhanced capability to aircraft systems.

Key Words: Fiber Optic Sensor, FBG, Aviation, Aerospace, Space, SHM

Biography

Dr. Alex Kazemi a world recognized Micro Technologist, and materials scientist is the CEO and President of ARK International LLC is focusing on development of fiber optics, miniaturized fiber components, fiber optic sensors, and micro/nano technology of laser components for aviation, aerospace and space applications. He is developer of the lightest fiber optic cable in aviation history, World 1st fiber optic sensor for rocket engine, U.S. 1st fiber optic delivery system for micro welding of laser chips, and leading-edge technologies. He is The Boeing Company Fiber Optic Architect, Associate Technical Fellow, and worked for 25 years for Boeing as well as 10 years for telecom, lasers, sensors and MEMS industries. He also taught physics and materials science for several years at University of Southern California. Currently he is the Principal Consultant for development of new generation of fiber optics and sensors to the Boeing Company. He has authored/edited 8 books and one book chapter in the area of photonics, lasers, sensors, fiber optics, micro and nano technologies, plus published over48 papers in International Journals and hundreds of presentations throughout of conferences and technical community's world-wide. In recent survey by "Research Gate" organization over 1000of his peers reviewed his published papers. In 2018, 2019 and 2021 three separate International Awards were presented to him for the phenomenal presentation for his research on fiber optic sensor and lasers. He has been Chairman of SPIE International Conferences in Photonics Applications for Fiber Optic Sensors and Lasers for 8 years and Chairman, Chief Scientific Committee and Chief Editor of Excel Global International Conference on Lasers, Optics, Photonics, and Sensors in 2021. He has bestowed hundreds of recognitions, awards and patents

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

MID-INFRARED (MIR) CONTINUOUS WAVE, ROOM TEMPERATURE, FIRST TIME FIBRE LASING BEYOND 5 MM

Joel J. Nunes[1], Łukasz Sojka[2], Richard W. Crane[1,5], David Furniss[1], Zhuoqi Tang[1,6] Boyu Xiao[1], Mark C. Farries[1], Nikolaos Kalfagiannis[3,4], Demosthenes Koutsogeorgis3, Emma Barney[1], Sendy Phang[1], Slawomir Sujecki[2] and Angela B. Seddon[1]*.

[1]Mid-Infrared Photonics Group, George Green Institute for Electromagnetics' Research, Faculty of Engineering, University of Nottingham, Nottingham NG7 2RD, UK.

[2]Department of Telecommunications and Teleinformatics, Faculty of Electronics, Wroclaw University of Science and Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland.

[3]School of Science and Technology, Nottingham Trent University, Nottingham NG11 8NS, UK.

[4]Department of Materials Science and Engineering, University of Ioannina, Ioannina 45110, Greece.

[5]Now at Dept. of Electrical and Photonics Engineering, Fibre Sensors and Supercontinuum, Technical University of Denmark, Ørsted Plads, 343 028 2800 Kgs. Lyngby, Denmark.

[6]Now at Fibrecore Limited, Fibrecore House, Southampton Science Park, Southampton SO16 7QQ, UK.

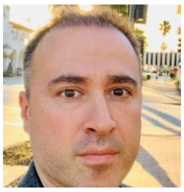
We review here our recent work in achieving first time, room temperature, continuous wave mid- infrared (MIR) fibre lasing beyond 5 μm wavelength [1]. This is accomplished in a small core Ce3+-doped selenide chalcogenide SIF (step index fibre) of core: Ge-As-Ga-Se chalcogenide glass, doped with 500 ppmw (parts-per-million by weight) of cerium, employing in-band pumping by means of a 4.15 μm quantum cascade laser (QCL). The lasing fibre is 64 mm long, with a calculated numerical aperture of 0.48 at the lasing wavelengths. The core glass is Ge15As21Ga1Se63 atomic % (at. %), doped with 500 ppmw Ce, and of diameter: 9 μm; the cladding glass is Ge21Sb10Se69 at. % and the fibre outer diameter was 190 μm. As pump power is increased, continuous wave lasing corresponding to the 2F5/2 → 2F7/2, emission of Ce3+ occurs at 5.14 μm, 5.17 μm, and 5.28 μm, and threshold pumping of ~ 80 mW. Also we review here the related photoluminescence in samples of the same composition but in particulate and bulk glass form, as well as unstructured fibre and in the SIF (step index fibre) in which fibre lasing took place [2]. In-band pumping of Ce3+ in selenide-chalcogenide glass gives MIR photoluminescence (PL) spanning 3.40–5.80 μm wavelength, corresponding to the 2F5/2 → 2F7/2 electronic emission transition due to Ce3+. Room temperature emission and MIR absorption spectra together enable interpretation of the manifold energies of the first excited state and there is potential for occupied Stark levels in the ground state at room temperature. Both 'τrad' (PL lifetime) and 'trise' (rise-time through 10% to 90% of maximum PL intensity) are determined. For the particulate glass at 4.60 μm wavelength, the best decay fit comprises a primary, and perhaps secondary, lifetime for particulate glass of 3.5 ms, and 1.2 ms, and PL rise time of 3.9 ms. The MIR spectral region is defined as the 3–50 μm wavelength range and enables direct molecular sensing with high selectivity and high specificity. MIR fibre lasers offer excellent beam quality of bright, spatially and temporally coherent light, routable in MIR fibre-optics for applications such as narrow- band sensing, clinical diagnostics, new medical laser wavelengths, and pulsed seeding of MIR-supercontinua for MIR broadband sensing. We place this disruptive breakthrough into the wider fibre laser context, and also present the unprecedented advances in new cross-sector applications that will be enabled by mid-infrared fibre lasers in the 4-10 μm wavelength-range.

To surpass the few mW power output of the Ce3+-doped chalcogenide glass fibre lasing achieved to date, the glass quality of the doped chalcogenide fibres must now be improved, similar to the challenges originally facing the first glass fibre lasers based on silica.

1. J.J. Nunes, Ł. Sojka, R.W. Crane, D. Furniss, Z.Q. Tang, D. Mabwa, B. Xiao, T.M. Benson, M.C. Farries, N. Kalfagiannis, E. Barney, S. Phang, A.B. Seddon, and S. Sujecki, Opt. Lett. 46, 15 3504-7 (2021).
2. J.J. Nunes, R.W. Crane, Z.Q. Tang, Ł. Sójka, N. Kalfagiannis, D. Furniss, M.C. Farries, T.M. Benson, S. Sujecki and A.B. Seddon, Opt. Mat. 137, 113543-53 (2023).

Biography

I lead the Mid-Infrared Photonics Group at the University of Nottingham, UK. My vision is to bring about a new paradigm in mid-infrared (MIR) biophotonics for portable, real-time, sensing and imaging in medicine based on new MIR fibreoptics, including for real-time, in vivo cancer diagnosis. I run a world-class suite of labs. dedicated to the synthesis and characterisation of long-wavelength mid-infrared optical fibres and devices. My seminal 1995 paper cited 591x rekindled interest in MIR chalcogenide-glass photonics. The Royal Academy of Engineering /Leverhulme Trust Senior Research Fellowship (2007 /08) & Medical Research Council, Discipline Hopping Fellowship (2008 /09) were awarded to initiate my MIR biophotonics' research. My Optics Express review re-set some ground rules for achieving MIR fibre lasingcited 274x. With DTU, Denmark, we set a world record (held for 6 months) in 2014 in broadband MIR sources demonstrating a MIR-supercontinuum spanning 1.4 mm to 13.3 mm spectral range in fibrecited 745x.This was the first experimental demonstration truly to reveal the potential of MIR fibres to emit across the MIR molecular "fingerprint spectral region" and a key first step towards bright, portable, broadband MIR sources for biomolecular sensing, including for cancer detection. I am elected Fellow of SPIE for special contribution to glass photonics, Fellow of the Society of Glass Technology, Fellow of the Institute of Materials, Minerals and Mining and Fellow of the Royal Society of Chemistry. 269 publications, 238 talks at conferences and institutions, including 100 invited.



THE EMERGENCE OF SUPER RESOLUTION OPTICAL PHOTOTHERMAL INFRARED SPECTROSCOPY AND IMAGING

Mustafa Kansiz and Craig Prater

Photothermal Spectroscopy Corp., USA

Optical Photothermal Infrared (O-PTIR) is a rapidly emerging technique for super-resolution infrared spectroscopy. O-PTIR illuminates a sample with pulses of light from a tunable infrared laser and then uses a shorter wavelength visible probe beam to detect infrared absorption at specific molecular bonds by detecting subtle heating in IR absorbing regions of the sample. Since the probe beam can be focused much smaller than the infrared excitation beam, O-PTIR can achieve spatial resolution 10-30X better than conventional infrared spectroscopy. O-PTIR has been used for a wide variety of biomedical research, including analysis of cells and tissue. O-PTIR has been combined recently with fluorescence imaging to enable the use of fluorescent tags to localize IR spectroscopic measurements, to explore differences in protein secondary structure between normal and diseased tissue related to neurogenerative disease. O-PTIR has also been used for cancer research for the study of microcalcifications in breast cancer and even automated label-free histological recognition of ovarian tissue. O-PTIR has also recently been used for spectroscopic analysis of bacteria, enabling studies of spectroscopic phenotyping, assessing antimicrobial resistance, and single cell metabolic studies. Researchers at Boston University, Purdue, and Photothermal Spectroscopy Corp. have also demonstrated fluorescence-enhanced photothermal infrared spectroscopy (FE-PTIR) in which the absorption of IR light is detected over a wide area by detecting modulations in fluorescent emission from a sample due to local temperature increases in the same due to IR absorption. This presentation will overview O-PTIR and FE-PTIR technology and survey a variety of applications.

Biography

Dr. Mustafa Kansiz is currently the Director of Product Management and Marketing for the mIRage IR Microscope at Photothermal Spectroscopy Corp with responsibilities for new product development, marketing and applications development. He has over 25 years of experience working with FTIR Microscopy and Imaging and Raman, spanning routine to research applications, in both industry and academia. Throughout his time, he has worked at Varian and Agilent Technologies serving in a range of technical and business development roles, including FTIR Microscopy & Imaging Product Manager, Product Specialist, R&D Scientist and European FTIR Sales Manager. He has a Ph.D. from Monash University on biotechnological application of FTIR spectroscopy and multivariate statistics

CHALLENGES OF AND DEVELOPMENTS TOWARDS OFF-CONTACT DIFFUSE REFLECTANCESPECTROSCOPY

Daqing Piao
School of Electrical and Computer Engineering,
Oklahoma State University, Stillwater, USA

Diffuse reflectance spectroscopy (DRS) being a many-decades-long near-mature technology is finding new applications that may not be addressed well by other forms of spectroscopy or light-based technologies. Some of those applications that must take non-contact or off-contact means of measurement face unique challenges regarding how DRS can be implemented. For example, DRS may be utilized to characterize the below-surface myoglobin oxygenation that impacts the meat industry, but the realization is challenging.

This talk will present recent developments in the theoretical models and experimental methods of DRS that not only are specifically useful to non-contact or off-contact applications but also help advance the general understanding of DRS. The new theoretical models and experimental methods have been prompted by addressing the "photon budget" issue of DRS. Although being not exclusive to non-contact DRS, the "photon-budget" issue becomes significant in association with non-contact applicator-probe when needing to also provide differential sensitivities between the surface and below-surface properties.

We present how the method of area-collection versus spot-collection helps ease the "photon budget" issue and how the combination of center-accepted and center-blocked area-collection approaches help improve the differential sensitivities between the surface and below-surface properties. These understandings have been facilitated by new insights into the analytical model-approach supported by Monte Carlo simulations and experimental validations. On-going work to capitalize these new developments will be discussed.

Biography

Daqing (Daching) Piao, PhD received BS in Physics (Applied Optics) in 1990 from Tsinghua University, Beijing, China. He earned MS and PhD, both in Biomedical Engineering, in 2001 and 2003, respectively, from the University of Connecticut (UCONN), Storrs, CT. After a total of two years of post-doctoral training in UCONN and Dartmouth College, he joined the faculty of the School of Electrical and Computer Engineering at Oklahoma State University in 2005. His research interest centers on applying light-tissue interaction principles for identifying and modulating tissue properties. Among the recognitions he has received, a New Investigator Award from the Prostate Cancer Research Program of DoD (Army Medical Research and Material Commaond) recognized his origination of transrectal diffuse optical tomography and the combination of it with transrectal ultrasound for prostate cancer research.

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

DoubleTree Resort by Hilton Hollywood Beach,
4000 South Ocean Dr., Hollywood, FL 33019

DAY 4
SEPEAKER PRESENTATIONS

VISIBLE RESONANCE RAMAN SCATTERING IN BRAINS

Binlin Wu

Department of Mathematics Southern Connecticut State University, 501 Crescent Street, New Haven, CT 06515, USA.

Raman spectroscopy is a technique that can detect molecular vibrational, rotational, and other low-frequency modes in a substance. It is commonly used to identify molecules based on the spectral fingerprints. When used for optical biopsy, Raman spectroscopy uses intrinsic biomarkers and can operate in situ and in real time, which leads to rapid progress in research and clinical applications in cancer diagnosis. But most reports in the literature which demonstrated spectral differences between normal and cancerous tissues used near-infrared (NIR) laser excitation. Since Raman scattering is very weak, some researchers used high power (e.g. 300mW) and long signal collection time (e.g. minutes). Such approaches have limitations for practical applications. We have developed a visible resonance Raman (VRR) spectroscopy technique using 532nm excitation which can provide resonance-enhanced Raman signals from various large biomolecules and facilitate the study of the presence of compounds at low concentrations. Therefore, VRR can overcome the limitations of the conventional Raman technique and has great potential for various applications. In this talk, I will report the results from different studies on brains using VRR as a technique to distinguish glioma and meningioma from normal brain tissues, detect Alzheimer's disease using brain tissues and cerebrospinal fluid, and detect rapid metabolic molecular changes during embryonic development which is essential for early-stage neural development.

Biography

Dr. Binlin Wu is currently an Assistant Professor in the Physics Department at Southern Connecticut State University. Dr. Wu earned his PhD degree from City College of New York. After that, he did two-year postdoc at Weill Cornell Medical College. Dr. Wu's research is focused on biomedical optical imaging and spectroscopy mainly for cancer imaging and diagnosis. Dr. Wu has expertise in diffuse optical imaging, fluorescence spectroscopy, Raman spectroscopy, multiphoton imaging, and machine learning.

Biography

Andrei Afanasev currently leads the physics effort for the GWU energy initiative. He has made significant research contributions in the field of nuclear and particle physics probed with high-power electron accelerators and free-electron lasers. Presently Prof. Afanasev contributes to energy research in three areas: (a) High-power particle accelerators that may serve as drivers for accelerator-driven subcritical nuclear reactors (ADSR), as well as probes of new materials for energy applications; (b) Development of novel techniques in photovoltaics, including nanostructures, quantum dots, and surface acoustic waves; (c) New technologies for non-proliferation of nuclear materials. Prof. Afanasev is the Director of the Photoemission Research Laboratory where new solutions for particle accelerator sources and photovoltaics are being developed and tested.

Research Interests: Nuclear & Particle Physics, Physics of Particle Accelerators; Quantum Electrodynamics; Condensed Matter Physics

SPATIALLY STABLE CONSTELLATIONS OF POLARIZATION SINGULARITIES IN THE OPTICAL WAVEFRONTS

Andrei Afanasev
The George Washington University United States

LOPS® 2024

4th Edition of Annual Conference on

LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS

JUNE 07-10, 2024

KIDNEY CANCER CLASSIFICATIONMODELUSING DEEP LEARNING

Joseph Neumann[1], Yulei Pang[1], and Binlin Wu[2,*]

[1]Department of Mathematics Southern Connecticut State University, 501 Crescent Street, New Haven, CT 06515, USA.

[2]Department of Physics and CSCU Center for Nanotechnology, Southern Connecticut State University, 501 Crescent Street, New Haven, CT 06515, USA.

Accurate discrimination between oncocytoma and chromophobe renal cell carcinoma (chRCC) is critically important for the clinical management of patients, because oncocytoma is a benign tumor with excellent prognosis, whereas chRCC is a malignant tumor with metastatic potential. However, these two types of kidney tumors may at times pose difficulties with differential diagnosis on H&E. In this study, multiphoton microscopy (MPM) images collected from chRCC and oncocytoma kidney tumors were analyzed and classified using convolutional neural network (CNN). We configured and trained a CNN model for the classification to differentiate chRCC and oncocytoma. The model is also capable of obtaining saliency maps to identify the most influential features, such as collagen structure and cytoplasm, which may be used by a pathologist to further verify the results. Multiple trials were run using different methods of transforming the image data. Currently, our best models yield results with an accuracy of over 70%. The results outperform random chance but leave room for further improvement in our future studies. Our current findings demonstrate the immense potential of deep learning for distinguishing chRCC and oncocytoma kidney tumors as well as other cancers in general.

Name :	**Remark**
Conference Program Execution	
Techincality of the conference	
What needs to be improoved	
Are you interested for collaboration or want to be a "Joint Organizer" with us?	
Which destinations do you like more for next conference	
Will you join for next conference	
Doyou have specific topic interested ?	
Further Suggestions	

Note:

Note:

INDEX

JOIN THE WORLD RENOWNED SPEAKERS AT LOPS 2025

Robert Alfano
The City College of New York, USA

Robert Boyd
The Institute of Optics
University of Rochester, USA

Dr. Alex Kazemi
The Boeing Company, USA

Federico Capasso
Harvard University School of Engineering & Applied Sciences, USA

Paul Corkum
University of Ottawa, Canada

Lingyan Shi
UCSD Bioengineering, USA

Boris Gramatikov
Wilmer Eye Institute
Johns Hopkins University, USA

Brock Koren
DRS Daylight Solutions, USA

Yu, Bing
Marquette University
Medical College of Wisconsin, USA

Program Highlights

Plenary Forum
Panel Discussions
Keyniotes Forum
Session Speaker Forum
Networking Sessions
Exhibitor Networking
Networking Dinner

LOPS 2025

MAY 29- JUNE 01, 2025
FORT LAUDERDALE, FLORIDA

MINI SPONSORS SLOTS AVAILABLE