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PLENARY PRESENTATION

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Biography

Steven Chu is the William R. Kenan, Jr. Professor of Physics, of Molecular and Cellular Physiology, and of Energy Science and Engineering at Stanford University. He received an A.B. degree in mathematics and a B.S. degree in physics from the University of Rochester, and a Ph.D. in physics from the University of California, Berkeley. After a postdoctoral fellowship at Berkeley, he was at Bell Labs as a member of the technical staff in 1978 and then department head in 1983. From January 2009 to April, 2013, Dr. Chu served as U.S. Secretary of Energy under President Barack Obama. During his tenure, he began several initiatives, including ARPA-E (Advanced Research Projects Agency – Energy), the Energy Innovation Hubs, and the Clean Energy Ministerial meetings. As the first scientist Cabinet member, Chu recruited dozens outstanding scientists and engineers to the Department of Energy, and was personally tasked by President Obama to help stop the BP Oil leak. From 2004-2009, he was the director of the Lawrence Berkeley National Laboratory and Professor of Physics and of Molecular and Cell Biology at the University of California Berkeley. Prior to those positions, he was the Theodore and Francis Geballe Professor of Physics and Applied Physics at Stanford University. During this time, he helped start Bio-X, a multi-disciplinary initiative combining the physical and biological sciences with engineering and medicine. His contributions include the introduction of laser cooling and optical trapping of atoms and particles, atomic fountain clocks and atom interferometers, the optical tweezers of biomolecules, and single molecule FRET of biomolecules tethered to surfaces. His current research is in biophysics, molecular and cellular physiology, medical imaging, nanoparticle synthesis and battery research. He has received many awards, including the 1997 Nobel Prize for laser cooling and optical trapping of atoms. He is a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, National Academy of Inventors, and a foreign member of the Royal Society, the Royal Academy of Engineering, the Chinese Academy of Sciences, the Academia Sinica, the Korean Academy of Sciences and Technology and the Pontifical Academy of Sciences. He received an A.B. degree in mathematics, and a B.S. degree in physics from the University of Rochester, and a Ph.D. in physics from the University of California, Berkeley, and 35 honorary degrees.

Steven Chu

King Faisal Prize (1993), Nobel Prize in Physics (1997)
Golden Plate Award (1998)William R. Kenan, Jr. Professor of Physics and Professor of Energy Science and Engineering, Stanford University, USA

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SHARPER IMAGES THROUGH QUANTUM IMAGING

Robert W. Boyd
Department of Physics, University of Ottawa, Ottawa, ON Canada
Institute of Optics, University of Rochester, Rochester, NY USA
boydrw@mac.com

Quantum imaging is a research area that seeks to produce "better" images using quantum methods We review some recent research in the field of quantum imaging.

Quantum imaging is a research area that seeks to produce "better" images using quantum methods. The image can be better in one of several different ways. It might possess better spatial resolution, it might display better signal-to-noise ratio, or it might be able to be formed using a very small number of photons. From an operational standpoint, we can consider quantum imaging to be an imaging modality that seeks to exploit the quantum properties of the transverse structure of light fields. In this presentation, we describe several different recent examples of advances in the field of quantum imaging.

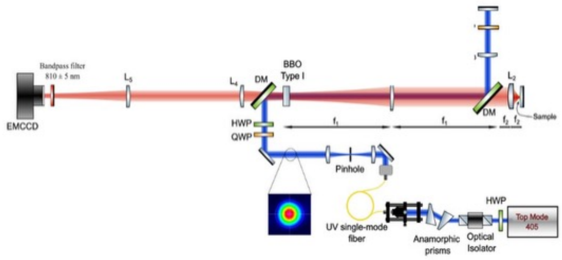

Figure 1. Typical quantum imaging setup.

One such example is afforded by quantum phase imaging. Many biological materials, especially cellular materials, possess very small contrast in terms of the amplitude of a light field transmitted through the material. However, the transmitted field does show significant structure in terms of the phase of the transmitted light. Many of these materials are optically quite fragile and cannot withstand a high intensity light field. High intensities are required for certain applications such as short-exposure imaging to monitor the dynamical changes in the structure of the material. The problem with optical damage is aggravated through use of short illumination wavelengths, which are normally required in order to obtain good spatial resolution of the image. These difficulties can largely be mitigated through use of quantum imaging methods. For example, quantum imaging can make optimum use of a small number of photons in an image-bearing field. Also, the spatial resolution can be limited not by the wavelength of light being used but by some fraction 1/N of this wavelength, where N is the number of photons in the quantum state that interrogates the object to be imaged. A quantum phase-imaging setup similar to the one used in our recent work is shown in Fig. 1. In our work, we were able to achieve a spatial resolution 1.7 times better than that of a classical imaging system with the same numerical aperture. Moreover, the measured phase shift of the light transmitted through the sample was 2.0 times larger than that of a classical imaging system.

Other examples of quantum imaging methods will be described in this talk. Quantum imaging has been shown to be a versatile method for enhancing the performance of optical imaging systems. One can expect additional improvements in imaging performance to be developed in the coming years.

Reference

1. Black, A. N., L. D. Nguyen, B. Braverman, K. T. Crampton, J. E. Evans, and R. W. Boyd, "Quantum-enhanced phase imaging without coincidence counting," Optica Vol.10, 952-958, 2023.

Biography

Professor Boyd was born in Buffalo, NY. He received the BS degree in physics from the Massachusetts Institute of Technology and in 1977 received the PhD degree in physics from the University of California at Berkeley. His PhD thesis work was supervised by Professor Charles Townes and involves the use of nonlinear optical techniques for infrared detection. Professor Boyd joined the faculty of the Institute of Optics of the University of Rochester in 1977 and is presently Professor of Optics and Professor of Physics. In 2010, Professor Boyd was awarded a highly competitive Canada Excellence Research Chair at the University of Ottawa. He currently directs a major research center at the University of Ottawa while still maintaining a significant research presence at the University of Rochester. Professor Boyd's research areas include optical physics, nonlinear optical interactions, nonlinear optical properties of materials, and applications of nonlinear optics including quantum and nonlinear optical imaging. Professor Boyd is a fellow of the Optical Society of America and a fellow of the American Physical Society. He is author of Radiometry and the Detection of Optical Radiation (1983), Nonlinear Optics (1992), is co-editor of Optical Instabilities (1986) and Contemporary Nonlinear Optics (1992). Professor Boyd has published approximately 350 research papers, has been awarded nine US patents, and has supervised the PhD theses of 33 students. Robert Boyd's Ottawa website is http://www.boydnlo.ca. Research Interests:

Nonlinear Optics

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ROTATUM OF LIGHT

Federico Capasso
John A. Paulson School of Engineering and Applied Sciences
Harvard University, Cambridge, MA 02138
capasso@seas.harvard.edu

Vortices are ubiquitous in nature and can be observed in fluids, condensed matter, and even in the formation of galaxies. Light, too, can evolve like a vortex. Optical vortex beams are exploited in light-matter interaction, free space communications, and imaging. Recently we introduced optical rotatum, a behavior of light in which an optical vortex beam experiences a quadratic chirp in its orbital angular momentum along the optical path [1]. Such an adiabatic deformation of topology is associated with the accumulation of a Gouy phase factor, which, in turn, perturbs the propagation constant (spatial frequency) of the beam. The spatial structure of optical rotatum follows a logarithmic spiral—a signature that is commonly seen in the pattern formation of seashells and galaxies. Our work expands the previous literature on structured light, offers new modalities for light-matter interaction, communications, and sensing, and hints at analogous effects in condensed matter physics and Bose-Einstein condensates. A class of optical vortices with chirped orbital angular momentum is generated for use in light-matter interaction and sensing.

[1] A. H. Dorrah, A. Palmieri, L. Li and F.Capasso Sci. Adv. 11, eadr9092 (2025)

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

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HIGH-ACCURACY RANGING IN TURBID WATER USING STRUCTURED LIGHT

Alan Willner
Steven, Kathryn Sample Chair, Engineering
Distinguished Professor, ECE
Ming Hsieh Dept. of Electrical and Computer Engineering
University of Southern California, USA
Viterbi School of Engineering
(Joint Appointment w/ Dept. of Physics & Astronomy)
Website: https://ee.usc.edu/~willner

There is increased interest in using optical approaches for ranging applications in underwater environments. As compared to acoustic waves, optics can potentially provide higher ranging accuracy, albeit over <50 meters due to power loss. A typical optical ranging approach measures the time-of-flight (ToF) of a transmitted pulse that is reflected from a target object. However, underwater turbidity causes scattering that can result in temporal spreading of the optical pulse and degrade the ranging accuracy. One potential method to accurately retrieve the object's distance is to measure the transverse spatial power distribution of an optical beam reflected from an object.

This presentation will highlight accurate ranging in turbid water using a distance-dependent spatially structured optical beam. The spatial structure can have unique phase and amplitude distributions in both the transverse and longitudinal directions. In our approach, the beam consists of two Bessel-Gauss modes with: (i) different orbital angular momentum (OAM) orders that define the number of 2p phase changes in the azimuthal direction that leads to a "petal-like" intensity profile; and (ii) different longitudinal wavenumbers that result in angular rotation of the petals as the beam propagates. Such a beam is reflected from an object after propagating through turbid water, and the object's distance is retrieved by measuring the rotation angle of the petal profile. Additional discussion will include: (a) using multiple OAM orders to increase the petal signature, (b) combining coarse and fine ranging to achieve high accuracy with a large dynamic range, and (c) tailoring the longitudinal wavenumbers to mitigate scattering-induced petal power loss.

Biography

Prof. Alan Willner received the Ph.D. (1988) in Electrical Engineering from Columbia University, as well as a B.A. (1982) in Physics and an Honorary Degree (Honoris Causa, 2012) from Yeshiva University. Prof. Willner was a Postdoctoral Member of the Technical Staff at AT&T Bell Laboratories and a Member of Technical Staff at Bellcore. He is currently the Steven and Kathryn Sample Chaired Professor in Engineering and Distinguished Professor of Electrical & Computer Engineering in the Ming Hsieh Dept. of Electrical & Computer Engineering of the Viterbi School of Engineering at the Univ. of Southern California; he also has a joint appointment with the Dept. of Physics & Astronomy in the USC Dornsife College. Prof. Willner has been: a Visiting Professor at Columbia University, the Univ. College London, and the Weizmann Institute of Science; and a Visiting Scholar at Yeshiva University. He is a Member of the U.S. Army Science Board, was a Member of the Defense Sciences Research Council (a 16-member body that provided reports to the DARPA Director and Office Directors), has served on many scientific advisory boards for small companies, and has advised several venture capital firms. Additionally, Prof. Willner was Founder and CTO of Phaethon Communications, a company whose technology was acquired by Teraxion, that created the ClearSpectrum® dispersion compensator product line which is presently deployed in many commercial 40-Gbit/s systems worldwide. Prof. Willner has received the following honors/awards: Member of the U.S. National Academy of Engineering, International Fellow of the U.K. Royal Academy of Engineering, Presidential Faculty Fellows Award from the White House, Ellis Island Medal of Honor, IEEE Eric E. Sumner Award, John Simon Guggenheim Foundation Fellowship, David & Lucile Packard Foundation Fellowship in Science & Engineering, Thomas Egleston Medal for Distinguished Engineering Achievement from Columbia Eng. Alumni Association, U.S. Vannevar Bush Defense Security Science and Engineering Faculty Fellowship (formerly NSSEFF), Fellow of National Academy of Inventors, Institution of Engineering & Technology (IET) J.J. Thomson Medal, National Science Foundation National Young Investigator Award, Fulbright Foundation Senior Scholar Research and Lecturing Fellowship, Honorary Professor of Huazhong Univ. of Science & Technology, the Optical Society (OSA) Paul Forman Engineering Excellence Award, IEEE Photonics Society Engineering Achievement Award, SPIE President's Award, IEEE Photonics Society Distinguished Lecturer Award, IEEE Photonics Society Distinguished Service Award, USC Associates Award for University-Wide Creativity in Research (highest university research award), OSA Robert Hopkins Leadership Award, Civilian Service

Commendation Medal from the U.S. Dept. of the Army, USC Associates Award for University-Wide Excellence in Teaching (highest university teaching award), USC Phi Kappa Phi Faculty Recognition Award (for significant scholarly work), USC Senior Engineering Research Award, USC/TRW Best Engineering Teacher Award, USC/Northrop Outstanding Junior Engineering Faculty Research Award, 2001 Eddy Paper Award from Pennwell Publications for the Best Contributed Technical Article (across all 30 magazines in Pennwell's Advanced Technology Division), IEEE Globecom Best Paper Award, and Edwin Howard Armstrong Foundation Memorial Award for the highest-ranked EE Masters student at Columbia University. He is a Fellow of the AAAS, APS, IEEE, IET, OSA and SPIE, and he was a Fellow of the Semiconductor Research Corporation. Prof. Willner was an invited foreign dignitary representing the sciences for the 2009 Nobel Prize Ceremonies in Stockholm.

WHOLE BODY DISEASE ASSESSMENT WITH VASCULAR OPTICAL TOMOGRAPHIC IMAGING

Andreas h. Hielscher
Professor and Chair
Director, Clinical Biophotonics Laboratory (CBL), New York University, USA

Vascular Optical Tomographic Imaging (VOTI) is a non-invasive imaging technique that can be used to visualize blood flow, tissue oxygenation, and vascular function throughout the body. Near-infrared light is employed to illuminate the body part under investigation and transmitted and reflected light intensities are measured. So-called model-based iterative image reconstruction algorithms are then used to convert this information into 3-dimensional tomographic concentration maps of oxy-hemoglobin (HbO2), deoxy-hemoglobin (Hb), and total hemoglobin (THb). Furthermore, other physiologically important parameters such as oxygen saturation (StO2), water content, tissue scattering, etc. Over the last decade, considerable progress has been made toward clinically VOTI systems that assess brain function and diseases, cancer, vascular disease, and joint diseases. In addition to providing insights on hardware design and the latest AI-based real-time image reconstruction software, the presentation will focus on recent results obtained in clinical studies involving breast cancer, peripheral artery disease in diabetics, lupus arthritis, and stroke. Moreover, the most recent advance in making DOTI a wearable technology will be described. Novel flexible electronics allow the integration of related hardware into fabrics, which provides for a more user-friendly interface and in-home monitoring capabilities. (For more information have a look at https://wp.nyu.edu/tandonschoolofengineering-cbl/)

Biography

Professor Hielscher leads the recently established Department of Biomedical Engineering and directs research in his Clinical Biophotonics Laboratory (CBL). The mission of the CBL is to establish optical tomography as a viable biomedical imaging modality and transfer this technology into clinical practice. The goal is to develop a patient-centered approach that addresses all aspect of modern precision medicine in state-of-the art healthcare. To this end Prof. Hielscher's team is developing cutting- edge imaging hardware and software that provide 3-dimensional distributions of physiologically relevant parameters such as oxygen saturation or total hemoglobin concentrations and more. This includes the design of wearable devices that allow continuous patient monitoring. The CBL is currently applying this emerging technology in various clinical and preclinical studies that focus on the diagnosis and monitoring breast cancer, arthritis, peripheral artery disease (PAD), and diabetic foot syndrome (DFS). Furthermore, techniques are being developed for real-time monitoring of brain activities.

NONLOCAL POLARIZATION METROLOGY

Enrique J. Galvez, Chan Ju You, Valeria Rodriguez-Fajardo, Leia Francis, Bill Luo
Department of Physics and Astronomy, Colgate University, USA

We investigate using polarization-entangled photons in a new form of Mueller polarimetry. This involves replacing the classical method, involving two consecutive manipulations of the polarization of the light, with a quantum-correlated method where the two manipulations are done on separate photons. The latter removes the causal order that is the basis for the classical method. The method relies on the production of a polarization entangled state. We investigate the resiliency of the method for variations on the state of the light.

Biography

Enrique (Kiko) Galvez earned his PhD in physics at Notre DamKiko head shote in 1986. He has been a member of the faculty at Colgate University since 1988, and is currently the Charles A. Dana Professor of Physics and Astronomy. His research focuses on atomic and optical physics, and physics education, and he has been funded by numerous grants from the NSF and Research Corporation. His recent research projects include experimental atomic physics with Rydberg atoms, geometric phases in optics, and photon entanglement. His educational work includes modernizing the introductory curriculum and developing new teaching laboratories for quantum mechanics.

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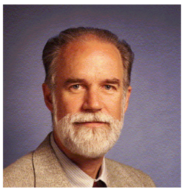
Louis F. DiMauro
Hagenlocker Chair/Professor of Physics
The Ohio State University
Director, Institute for Optical Science
Co-Director, NSF NeXUS Facility

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.



EXTREMELY NON-DEGENERATE NONLINEAR PHOTONICS

Eric w. Van stryland

Founding Dean, Pegasus Professor Emeritus, CREOL, The College of Optics & Photonics, USA

Extremely Non-Degenerate Nonlinear Photonics Eric Van Stryland, et. al., CREOL, The College of Optics and Photonics University of Central Florida, Orlando, FL Our invention of the Z-scan method for obtaining separate measurements of the nonlinear absorption, NLA, and nonlinear refraction, NLR, of materials, allowed the determination of the ultrafast bound-electronic response separate from other responses, e.g. free-carrier effects in semiconductors. It became clear that there must be a relation between these properties analogous to the usual linear dispersion theory of Kramers-Kronig. In fact, we found a simple way to linearize the nonlinear response using excite-probe measurements of the frequency nondegenerate responses. This led to a general theory describing these measurements. This, in turn, shows that by going to extreme nondegeneracy, i.e., involving 2 photons of very different wavelengths, the nonlinearities can be enhanced by orders of magnitude. A nice example of an application is for a linear IR detector using uncooled wide-gap semiconductors that can be turned on and off in femtoseconds by a gating pulse of a very different wavelength. We find that this detector can be more sensitive than a liquid-nitrogen-cooled HgCdTe detector; however, you need to know when to look! More recently we have developed a 2-beam characterization method (Nonlinear Beam Deflection) that also allows determination of the separated temporal dependencies of the nondegenerate NLA and NLR. These results open many avenues for other potential applications, e.g., THz sensing.

Biography

Eric received his physics PhD in 1976 working at the Optical Sciences Center, University of Arizona, and then joined the Center for Laser Studies at the University of Southern California, soon leaving to spend 9 years on the faculty of the University of North Texas. He joined the start of CREOL at the University of Central Florida in 1987, becoming its director in 1999, and its founding Dean in 2004, The College of Optics and Photonics. He is a Fellow of Optica, SPIE, IEEE and APS, 2006 President of Optica/OSA and 2012 R.W. Wood Prize recipient, and a past Board member of LIA. He graduated 42 Ph.D.'s, published >300 publications primarily in the field of nonlinear optics (e.g., Z-scan, nonlinear Kramers-Kronig, cascaded second-order nonlinearities). He is Emeritus Pegasus Professor at CR

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Paul Corkum
University of Ottawa, Canada

Developing ultra-rapid laser technology

Biography

Paul Corkum graduated from Lehigh University, USA, in 1972 with a Ph. D. in theoretical physics. In 1973 he joined the staff of the National Research Council of Canada where he built one of the world's most famous groups working on the interaction of very short light pulses with matter. Corkum is a Full Professor of Physics, a Distinguished Research Chair at the University of Ottawa and directs the Joint NRC/University of Ottawa Attosecond Science Laboratory. He is a member of the Royal Societies of London and of Canada and also a foreign member of the US National Academy of Science, the Austrian Academy of Science, and the Russian Academy of Sciences. Among his many honours and recognitions, he has received the 2017 Royal Medal, for his major contributions to laser physics and the development of the field of attosecond science, as well as the National Research Council of Canada's Schneider Medal, their highest distinction bestowed upon employees. In 2018, Corkum was awarded both the SPIE Gold Medal, and the Isaac Newton Medal and Prize from the UK Institute of Physics, and is a recipient of the 2019 Willis E. Lamb Award for Laser Science and Quantum Optics. Most recently, The Wolf Foundation selected Corkum as a 2022 Wolf Prize Laureate in Physics and in 2023 he is a co-recipient of the BBVA Foundation 15th Edition Frontiers of Knowledge Award in Basic Sciences.

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Zenghu Chang
Canada Excellence Research Chair Professor
Department of Physics, University of Ottawa, Canada

Biography

Zenghu Chang is a Canada Excellence Research Chair Professor in the Department of Physics at the University of Ottawa who is an author and coauthor of over 350 articles which carry the h-index of 65.[1] His team developed the world's shortest laser pulse in 2013 and was given $6.9 million from the Defense Advanced Research Projects Agency in the U.S. to strengthen the pulses for ultrafast sensors. He is partnering with researchers from other Universities on the project.[2] Since 2018 he is fellow of the National Academy of Inventors. Zenghu Chang is a Canada Excellence Research Chair Professor in the Department of Physics at the University of Ottawa who is an author and coauthor of over 350 articles which carry the h-index of 65.[1] His team developed the world's shortest laser pulse in 2013 and was given $6.9 million from the Defense Advanced Research Projects Agency in the U.S. to strengthen the pulses for ultrafast sensors. He is partnering with researchers from other Universities on the project.[2] Since 2018 he is fellow of the National Academy of Inventors.

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TOPOLOGICALLY STRUCTURED WAVES AND MANIPULATION OF PARTICLES

Konstantin Y. Bliokh
(DIPC, Spain)

I will present recent theoretical and experimental results on: (i) subwavelength high-intensity vortices around 'holes' or 'islands' in 2D wave systems: from polaritons to ocean waves, (ii) generation of the Bessel-type vortices, displacement-field skyrmions, and polarization Möbius strips in sound and water waves, and (iii) manipulation of floating particles using topologically structured water waves.

Biography

Konstantin Bliokh received the MSc and PhD degrees in physics from the Kharkov National University (Ukraine) in 1998 and 2001, respectively. After that, he worked as a research scientist at the Institute of Radio Astronomy (Ukraine, 2001–2009). He was a post-doctoral fellow at Bar-Ilan University (Israel, 2003–2005), a visiting research scientist at Technion–Israel Institute of Technology (Israel, 2007), a Linkage International research fellow at the Australian National University (Australia, 2008–2009), a Marie Curie research fellow at the National University of Ireland (Ireland, 2009–2011), an associate professor at the Australian National University (Australia, 2015–2019), and a senior research scientist at RIKEN (Japan, 2011–2024). Starting from 2024, he is an Ikerbasque Professor at the Donostia International Physics Center (Spain). His ongoing research areas include: complex wave systems, geometric phases, spin-orbit interactions, wave momentum and angular momentum, wave vortices, wave-matter interactions, etc. He has co-authored more than 130 scientific papers, reviews, and book chapters.

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KEYNOTE PRESENTATION

As data centers evolve into AI factories, interconnect requirements become ever more challenging. In this talk I provide a brief introduction to the current status and present a component level design for a Petabyte/second transmitter using a novel laser on silicon technology.

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.

Dr. Doug Dykaar
University of Rochester in 1987 in Gerard Mourou's Ultrafast Science group

METABOLIC NANOSCOPY FOR SPATIAL LANDSCAPE OF AGING AND METABOLISM

Lingyan Shi
Associate Professor of Bioengineering at UCSD, l2shi@ucsd.edu

Understanding metabolism in living organisms is essential for uncovering the mechanisms underlying numerous biological processes. Our research has developed a multimodal microscopy platform that integrates heavy water-probed stimulated Raman scattering (DO-SRS), multiphoton fluorescence (MPF), Fluorescence Lifetime Imaging Microscopy (FLIM), and second harmonic generation (SHG) into a unified nanoscopy system. By implementing the A-PoD and PRM algorithms, we have transformed this metabolic imaging platform into a super-resolution multiplex nanoscopy, achieving 59 nm resolution in volumetric imaging. Utilizing deuterated molecules—including glucose, amino acids, fatty acids, and water—as bioorthogonal metabolic probes, we exploit the enzymatic incorporation of deuterium to form carbon-deuterium (C-D) bonds in newly synthesized molecules. These newly formed molecules are detectable by DO-SRS within the spectral cell-silence region of the Raman spectrum, distinguishing them from older molecules. This approach offers unprecedented biological insights into the metabolic heterogeneity of cells and tissues under both physiological and pathological conditions.

In a collaborative study, we discovered that over-expressed tau proteins significantly disrupt lipid metabolism in the brains of aged or Alzheimer's patients, leading to an accumulation of lipid droplets in glial cells. This phenomenon could be rescued by activating AMPK, demonstrating the potential of this platform in disease-modifying interventions. Our metabolic nanoscopy imaging platform has broad applications, including disease detection, diagnosis, drug discovery, assessing drug efficacy and resistance, and providing a deeper mechanistic understanding of aging processes and disease development.

Biography

Lingyan Shi is a tenured Associate Professor in the Shu Chien Gene Lay Department of Bioengineering at UCSD. She joined UCSD in 2019 after completing her postdoctoral training in the Department of Chemistry at Columbia University. Dr. Shi's lab focuses on developing high-resolution metabolic nanoscopy to study aging processes and related diseases. She is the inventor of the "Golden Window" (1550nm to 1870nm) for deep tissue imaging and the "DO-SRS" metabolic imaging platform, which visualizes metabolic dynamics in cellular organelles and tissues. Dr. Shi's group has advanced stimulated Raman scattering (SRS) microscopy into super-resolution multiplex nanoscopy, revealing lipid metabolic changes in organ tissues during aging and disease. She holds 10 awarded patents and 14 pending, and has received numerous prestigious awards, including the Blavatnik Regional Award for Young Scientists (2018), Nature Light Science & Applications' Rising Star Award (2021), Sloan Research Fellowship in Chemistry (2023), BMES-Cellular Molecular Bioengineering Rising Star Award (2024), and the Emerging Leader in Molecular Spectroscopy Award (2025). Dr. Shi is a Senior Member of the National Academy of Inventors (NAI, 2025).

THE PAST, PRESENT, AND FUTURE OF QUANTUM CASCADE LASERS TECHNOLOGY (QCL-IR)

Brock Koren
DRS DAY LIGHT 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 and has a Bachelor of Science in Electrical Engineering from the California State University of Long Beach. Mr. Koren is currently the Director of Sales/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. Mr. Koren was most recently the Vice President of Sales and Marketing/ Product Management for Gamma Scientific, a manufacturer of light measurement instruments for display testing, LED testing, light meters, light sources, and spectrometers. He is a native Californian and has spent his entire life in Southern California. He currently resides in San Diego, where he enjoys physical and outdoor activities and restoring vintage Tektronix Oscilloscopes.

Peter j. Delfyett

University Trustee Chair,Pegasus Professor, Optics & Photonics, ECE & Physics,Director, Townes Laser Institute, University of Central Florida, USA

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. Awards & Honors International Society for Optics and Photonics (SPIE) Fellow American Physical Society (APS) Fellow IEEE Photonics Society Fellow Optical Society of America (OSA) Fellow 2019 Excellence in Graduate Teaching College Award 2014 Florida Academy of Science's 2014 Medalist 2013 National Academy of Inventors Fellow 2013 Letter of Appreciation – SPIE 2013 Faculty Excellence for Mentoring Doctoral Students 2013 College Research Incentive Award (RIA) 2012 Faculty Excellence in Mentoring Doctoral Students 2012 College Excellence in Graduate Teaching Award 2012 Excellence in Graduate Teaching Award 2011 Excellence in Graduate Teaching Award 2011 APS Edward Bouchet Award 2010 American Physical Society Edward Bouchet Award 2010 IEEE Photonic Society Graduate Student Fellowship 2010 SPIE Educational Scholarship in Optical Science and Engineering 2010 Incubic/Milton Chang Travel Award to attend CLEO 2006 Science Spectrum Trailblazer 2005 District Advocate for the American Physical Society 2005 Science Spectrum Outstanding Black Professional in Science 2003 Technology Innovation Award 2003 UCF Millionaire's Club 2002 Pegasus Professor Award 2002 UCF Distinguished Research Professor Award 2002 UCF Millionaire's Club 2001 UCF Nguzo Saba Award 2000 Research Incentive Award (RIA) Research Group

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IN VIVO MOTION-TOLERANT 3D VOLUMETRIC MULTIMODALITY MICROSCOPY IMAGING OF HUMAN SKIN WITH SUBCELLULAR RESOLUTION AND EXTENDED FIELD OF VIEW

Haishan Zeng
BC Cancer Research Institute, University of British Columbia
Vancouver, BC, Canada

Current state-of-the-art in vivo skin microscopy takes images in the en-face (horizontal, x-y) plane parallel to the skin surface with sub-micron cellular resolution, but a limited field of view (FOV) of sub-millimeter and is difficult to realize perfect 3-D volumetric reconstruction due to involuntary motion interference. In this work, we derived a novel skin microscopy method that takes images in the vertical (x-z) plane and extends the field of view by lateral skin translation along the y-direction. This new approach is conceived based on our observation that the skin's involuntary motions are mostly up and down along the vertical direction. In combination with a unique motion correction method, we realized perfect sub-centimeter wide extended FOV 3D volumetric image reconstruction. This resulted in a highly sought-after 3-D volumetric multimodality microscopy system for imaging human skin in vivo with subcellular resolution and also extended field of view. Using this system, we successfully realized noninvasive acquisition of histology-like diagnostic features from normal skin and melanoma three-dimensionally, thereby demonstrating the great potential of this novel 3D imaging method for in vivo skin biology study, clinical diagnosis, pre-treatment planning, and post-treatment monitoring among others.

Biography

Prof. Haishan Zeng is a distinguished scientist of the BC Cancer Research Institute and a professor of Dermatology, Pathology, and Physics of the University of British Columbia. Prof. Zeng's research focuses on biophotonics and its medical applications. His group has pioneered the multiphoton-absorption based laser therapy and is at leading position in endoscopy imaging and Raman spectroscopy for noninvasive early cancer detection. He has published over 190 refereed papers and holds 30 granted patents. Several medical devices derived from these patents including fluorescence endoscopy (ONCO-LIFE™) and rapid Raman spectroscopy (Aura™) have passed regulatory approvals and are in clinical uses. The Aura™ device was awarded the Prism Award in 2013 by the International Society for Optics and Photonics.

ADVANCED FIBER OPTIC SENSING SYSTEMS FOR AVIATION & AEROSPACE APPLICATIONS

Dr. Alex Kazemi
Chief Fiber Optic Architect, Associate Tech Fellow
Product Development, Advanced Concepts

This presentation is an outline of 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 close to speed of light at 69 Tbsp 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 important 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 current and aging aircrafts. 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.

Biography

Dr. Alex Kazemi a world recognized micro technologist, and materials scientist 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, United States first fiber optic delivery system for micro welding of laser chips, and leading-edge technologies.

He is Chief Fiber Optic Architect, Associate Technical Fellow, and worked 27 years for Boeing as well as 10 years for telecom, lasers, sensors and MEMS industries. 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 over 48 papers in International Journals and hundreds of presentations throughout of conferences and technical community's world-wide. He has been Chairman of SPIE International Conferences in Photonics Applications for Fiber Optic Sensors and Lasers for 8 years and for past four years has been Chairman, and Chief Editor of Excel Global International Conference on Lasers, Optics, Photonics. He received International Award for his pioneering work for the development of fiber optic sensors for space applications. In recent survey by "Research Gate" organization close to 2000 of his peers reviewed his published papers. He has bestowed hundreds of recognition, awards and patents.

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ELECTRIC AND MAGNETIC CHIRAL PAIRS NEAR SINGULARITIES OF STRUCTURED LIGHT

Andrei Afanasev

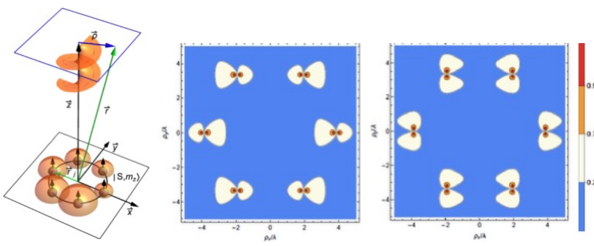
The George Washington University, Washington, DC 20052, USA

Spatial separation of electric and magnetic field singularities was pointed out by Berry [1]. Here we analyze polarization of vectorial structured light near phase singularities, where longitudinal fields may play an essential role. We use an example of an array of N radiation sources to study formation and propagation of polarization singularities in the wave front, as shown in the Fig.1.

Using the formalism developed in Ref. [2], we demonstrate both analytically and numerically that polarization singularities are displaced from phase singularities by a sub-wavelength distance and spatial separation of electric and magnetic singularities may become independent of propagation away from the near-field region.

While constellations of singularities expand during propagation, certain polarization features near phase singularities – that we define as anti-aligned chiral doublets - maintain constant transverse spatial dimensions under propagation independently of diffraction, the property noticed near dark interference fringes in Ref. [3]. Spin-induced optical forces may generate size-selective pulling effects on particles in the described geometries.

We further discuss novel angular momentum selection rules for photoabsorption by quantum systems that emerge from the properties of singular fields, with a particular focus on quantum sensing and quantum communications.



(a) (b) (c)

Fig. 1. Formation of polarization singularities from the phased arrays of electric-dipole radiation sources. (a) Array geometry of N sources; (b) Transverse-plane view of the degree of electric-field spin polarization for N=3, the field from individual sources is linearly polarized in the vertical direction; (c) Same as in (b) but for magnetic fields, note that alignment of singularities changed by 90 degrees.

References

[1] M. Berry, J. Opt. A: Pure Appl. Opt. 6, 475 (2004).

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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

SIGNAL NORMALIZAION IN POLARIZAION-SENSIIVE SYSTEMS

Boris Gramatikov
Wilmer Eye Institute
Johns Hopkins University, USA
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Signal amplitudes obtained from polarization-sensitive systems may depend on numerous factors, such as reflectivity and/or transparency of the object being measured, the optical medium between the object and the measuring system, as well as the presence of optical asymmetries, instrumental noise, device-to-device variability, choice of the exit pupil, use of controlled filters or attenuators, or even polarization compensators. In most all cases, some kind of normalization is needed, especially when signal or object classification is based on some kind of amplitude-related threshold. Ideally, a separate channel would be used to provide a normalization signal, preferably delivering unpolarized light which would be affected in the same way by the above mentioned factors. Unfortunately, such hardware-based approach is not always practical or even possible. As an alternative, pure software normalization is possible, if sufficient components of the polarized light are available. This presentation discusses both hardware and software polarization methods, based on examples from retinal birefringence scanning in polarization-sensitive ophthalmic instruments. After discussing the pros and cons of employing a normalization signal obtained by means of added optoelectronic hardware, the focus shifts over to a numerical normalization method based on merely the s- and p-polarization components, without additional optical or electronic hardware. This minimizes the adverse effects of optical asymmetries, pupil diameter, retinal reflectivity, subject-to-subject variations, the position of the eye in the exit pupil of the device, and even signal degradation by cataracts. Results are experimentally and numerically tested on human data, and demonstrate the signal standardization achieved by numerical normalization. This is expected to lead to substantial improvement in algorithms and decision-making software, especially in ophthalmic screening instruments for pediatric applications, without added hardware cost.

Biography

Boris Gramatikov is an Associate Professor at Johns Hopkins University, Department of Ophthalmology. He 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 Johns Hopkins 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, and 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 over 120 publications, 41 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 Continuing Education of the Baltimore Section of the IEEE.

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ASSESSING OAM TRANSPORT IN MULTIPOLE-MATCHED SCATTERING MEDIA: NUMERICAL SIMULATIONS AND EXPERIMENT

Alexander Doronin[1], Sandra Mamani[1], Robert R. Alfano[2,*]

[1]School of Engineering and Computer Science, Victoria University of Wellington, Wellington 6140, New Zealand

[2]Institute for Ultrafast Spectroscopy and Lasers, Departments of Physics and electrical Engineering, The City College of the City University of New York, 160 Convent Avenue, New York, NY 10031, USA

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Salient properties of light, such as polarization or Spin Angular Momentum (SAM), as well as Orbital Angular Momentum (OAM), play a crucial role in quantifying light propagation through turbid media, where unique scattering phenomena such as phase preservation, helicity flips, and polarization memory effects emerge. This paper focuses on the development of a novel Monte Carlo photon transport method that considers OAM transport in structured media with inherent topological properties. We discuss the developed expansion of the Monte Carlo method within the framework of customized phase scattering functions that accounts for multipole moments. Using in silico simulations, we quantify how structured light, exhibiting multiple poles of OAM, travels through both random and structured media. Our models are accelerated by recent advances in parallel programming on modern Apple M-series processors and execute in real time. To validate our simulation approach, we compare our results with previously conducted experiments on the transmission of Laguerre–Gaussian modes through brain tissue. Aligning the multipole moments of the material with those of the light results in significant optimization and enhancement of optical transmission processes.

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

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VISUALIZING THE INVISIBLE: SPECTROSCOPIC APPROACHES TO CELLULAR MOLECULAR PROFILING

Hyeon Jeong Lee

College of Biomedical Engineering & Instrument Science, Zhejiang University, Hangzhou, Zhejiang, China 310027

Accurate disease classification represents a critical challenge in clinical decision-making. Traditional histopathological evaluation often relies on morphological assessment, extensive labeling, and labor-intensive analysis. While molecular information enhances our understanding of cellular physiology, ensemble-averaged measurements from complex tissues can exhibit high variability, complicating disease classification. To address these challenges, spectroscopic imaging modalities, such as stimulated Raman scattering (SRS) and mid-infrared photothermal microscopy (MIP), have been developed to directly measure molecular concentrations and physical properties via chemical bond vibrations. By employing a pump-probe detection scheme, they achieve enhanced sensitivity and spatial resolution, enabling high-speed chemical imaging for disease diagnosis and classification. Our recent work has developed a novel multimodality spectroscopic imaging method termed in situ pump-probe IR and Raman excitation (INSPIRE) microscopy, that allows comprehensive chemical analysis in cells and tissues at submicron resolution. Furthermore, we developed a hyperspectral stimulated Raman scattering imaging and analysis method for in situ lipid profiling in single cells and tissues by identifying spectroscopic signatures of chain length and unsaturation levels. A linear relationship between chain length and SRS spectral profile was established, utilizing CH and C=CH segments for local chain length calculation. This enables the generation of a distribution map of lipid chain length and unsaturation levels for lipid profiling, demonstrating a new spectroscopic analysis method for lipid chain length and unsaturation level imaging with submicron resolution. Together these technological advancements decode the molecular machinery of living systems, providing unique insights into subcellular biomolecular dynamics and enhancing the identification of spatio-spectral signatures for disease classification.

Biography

Hyeon Jeong Lee is an assistant professor in the College of Biomedical Engineering and Instrument Science at Zhejiang University. She received her PhD in the Interdisciplinary Life Science program from Purdue University in 2017. After that, she worked as a postdoctoral researcher and a visiting scholar at Boston University Photonics Center. She joined Zhejiang University in 2019. Dr. Lee's research interests center on understanding the chemical dynamics of cells at the single-cell level. Her work focuses on single-cell functional imaging with vibrational spectroscopic signature, including studying cancer metabolism using multimodal non-linear optics, visualizing cholesterol trafficking using bio-orthogonal Raman tag, and vibrational imaging of neuronal membrane potentials. Dr. Lee was awarded the Innovator Under 35 Asia Pacific by MIT Technology Review, and selected as 2022 Optica Ambassadors.

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PHASE RETENTION IN CHAOS: THE ROLE OF TWISTED LIGHT IN BIOMEDICAL TECHNOLOGIES AND BEYOND

Igor Meglinski
College of Engineering and Physical Sciences, Aston University, Birmingham, UK
Correspondence: i.meglinski@aston.ac.uk

The remarkable ability of light beams carrying orbital angular momentum (OAM), or "twisted light," to maintain their helical phase structure through scattering media has unlocked exciting new possibilities in science and technology. This keynote lecture will focus on the unique phase retention properties of OAM light in chaotic environments, such as biological tissues, and its transformative applications in biomedical diagnostics and optical communication. We will explore recent advancements demonstrating how OAM light, despite traversing complex, turbid media, preserves its structured phase. This property is paving the way for cutting-edge, non-invasive diagnostic techniques, enabling early detection of neurological disorders and other medical conditions by analysing subtle changes in tissue properties. Moreover, OAM's resilience in optically dense environments holds promise for secure, high-bandwidth optical communication, even in media traditionally challenging for conventional light. By drawing on experimental results, theoretical models, and emerging technologies, this lecture will illustrate the potential of OAM light to transcend the limitations of traditional optical systems. Attendees will gain insights into how twisted light can revolutionize medical imaging, real-time diagnostics, and communications in diverse fields, from healthcare to telecommunication. This presentation aims to ignite new interdisciplinary research and applications that leverage the robustness and sensitivity of OAM light, offering innovative solutions for some of the most pressing challenges in science and engineering.

Biography

Igor Meglinski is Professor in Quantum Biophotonics and Biomedical Engineering and the Head of the Quantum Biophotonics Research Group at the College of Engineering & Physical Sciences, Aston University (UK). His research focuses on advancing the field of quantum biophotonics, particularly in the application of Orbital Angular Momentum (OAM) of light and quantum entagelemnts for tissue characterization and the exploration of intracellular communication. His significant contributions to the field have earned him recognition as one of the top 100 influencers in Life Sciences and Biomedical Engineering, as well as a place among the Top 100 in Photonics in 2024. He is a Chartered Physicist (CPhys), Chartered Engineer (CEng), and a Fellow of several prestigious societies, including the Institute of Physics, the Royal Microscopical Society, SPIE, and OPTICA (formerly the Optical Society of America).

ANALOGUE OPTICAL SIGNAL PROCESSING (AOSP) FOR ADVANCED ENERGY-EFFICIENT TERABIT SCALE OPTICAL TRANSCEIVERS USED IN SHORT-REACH APPLICATIONS

Ch. Christofidis, K. Moschopoulos, V. Tsourtis, S. Sygletos, M. Nazarathy, and I. Tomkos

The recently introduced "Linear Pluggable Optics" (LPO) paradigm promises significant improvements in the energy-efficiency of photonic interconnects serving applications ranging from datacenter interconnects to FTTH and 6G-fronthaul connectivity. This promise is expected to be realized by removing/replacing eventually some of the conventional power-hungry electronics-based Digital Signal Processing (DSP), high-order DACs/ADCs and the Serializer-Deserializer (SERDES) circuitry from the optical transceivers (TRx) connecting them to switch ASICs. The LPO-TRx based links will act like 'transparent pipes' linearly carrying the end-to-end analog signals between each pair of host switch ASICs. However, to warrantee appropriate signal transmission performance, innovative analog opto-electronic processing techniques should be adopted so that the mitigation of photonic transmission effects/impairments is taken on by those. In our novel proposed approach, called "Analogue Optical Signal Processing – AOSP", functionalities like dispersion compensation and polarization tracking/demultiplexing are implemented by means of analogue photonic and electronic integrated circuits (PICs/EICs), offering the required performance in targeted high-rate short-reach applications.

In this presentation, we will introduce our novel approaches (under investigation within the framework of European funded R&D projects FLEX-SCALE & PROTEUS), enabling the removal/replacement of high-order DACs and DSP functionalities from the TRx, while allowing us to double or even quadruple the data-rates to 800Gb/s and 1.6Tb/s per wavelength (for i) AOSP-enabled Dual-Polarization Intensity-Modulated/Direct-Detection, and ii) Field-Modulated I/Q Simplified-Coherent (aka LITE-COH) transceivers (TRxs) versions, respectively) compared with the current state-of-the-art 400Gbps TRxs. We will present the transmission performance of our innovative AOSP PIC concept, comprising All-Optical (AO) (aka Analog-Optical) Chromatic Dispersion Equalizer (AO-CDE), Differential-Group-Delay (AO-DGD) equalizer and Polarization-Demultiplexer (AO-PolDMUX), implemented based on Programmable Integrated Photonics (PIP) principles.

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PHASE-SHIFTED VOLUME BRAGG GRATINGS – DESIGN AND APPLICATIONS

Ivan Divliansky

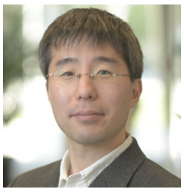
CREOL, The College of Optics and Photonics, USA

Phase-shifted Bragg gratings operate as a Fabry-Perot cavity to facilitate a narrow-band transmission line within the diffraction band of the grating. Such elements, when holographically encoded into a volume element, enable a set of technologies to become available in free-space regimes. Recent advances in PTR glass, a high-resolution medium used for the recording of volume Bragg gratings, have realized higher transmission efficiencies, allowing these elements to be used as a cost-effective laser-locking solution.

The talk will discuss the advantages of this type of gratings including uniform and chirped ones, and their applicability in laser systems.

Biography

Dr. Ivan Divliansky is a Research Assistant Professor in Optics and Photonics at CREOL- The College of Optics and Photonics at UCF with more than 20 years of experience. Dr. Divliansky has 33 peer review publications in journals such as Nature Photonics, Light: Science & Applications, Advanced Materials, Applied Physics Letters, Optics Letters, and others with over 1550 total citations and h-index of 16 (Google Scholar). He has edited one book and authored two book chapters, co-authored two patents, and is an Editorial Board member of the Journal of Lasers, Optics & Photonics. He is also frequent referee for Optics Express, Optics Letters, Applied Optics, and other peer review journals. Currently, his research topics include solid state and fiber lasers systems design, high-power laser beam combining, implementation of volume Bragg gratings in different photonics areas, and others. His research has also led to new applications and further development of various volume holographic elements.



COMPACT BAND-PASS RAMAN SPECTROSCOPY FOR NON-INVASIVE CONTINUOUS GLUCOSE MONITORING

Jeon Woong Kang
Research Scientist, MIT, USA

Developing a less invasive, more accurate, and lower cost technology to monitor blood glucose is critical given the increasing population of diabetics worldwide and the associated medical costs. While fingerstick is the gold standard approach for patients to regulate their own glucose level, the painful lancing process had deterred many people from sampling with sufficient frequency. Recently, minimally invasive continuous glucose monitoring (CGM) sensors from Dexcom, Medtronic and Abbott 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 and can be reasons for device discontinuation. High operating costs and short lifetime also limit the adoption of these devices.

Photonic solutions including Raman and NIR absorption have long been sought as a viable path towards entirely noninvasive continuous glucose monitoring with low-operating cost. However, most approaches have struggled to detect physiological levels or cannot be miniaturized for point-of-care diagnostics and broader use. Based on our previous success on direct observation of glucose signal from in-vivo skin, we introduce band-pass Raman spectroscopy, enabling non-invasive, physiological-level continuous glucose monitoring in a compact optical device. By employing off-axis 830 nm near-infrared illumination and an intra-spectrum reference, we filter out most elastically scattered photons and reveal the Raman signal of glucose through an amplified photodetector while correcting for background variations due to subject mobility and system noise.

Our band-pass Raman spectroscopy method eliminates the expensive bulky spectrometers and achieves system miniaturization while maintaining its sensitivity and specificity. This will enable portable Raman-based CGM devices. Our devices are currently undergoing human trials. We believe this innovation will change the current diabetes management by offering a non-invasive miniaturized CGM.

Biography

Dr. Jeon Woong Kang is a research scientist at Massachusetts Institute of Technology. He was trained as a physicist at Pohang University of Science and Technology (POSTECH). After PhD, He joined Wellman Center for Photomedicine in Massachusetts General Hospital as a research fellow. In 2009, he moved to MIT Laser Biomedical Research Center. With Drs. Michael Feld, Ramachandra Dasari and Peter So, he has taken care of biomedical spectroscopy activities in the center. His research topics include Raman-based CGM, spectroscopy-guided cancer biopsy, intra-operative cancer margin assessment, intra-needle optical sensor for medical needle guidance, label-free identification of cellular senescence and so on.

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Maxim Durach
Georgia Southern University, USA

Biography

Dr. Durach's research group is working in the field of theoretical and computational physics for applications in nanotechnology. His research interests are in the fields of optics, metamaterials, photonics and plasmonics, optoelectronics. Dr. Durach is known for solving the Mansuripur's paradox by assigning the difference between the Lorentz and Einstein-Laub forces to absorption of spin angular momentum of light. The corresponding torque on matter leads to plasmon drag pinning effect, which Dr. Durach predicted theoretically. The plasmon drag pinning effect is localization of optical forces on electrons in the metal in an angstrom-thick layer at the metal boundary, instead of the nanometric skin-depth layer as has been thought before. This localization of plasmon drag effect in the atomic layer at the metal surface causes the light-induced currents in the metal to be extremely sensitive to the atomic environment at the metal interface, which has been observed in the experimen ts at National Institute of Standards and Technology [Strait et al, PRL 123, 053903, (2019)]. The work on plasmon drag effect continues in collaboration with Dr. Noginova's experimental group and Norfolk State University.

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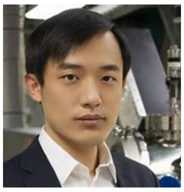

MAGIC-ANGLE EFFECTS AND OPTICAL VORTEX GENERATION ENABLED BY TWISTED BILAYER PHOTONIC CRYSTALS

Kaichen Dong
Tsinghua Shenzhen International Graduate School
Tsinghua University, Shenzhen 518055, China

Moiré superlattices formed in twisted bilayer van der Waals structures have been widely studied with exotic phenomena discovered, inspiring the investigations into their photonic counterparts, i.e., twisted bilayer photonic crystal (TBPC). The explorations into TBPC so far have justified the great opportunities in this unique system, including emerging moiré physics as well as unprecedented light engineering. In this talk, I will report the discovery of magic-angle effects in low-angle twisted bilayer honeycomb photonic crystals as a close analogy of twisted bilayer graphene [1]. A coupled-mode theory is formulated to discover the magic-angle photonic flat bands with a non-Anderson-type localization. A phase diagram is constructed to correlate the twist angle and separation dependencies to the photonic magic angles. Following this discovery, I will discuss the optical vortex generation enabled by TBPC [2]. We identify and theoretically formulate a non-trivial twist-enabled coupling mechanism in TBPC, which connects the bound state in the continuum (BIC) mode to the free space through the twist-enabled channel. The radiation from TBPC hosts an optical vortex in the far field with both odd and even topological orders. Moreover, the optical vortex generation is robust against geometric disturbance. As a result, TBPC not only provides a new approach to manipulating the angular momentum of photons, but may also enable novel applications in integrated optical information processing and optical tweezers.

Biography

Dr. Kaichen Dong is an assistant professor at Tsinghua Shenzhen International Graduate School, Tsinghua University. He received a B.E. and a Ph.D. degree from Tsinghua University. He did postdoctoral research at the University of California, Berkeley, and then began his faculty appointment at Tsinghua University. Dr. Dong has expertise in nano-photonics, micro-mechanics, and phase-change materials. His current research is focused on moiré photonics and physics, MEMS/MOEMS, temperature-adaptive radiative cooling, and AI-for-Science. His honor includes MIT Technology Review Top 35 Innovators Under 35 (global list), PIERS Young Scientist Award, MINE Young Scientist Award, etc.

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2. T. Zhang, K. Dong, J. Li, et al. "Twisted moiré photonic crystal enabled optical vortex generation through bound states in the continuum" Nature Communications, 14 (2023): 6014. (DOI: https://doi.org/10.1038/s41467-023-41068-1)and a senior research scientist at RIKEN (Japan, 2011–2024). Starting from 2024, he is an Ikerbasque Professor at the Donostia International Physics Center (Spain). His ongoing research areas include: complex wave systems, geometric phases, spin-orbit interactions, wave momentum and angular momentum, wave vortices, wave-matter interactions, etc. He has co-authored more than 130 scientific papers, reviews, and book chapters.

NOVEL ABLATIVE TM:YAP LASER FOR MEDICAL APPLICATION

Yoav Gronovich[1], Yaniv Raderman[1], Ronen Toledano[1], Rotem Nahear[2], Neria Suliman[2], Alon Shacham[2], David Friedman[2], Salman Noach[2, 3 #]

[1.] Plastic and Reconstructive Surgery Department, Shaare Zedek Medical Center, Faculty of Medicine, Hebrew University of Jerusalem, Jerusalem, Israel.
[2.] Laser Team Medical Ltd, Jerusalem, Israel.
[3.] Department of Applied Physics, Electro-Optics Engineering Faculty, Jerusalem College of Technology, Jerusalem, Israel.

In medical applications and especially in dermatology, lasers are classified as ablative or non-ablative based on tissue absorbance, determined by the laser wavelength and target properties [1-3]. Water's high absorption in the IR spectrum makes CO2 and Erbium lasers ablative, while 1.5-2 micron lasers are non-ablative.

We present for the first time an innovative approach using a 1.94 micron ablative Tm:YAP laser, strategically positioned at a water absorption peak. Utilizing high-energy nanosecond pulses [4], it achieves precise ablation with minimal thermal impact. Fractional ablation demonstrates clean deep and thin micro-cavities [5].

The ablative Tm:YAP laser shows great promise for precise dermatological and medical procedures, offering a new dimension in precision ablative technologies.

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Biography

Professor Salman Noach received his PHD in physics at 2003 from the Hebrew University Jerusalem ISRAEL. Since, he work at some startups companies and at 2007 he returned back to academy as a faculty member at the physics department at "Jerusalem College of Technology" there he founded the Solid State Lasers Laboratory. The lab is mainly engaged in applied research and development of CW and pulsed solid-state lasers, Nonlinear optics, Raman wavelength shifting and Optical amplifiers in the SWIR and mid IR range. The results of the lab research were the object of many publications in high-ranked journals in the optics and laser community and two patents. He is a senior member at OPTICA and member at SPIE.

CONTROLLING THE BRAIN AND HEART WITH LIGHT AND SOUND

Sukhdev Roy
Dayalbagh Educational Institute Agra 282 005, India

Optogenetics has made a strong impact in neuroscience by providing unprecedented spatiotemporal resolution in reading and writing neural codes with relatively lower invasiveness. In optogenetics, a genetically encoded light-sensitive protein is introduced into cells to make them sensitive to light. The expressed protein generates either inward or outward current in the presence of light, and can reversibly change the cell membrane voltage. Thus, the activity of these cells can be controlled and monitored with light. Optogenetics also enables all-optical control and recording of cellular activity in living tissue and opens up exciting prospects for optical neural prostheses. Recently, the first successful human trial of optogenetic retinal prostheses and promising results in cardiac optogenetics has been demonstrated.

A key challenge in optogenetics is to excite deeply situated neurons non-invasively with low power and negligible heating. Although two-photon optogenetic excitation with infra-red light has enabled the excitation of deeply situated neurons with sub-cellular specificity and millisecond temporal resolution, it also causes heating of the targeted tissue due to high intensity of light required for excitation. On the other hand, sonogenetics can non-invasively modulate the cellular activity of neurons expressed with mechano-sensitive proteins in the deeper areas of the brain but it lacks spatial selectivity. Recently, sono-opto-genetics has also emerged for deep brain stimulation. In this technique, focused transcranial-ultrasound (FUS) excites mechanoluminescent nanoparticles that have a strong emission for optogenetic neural stimulation.

The talk would discuss our recent exciting research results on efficient optogenetic and sono-optogenetic control of neurons and human ventricular cardiomyocytes and its application in synaptic plasticity, vision restoration and optical pacing of the human heart. The future prospects of optogenetics will also be discussed.

Biography

Professor Sukhdev Roy received the PhD. degree from IIT Delhi in 1993 and subsequently joined the Dayalbagh Educational Institute, India, where he is at present the Head of the Department of Physics and Computer Science. He has been a Visiting Professor at many universities that include, Harvard, Waterloo, Würzburg, Osaka, City University and Queen Mary University of London. He has won a number of awards and has published 180 research papers and 11 book chapters and holds 6 UK design patents on drone technology. He was the Guest Editor of the March 2011 Special Issue of IET Circuits, Devices and Systems Journal (UK) on Optical Computing. He is an Associate Editor of IEEE Access and a Fellow of SPIE, the Indian National Academy of Engineering, the National Academy of Sciences, India, IETE (India), and Distinguished Fellow of the Optical Society of India. He is also listed in the Stanford's Study of the Top 2% in World Ranking of Scientists in Optoelectronics and Photonics, 2023.

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CAN COMBINED NON-CONTACT DIFFUSE REFLECTANCE SPECTROSCOPY AND OPTICAL COHERENCE TOMOGRAPHY ASSESS THE MUSCLE-SPECIFIC COLOR INSTABILITY?

Daqing Piao[1] Scott Mattison[1], Ranjith Ramanathan[2]

[1]School of Electrical and Computer Engineering, Oklahoma State University, Stillwater, OK 74078

[2]Department of Animal and Food Sciences, Oklahoma State University, Stillwater, OK, 74078

Meat color is an important sensory attribute that influences purchasing decisions. Developing novel tools is necessary to better assess meat discoloration and minimize losses from wasting discolored beef. Previous studies reported that economically important psoas major (PM) and longissimus lumborum (LL) muscles have differences in color instability, a manifestation of the rate of metmyoglobin formation. This study investigated whether non-contact diffuse reflectance spectroscopy (DRS) and optical coherence tomography (OCT) could assess differences in metmyoglobin progression in paired PM and LL muscles in retail display. Non-contact DRS over 400-700nm configured in a unique center-illuminated-area-detection geometry, and OCT using swept source at 1260-1310 nm were conducted on eight USDA Choice steak sections with paired PM and LL muscles, over 10 days of retail display. Instrument color was measured using colorimeter, and the colorimetric spectral profiles were also used to deduce reference [Met]%. The colorimetric [Met]% of the PM increased from 22.8±10.1% on day-0 to peaking at 58.3±18.5% on day-5. And the colorimetric [Met]% of the paired LL increased from 20.7±13.2% on day-0 to peaking at 61.6±15.8% on day-8. The noncontact DRS resolved the following changes of [Met]% congruent with the colorimetric referenced trends. The [Met]% of the PM increased from 6.6±21.1% on day-0 to peaking at 48.1±28.0% on day-5. And the [Met]% of the paired LL increased from 6.9±25.1% on day-0 to peaking at 48.2±25.6% on day-7. The difference in the progression of [Met]% between paired PM and LL was however not significant ($p=0.7087$). In comparison, non-contact OCT resolved substantial differences in the depth of penetration (2.1-2.3mm versus 1.2-1.5mm, $p<0.0001$) and the rate of signal decay (3.8-4.6dB/mm versus 5.7-7.7 dB/mm, $p<0.0001$) between paired PM and LL muscles. The slower signal decay combined with greater penetration of OCT light in PM than LL could associate with more isotropic scattering of PM than LL, caused by smaller muscle fibers in PM than in LL. The backscattering acquired by OCT could be combined with DRS identification of myoglobin forms to better assess the color instability of meat.

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.

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MULTIMODAL PHOTOACOUSTIC, OCT, AND FLUORESCENCE IMAGING-GUIDED RETINAL STEM CELL THERAPY

Yannis M. Paulus,[1,2] Van Phuc Nguyen,[1] Wei Qian,[3] Abigail Fahim,[4] Xueding Wang[5]

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[2] Department of Biomedical Engineering, Johns Hopkins University, Baltimore, MD 21287 USA

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

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

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

Purpose | Stem cells offer promise to treat currently incurable diseases. A major challenge of stem cell therapy is to track the distribution of stem cells after transplantation. This study demonstrates a high resolution, multimodality 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 18 New Zealand white rabbits to damage RPE. On day 4 post laser, each eye received a subretinal injection of 30 µL(3.3×106 cells/ µL) human induced pluripotent stem cells differentiated to RPE (hiPSC-RPE) cells labeled with chain-like gold nanoparticle (CGNP) clusters conjugated with nuclear localization signal-containing peptides and indocyanine green. The location of hiPSC-RPE cells were followed up to 6 months after transplantation by color fundus photography, PAM, OCT, and FM.

Results | TEM and confocal images demonstrated that CGNP clusters penetrated the nucleus of hiPSC-RPE cells without affecting the cell's morphology, pigmentation, or function. PAM images at 578 nm and 650 nm visualized the microvasculature and transplanted cells, respectively. PAM demonstrated that the cells rapidly localized to laser burns and remained visible at the burn sites throughout 6 months. FM demonstrated significant reduction in 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.

Conclusion | This research presents an innovative technology for longitudinal imaging of transplanted cells within living animals through PAM, OCT, and FM imaging. Labeled cells can be tracked for at least 6 months within the subretinal space. This imaging platform holds promise as a valuable tool for investigating cell-based therapies.

Biography

Yannis M. Paulus, M.D., F.A.C.S, is an academic vitreoretinal surgeon and clinician scientist that loves applying optics, lasers, biomedical engineering, and nanoparticles to develop novel eye therapies. He is the Dr. Jonas Friedenwald Professor and an Associate Professor, Department of Ophthalmology and Department of Biomedical Engineering 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 laser therapies. He has published over 160 peer reviewed publications and started-up 3 companies.

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PROBING LIFE WITH PHOTONS: HOW OPTICAL IMAGING UNCOVERS CELLULAR MACHINERIES OF BIOLOGICAL SYSTEMS

Pu-Ting Dong, Ph.D.
NIH/NIDCR K99 Postdoctoral Fellow
The ADA Forsyth Institute
https://scholar.google.com/citations?user=aTUxriIAAAAJ&hl=en

Optical imaging techniques, such as label-free chemical imaging and fluorescence in-situ hybridization (FISH), have emerged as indispensable tools for unraveling the complexity of biological systems. Label-free chemical imaging enables non-invasive, high-resolution visualization of molecular composition, providing insights into cellular structures and dynamic processes without the need for exogenous markers. Complementing this, fluorescence in-situ hybridization facilitates the precise localization of specific nucleic acid sequences within cells, allowing for the targeted examination of genomic elements and microbial identification. My research will delve into the synergistic application of both label-free chemical imaging and next-generation multiplex FISH imaging, to offer a comprehensive perspective on the functional analyses of biological systems. The integration of these techniques will not only advance our understanding of cellular dynamics but also holds promise for diagnostic and therapeutic innovations in diverse biological research and clinical contexts.

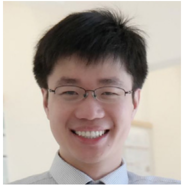
Biography

Dr. Pu-Ting Dong is currently an NIH/NIDCR K99 postdoctoral fellow under the mentorship of Dr. Gary Borisy at the ADA Forsyth Institute. Pu-Ting received her PhD in Chemistry at Dr. Ji-Xin Cheng's lab from Boston University in 2020. So far, she has 14 first or co-first author papers and co-authored 14 more. Pu-Ting is the exclusive recipient (1/300) of the 2018 SPIE Photonics West Translational Research Award, as well as the recipient of 2024 SPIE QPC Lasers Young Investigator Best Paper Award, the Susan Kinder Haake Travel Award (2024 IADR Microbiology/Immunology session), and the Ned Lally Award (2nd place, Mini-Symposium for Young Investigators, 2024 IADR). Pu-Ting was also selected as a 2024 Rising Star in Engineering in Health.

Jamal H. Ali
The City University of New York, USA

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.



FROM LIGHT TO SOUND: BREAKING LIMITS IN PHOTOACOUSTIC IMAGING, CAVITATION MAPPING, AND ULTRASOUND PRINTING

Junjie Yao
Duke University, USA

Photoacoustic imaging (PAI) is rapidly emerging as a transformative modality for multi-scale anatomical, functional, and molecular imaging, leveraging acoustic detection of optical absorption contrasts in biological tissues. By exploiting the superior penetration depth of ultrasound compared to light, PAI decouples light delivery from ultrasound detection, effectively surpassing conventional depth limitations and enabling deep-tissue visualization at clinically relevant depths. Recent advancements integrating innovative engineering solutions and artificial intelligence have accelerated microscopic PAI by a factor of 1000, significantly expanding the field of view and enabling real-time monitoring of dynamic or motion-sensitive biological processes, such as brain activity, placental development, and transparency mechanisms in glassfrogs.

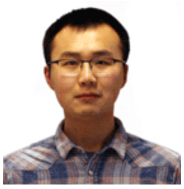
Utilizing genetically-encoded photoswitchable molecular probes, we have further harnessed ultrasound's deeper penetration capability, achieving an over 1000-fold enhancement in detection sensitivity. This breakthrough enables reliable visualization of complex biological phenomena, including cancer metastasis, tissue regeneration, and neuronal activity deep within the brain.

Moreover, we have extended the advantages of ultrasound into clinical settings through super-resolution passive cavitation mapping integrated with laser lithotripsy for kidney stone treatment. Ultrasound's deep penetration facilitates real-time, high-resolution guidance during procedures, significantly enhancing treatment efficiency, safety, and patient outcomes.

Lastly, our recent innovation, deep-penetration ultrasound printing technology, directly addresses the penetration limitations of traditional light-based bioprinting methods. Leveraging ultrasound's ability to penetrate deeply into tissues, this technology enables precise, through-tissue fabrication of intricate three-dimensional structures within deep-seated organs, marking a significant advancement in regenerative medicine and biofabrication.

Biography

Awards: Early Career Development (CAREER) Award. National Science Foundation (NSF). 2022 2019 Young Investigator Award. IEEE Photonics Society . 2019 Collaborative Sciences Award. American Heart Association . 2018 OSA/Quantel Bright Idea Competition (Finalist). Optical Society of America. 2017 Seno Medical Best Paper Award. SPIE conference Photons Plus Ultrasound 2016: Imaging and Sensing. 2016 Seno Medical Best Paper Award. SPIE conference Photons Plus Ultrasound 2015: Imaging and Sensing . 2015 Seno Medical Best Paper Award. SPIE conference Photons Plus Ultrasound 2013: Imaging and Sensing . 2013 Chinese Government Award for Outstanding Self-financed Students Aboard. The Education Ministry of China. 2012 Best Master Dissertation Award. Tsinghua University. 2008 Comprehensive Student Fellowship. Tsinghua University. 2008 KangShien Outstanding Graduate Fellowship. Tsinghua University. 2006 CyrusTang Fellowship (2002-2006). Tsinghua University. 2002 https://bme.duke.edu/faculty/junjie-yao



DEVELOPMENT OF A DEEP ULTRAVIOLET EXCITED FLUORESCENCE MICROSCOPE FOR RAPID ASSESSMENT OF LARGE TISSUE SPECIMEN

[1,]*Tongtong Lu, [1]Tianling Niu, [2]Julie M. Jorns, [3]Dong Hye Ye, [2]Mollie Patton, [4]Tina Yen, and [1]Bing Yu

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[2]Departments of Pathology & Laboratory Medicine, Medical College of Wisconsin, Wisconsin 53226, USA

[3]Departments of Computer Science, Georgia State University, Georgia 30303, USA

[2]Departments of Surgery, Medical College of Wisconsin, Wisconsin 53226, USA

*Currently with the Department of Engineering and Engineering Technology, University of Wisconsin Oshkosh, Wisconsin 54901, USA

Fluorescence imaging offers the capability to distinguish tumor cells from normal regions. However, the limited imaging speed commonly poses a challenge for various clinical applications, including intraoperative margin assessment. For instance, during breast-conserving surgery, the goal is to completely remove the tumor with a margin of normal tissue surrounding it. A positive margin status, defined as the presence of cancer cells on the surface of the excised tissue, is a predictor of higher rates of local recurrence. Re-excision is considered a measure of low-value care and therefore is desired to be avoided.

We previously investigated the feasibility of Microscopy with Ultraviolet Surface Excitation (MUSE) for breast margin assessment using ex vivo human breast specimens. Our results demonstrated excellent contrast in color, tissue texture, cell density, and cell shape between invasive carcinomas and normal tissue. However, the imaging speed of 1.0 min/cm2, while promising, is yet fast enough for clinical use.

Here, we report the development of a novel deep ultraviolet excited fluorescence microscope for rapid imaging speed of large tissue areas. The system includes two imaging channels, enabling simultaneous scanning of both the top and bottom surfaces of the tissue. Each imaging channel includes a ring of deep ultraviolet epi-illumination LEDs, a high numerical aperture 4x objective, and a color CCD camera. We achieved raster scanning of the top and bottom surfaces of a 2.5 x 2.5 cm2 tissue in 207 seconds, corresponding to a speed of 16.6 seconds/cm2 which is significantly faster than our first-generation system.

The system is ideally suitable for high-speed, large-area tissue imaging applications, such as intraoperative margin assessment.

Biography

Tongtong Lu is an Assistant Professor at the University of Wisconsin Oshkosh. Previously, he was a Postdoctoral Research Fellow at the Joint Biomedical Engineering Department of Marquette University and Medical College of Wisconsin. He received his bachelor's degree in information engineering from Zhejiang University in 2016 and his Ph.D. in Biomedical Engineering from Marquette University in 2022.

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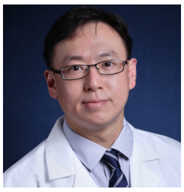

GUAN (GARY) XU
University of Michigan, USA

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.

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1. IUSL; The Institute for Ultrafast Spectroscopy and Lasers

https://www.ccny.cuny.edu/iusl

The Institute for Ultrafast Spectroscopy and Lasers (IUSL) of the City University of New York (CUNY) is a world-renowned multidisciplinary research laboratory devoted to promoting research and education in ultrafast optical science, photonic and laser technologies for scientific, engineering, medical, and industrial applications.

Established in 1982 by Professor R. R. Alfano, the IUSL has grown to encompass ten laboratories located in the Marshak Science Building of The City College of New York. Research , associated faculty , students, post doctors and support staff now total about 40 . Among the major technical accomplishments are inventions of chromium-based tunable lasers of forsterite, cunyite, and emerald lasers; fluorescence , Resonance Raman and excitation biopsy ,Golden optical window in tissues at 1560 nm to 1800nm and supercontinuum techniques for medical diagnostics and optical biomedical linear and nonlinear imaging techniques . The IUSL researchers over the past 5 years (2015 to 2019)have garner 241 publications , 17 patents, $11M in grant funding ,and $1.35M IDC . The IUSL have published over 800 papers and have thus far been awarded more than 140 U.S. patents. The IUSL receives research grants from various federal and state agencies and industrial concerns. The research funding garnered by the IUSL has been over $2 M per year for the past 5 years and 19 Ph.Ds. were awarded. To date, over 74 Ph.D students, including 8 female and 5 from underrepresented minority groups, have received their Ph.D. degrees conducting research at the IUSL laboratories.

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https://www.hamamatsu.com

Optical Information Processing and Measurement | Health Care and Medicine | Biophotonics | Photonic materials | Energy

Highlights : Devices & Units, Optical Sensors, Optical, Components Cameras Light & radiation, Sources, Lasers Systems Manufacturing, Support, Systems Semiconductor Manufacturing support Systems Photometry Systems Life Science, Medical systems

4. Edmund Optics

https://www.edmundoptics.com

Optics Manufacturer & Supplier | Imaging Lens Optics Manufacturer & Supplier | Imaging Lens & Laser Optics Manufacturer | Edmund Optics

5. Shu Chien-Gene Lay Department of Bioengineering, University of California, San Diego(LOPS 2024)(LOPS 2025)

https://bioengineering.ucsd.edu/about

Shu Chien-Gene Lay Department of Bioengineering, University of California, San Diego

Bioengineering@UCSD is an interdisciplinary major in which the principles and tools of traditional engineering fields, such as mechanical, materials, electrical, and chemical engineering, are applied to biomedical and biological problems. Engineering plays an increasingly important role in medicine in projects that range from basic research in physiology to advances in biotechnology and the improvement of health-care delivery. By its very nature, bioengineering is broad and requires a foundation in the engineering sciences as well as in physiology and other biological sciences.

6. AIAE (Association of Italian American Educators)

https://www.aiae.net

The AIAE was organized by a group of Italian American teachers and professors to enhance the Italian American image and presence in academia.

The AIAE promotes discussion of educational issues impacting Italian Americans; supports formal and pertinent education; facilitates professional development for teachers; sponsors the Programma Ponte Scholarship Program (a course of study in Rome on Contemporary Italy, designed for Italian American college and high school students); and recognizes, and presents awards to, outstanding Italian American educators and leaders of the community for their achievements in their professions.

7. XSoptix, LLC

https://www.xsoptix.com/

XSoptix is a North American Distributor focused largely on Fiberoptics and Electro-optical components and equipment. Our partners have solutions for today's emerging markets and applications such as: sensing, quantum computing and biotech. Our partners include: G&H, Toptica/eagleyard, Luna, RIO, Cristal Laser, OtO, exail, Coherent and Yokogawa. www.xsoptix.com

8. tec5usa

https://www.tec5usa.com

- OEM Components
- Optical Benches & Spectrometer Modules
- Sensor Electronics, Drivers and Software
- CCD, PDA, CMOS and InGaAs Sensors
- Diffraction Gratings
- Electronics Multiplexers and Optical Fiber Switchers
- OEM Light Sources
- Fiber Optic Cable Assemblies
- Probes & Other Optical Process Interfaces
- Technology Platforms
- Software
- Turnkey Solutions
- CID1 Online Raman Analyzer
- CID2 Online Raman Analyzer
- NIR (Near Infrared) Spectrometer and Analyzer
- UV-Vis Spectrophotometer (Spectrometer)
- HazLoc and OrdLoc Compact NIR Analyzer
- NIR Distance Measurement Head
- Contact Measurement Head
- Ultrasonic Levitator

9. MDPI Photonics

https://www.mdpi.com/journal/photonics

Photonics is an international, scientific, peer-reviewed, open access journal on the science and technology of optics and photonics, published monthly online by MDPI.

- Open Access— free for readers, with article processing charges (APC) paid by authors or their institutions.
- High Visibility: indexed within Scopus, SCIE (Web of Science), Inspec, CAPlus / SciFinder, and other databases.
- Journal Rank: JCR - Q2 (Optics)
- Rapid Publication: manuscripts are peer-reviewed and a first decision is provided to authors approximately 14.8 days after submission; acceptance to publication is undertaken in 2.6 days (median values for papers published in this journal in the first half of 2024).
- Recognition of Reviewers: reviewers who provide timely, thorough peer-review reports receive vouchers entitling them to a discount on the APC of their next publication in any MDPI journal, in appreciation of the work done.

10. Nanoscribe GmbH & Co. KG

We provide the most advanced, high-precision 3D printers and grayscale lithography systems with application-specific solutions.
As the leading innovator and market leader in additive manufacturing, we provide application-specific solutions at the nano-, micro-, meso- and macro-scale. Our patented technology empowers cutting-edge science and drives industrial innovations in various sectors, including microoptics, micromechanics, biomedical engineering, and photonics technologies.

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