LOPS Annual Conferences®

JUNE 02-04
(5th Virtual), 2023

LOPS 2023

3rd Edition of Annual Conference

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

Exhibitor

DRS DAYLIGHT SOLUTIONS

Supporters

Division of Science – The City College of New York

AIAE – Association of Italian American Educators

TomoWave Laboratories, Inc.

DRS DAYLIGHT SOLUTIONS

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

https://lopsconference.com/speakers.php

3rd Edition of Annual Conference

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

JUNE 02-05, 2023

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

PLENARY PRESENTATIONS

STRUCTURED LIGHT FOR HIGH-CAPACITY COMMUNICATIONS

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)

Structured vortex optical beams (and even single photons) can carry a discrete value of orbital-angular-momentum (OAM). A beam can carry OAM if its spatial phasefront "twists" in a helical fashion as it propagates, and the amount of OAM corresponds to the number of 2*pi phase shifts in the azimuthal direction. Multiple OAM beams each with a different OAM value are spatially orthogonal, such that they can be multiplexed, co-propagate, and be demultiplexed with little inherent crosstalk. Therefore, the multiplexing of independent data-carrying OAM beams has the potential to increase data capacity. This presentation will highlight OAM multiplexed links, challenges and mitigation techniques due to turbulence-induced modal coupling, OAM in different frequency regimes, and OAM-encoded quantum links.

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.

Prof. Willner's professional activities:

Co-Chair, U.S. National Academies Committee on the Optics and Photonics Study,President, The Optical Society (OSA) | President, The IEEE Photonics Society (formerly LEOS),Co-Chair, Science & Engineering Council of the OSA,Vice-President, Technical Affairs of the IEEE Photonics Society, Photonics Division, Chair, OSA,Chair, IEEE TAB Ethics and Member Conduct Committee, General & Program,Co-Chair, the Conference on Lasers and Electro-Optics (CLEO), Program Co-Chair of the OSA Annual Meeting, General Chair of the IEEE LEOS Annual Meeting, Program Chair of Telecommunications Engineering at SPIE's Photonics West,Chair of the Unclassified Technical Program for IEEE MILCOM, Elected Member of the Board of Governors for the IEEE Photonics Society,General Co-Chair of the IEEE Photonics Society Topical Meeting on Broadband Networks, Steering Committee and Technical Committee Member of the Conference on Optical Fiber Communications (OFC),,Member, US Advisory Committee for Int'l Commission for Optics (activity of the National Academies, IEEE, OSA and SPIE).

Editorial positions:

Editor-in-Chief, IEEE/OSA Journal of Light wave Technology (JLT),Editor-in-Chief, OSA Optics Letters,Editor-in-Chief, IEEE Journal of Selected Topics in Quantum Electronics, Associate Editor, IEEE Journal of Selected Areas in Communications Series on Optical Networks (now IEEE/OSA JOCN), Guest Editor, JLT, JSAC for the Joint Special Issue on Multiple-Wavelength Technologies & Networks,

Guest Editor, IEEE J. of Quantum Electronics Focus Issue on High-Capacity Optical Transmission Systems.

Prof. Willner has >1500 publications, including one book, 10 edited books, ~44 U.S. patents, ~47 keynotes/plenaries, ~24 book chapters, >400 refereed journal papers, and >300 invited papers/presentations. His research is in optical technologies, including: communications, signal processing, networks, and subsystems.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

FLAT OPTICS: ARBITRARY WAVEFRONT CONTROL WITH PASSIVE AND ACTIVE METASURFACES

Federico Capasso
John A. Paulson School of Engineering and Applied Sciences
Robert L. Wallace Professor of Applied Physics, Vinton Hayes Senior Research Fellow in Electrical Engineering Harvard University School of Engineering & Applied Sciences, USA

Metaoptics offer fresh opportunities for structuring light as well as dark as well as for active control. I will discuss metasurfaces that enable light's spin and OAM to evolve, simultaneously, from one state to another along the propagation direction1,2, along with nonlocal supercell designs that demonstrate multiple independent optical functions at arbitrary large deflection angles with high efficiency.3 In one implementation the incident laser is simultaneously diffracted into Gaussian, helical and Bessel beams over a large angular range and in another one a compact wavelength-tunable external cavity laser with arbitrary beam control capabilities including hologram lasing was demonstrated. 3 2D phase and polarization singularities ("structured dark") have been realized, which open up new opportunities for the detection of point defects in transparent materials for failure mode detection.4

Transparent materials do not absorb light but have profound influence on the phase evolution of transmitted radiation. One consequence is chromatic dispersion causing ultrashort laser pulses to elongate in time while propagating. We experimentally demonstrated ultrathin nanostructured coatings that resolve this challenge: we tailored the dispersion of silicon nanopillar arrays such that they temporally reshape pulses upon transmission using slow light effects and act as ultrashort laser pulse compressors.5 The coatings induce anomalous group delay dispersion in the visible to near-infrared spectral region around 800 nm wavelength over an 80 nm bandwidth. We characterized the arrays' performance in the spectral domain via white light interferometry and directly demonstrate the temporal compression of femtosecond laser pulses. Applying these coatings to conventional optics renders them ultrashort pulse compatible and suitable for a wide range of applications.

Tailored nanostructures also provide at-will control over the properties of light using nonlinear optics, with applications in imaging and spectroscopy. Nanomaterials with x(2) nonlinearities achieve highest switching speeds. We have shown that a thin film of organic electro-optic molecules JRD1 in polymethylmethacrylate combined with nanograting provides excellent performance for free-space optics: broadband record-high nonlinearity (10-100 times higher than traditional materials at wavelengths 1100-1600 nm), a custom-tailored nonlinear tensor at the nanoscale, and engineered optical and electronic responses.6

We demonstrated a tuning of optical resonances by $\Delta\lambda$ = 11 nm at DC voltages and a modulation of the transmitted intensity up to 40%. We realize 2 × 2 single- and 1 × 5 multi-color spatial light modulators and showed their potential for imaging and remote sensing.6 We have also employed a metasurface from sub-wavelength Mie resonators that support quasi bound states in the continuum (BIC) as a key mechanism to demonstrate electro-optic modulation of free-space light with high efficiency at GHz speeds7 . Our geometry relies on hybrid silicon- organic 35 nanostructures that feature low loss (Q = 550 at λ=1594 nm) while being integrated with GHz compatible coplanar waveguides. We maximized the electro-optic response by using the high-performance electro-optic molecules of Ref. 6 and by nanoscale optimization of the optical modes. We demonstrated both DC tuning and high -speed modulation up to 5 GHz. 7

1. Ahmed H. Dorrah, Noah A. Rubin, Aun Zaidi, Michele Tamagnone & Federico Capasso Nature Photonics 15, 287 (2021)
2. Ahmed H Dorrah, Noah A Rubin, Michele Tamagnone, Aun Zaidi, & Federico Capasso Nature Communications, 12, 6249 (2021)

3. Christina Spägele, Michele Tamagnone, Dmitry Kazakov, Marcus Ossiander, Marco Piccardo, and Federico Capasso Nature Communications, 12, 3787 (2021).
4. Soon Wei Daniel Lim, Joon-Suh Park, Maryna L. Meretska, Ahmed H. Dorrah, & Federico Capasso Nature Communications, 12, 4190 (2021)
5. M. Ossiander, Y.-W. Huang, W. T. Chen, Z Wang, X Yin, YA Ibrahim, M Schultze, and F. Capasso Nature Communications, 12, 6518 (2021)
6. Ileana-Cristina Benea-Chelmus, M. L Meretska, D. L Elder, M. Tamagnone, L. R Dalton, and F. Capasso Nature Communications, 12, 5928 (2021)
7. Ileana-Cristina Benea-Chelmus, Sydney Mason, Maryna L Meretska, Delwin L Elder, Dmitry Kazakov, Amirhassan Shams-Ansari, Larry R Dalton, and Federico Capasso. Nature Communications, 13, 3170 (2022)

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.

2021 Frederic Ives Medal and Jarus W. Quinn Prize, Optical Society of America

2020 Honorary Award, IEEE Italy Section

2019 Matteucci Medal, Accademia Nazionale delle Scienze, detta dei XL

2019 Guglelmo Marconi Science Award, UNICO

2018 Fermi Prize of the Italian Physical Society

2017 Kenneth Button Prize, International Society of Infrared, Millimeter and Terahertz Waves and Institute of Physics (UK)

2016 Balzan Prize for Applied Photonics, Balzan Foundation

2015 Rumford Prize, American Academy of Arts and Science

2013 Gold Medal of SPIE | 2013 European Physical Society Quantum Electronics and Optics Award 2013 Humboldt Research Award

2011 Jan Czochralski Award of the European Materials Research Society

2011 Galileo Galilei Medal of the Italian Society for Optics and Photonics

2010 Julius Springer Prize in Applied Physics

2010 Berthold Leibinger Zukunft Prize (Future prize)

2005 King Faisal International Prize for Science

2005 Gold Medal of the President of Italy for meritorious achievement in science

2004 Edison Medal, Institute of Electrical and Electronic Engineers (IEEE)

2004 Arhur Schawlow Prize in Laser Science, American Physical Society

2004 Tommasoni & Chisesi Prize for Outstanding Achievements in Physics

2003 Goff Smith Prize and Lecture, University of Michigan

2002 Duddell Medal and Prize of the Institute of Physics (London, UK)

2001 Robert Wood Prize of the Optical Society of America

2000 Willis E. Lamb Medal for Laser Physics and Quantum Optics

2000 NASA Group Achievement Award

1998 IEEE/Laser & Electrooptics Society W. Streifer Award for Scientific Achievement

1998 Rank Prize in Optoelectronics (UK)

1998 Capitolium Prize of the Mayor of Rome, Italy

1997 Wetherill Medal of the Franklin Institute

1997 Bell Laboratories Fellow Award

1995 Materials Research Society Medal

1995 Moet Hennessy•Louis Vuitton “Leonardo da Vinci” Award of Excellence (France)

1995 Newcomb Cleveland Prize of the American Assosciation for the Advancement of Science (AAAS) for best paper published in Science

1995 Electronics Letters Prize of the Institute of Electrical Engineers (London, UK)

1994 Heinrich Welker Memorial Medal (Germany) and International CompoundSemiconductors Symposium Award

1993 The New York Academy of Sciences Award

1991 IEEE David Sarnoff Award in Electronics

1984 Bell Laboratories Distinguished Member of Technical Staff

Award

Memberships/Fellowships

2019 Fellow, National Academy of Inventors

2015 Member, Academia Europaea

2012 Foreign Member, Accademia dei Lincei

1995 Member, National Academy of Sciences

1996 Member, National Academy of Engineering

1998 Fellow, American Academy of Arts and Sciences

1999 Fellow, The Institute of Physics (UK)

1997 Honorary Member, of the Franklin Institute

1992 Fellow, American Association for the Advancement of Science

1991 Fellow, International Society for Optical Engineering (SPIE)

1989 Fellow, Optical Society of America

1987 Fellow, Institute of Electrical and Electronic Engineers

1986 Fellow, American Physical Society

Honorary Doctorates and Other Honors

2019 Honorary issue of Nanophotonics (Volume 7, Issue 6, Jun 2018) for Federico Capasso on "Metamaterials & Metasurfaces"

2011 Honorary Doctorate University Paris Diderot, France

2011 Honorary Doctorate of Technology, Lund University, Sweden

2011 Honorary Doctorate in Materials Science, University of Roma III, Italy

2003 Honorary Doctorate in Electrical Engineering, University of Bologna, Italy

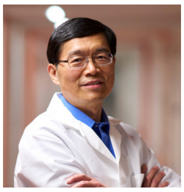
2004 Commendatore of the Italian Republic For information on Awards and Achievements follow:https://capasso.seas.harvard.edu/federico-capasso

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA



PHOTOACOUSTIC TOMOGRAPHY AND COMPRESSED ULTRAFAST PHOTOGRAPHY

Lihong V. Wang, Ph.D., Bren Professor

Andrew and Peggy Cherng Department of Medical Engineering, Department of Electrical Engineering, California Institute of Technology

We developed photoacoustic tomography (PAT) to peer deep into biological tissue. PAT provides in vivo omniscale functional, metabolic, molecular, and histologic imaging across the scales of organelles through organisms. We also developed compressed ultrafast photography (CUP) to record 70 trillion frames per second, orders of magnitude faster than commercially available camera technologies. CUP can record in real time the fastest phenomenon in nature, namely, light propagation, and can be slowed down for slower phenomena such as neural conduction.

PAT physically combines optical and ultrasonic waves. Conventional high-resolution optical imaging of scattering tissue is restricted to depths within the optical diffusion limit (~1 mm). PAT beats this limit and provides deep penetration at high ultrasonic resolution and high optical contrast by sensing molecules. Broad applications include early-cancer detection and brain imaging. The annual conference on PAT has become the largest in SPIE's 20,000-attendee Photonics West since 2010.

CUP can image with a single exposure transient events occurring on a time scale down to 10s of femtoseconds. Akin to traditional photography, CUP is receive-only—avoiding specialized active illumination required by other single-shot ultrafast imagers. CUP can be coupled with front optics ranging from microscopes to telescopes for widespread applications in both fundamental and applied sciences, ranging from biology to cosmophysics.

Biography

Lihong V. Wang, Ph.D.

Lihong Wang is Bren Professor of Medical and Electrical Engineering at Caltech. His book entitled "Biomedical Optics: Principles and Imaging" won the Goodman Book Writing Award. Published 560 journal articles (h-index = 149, citations = 94,000). Delivered 570 keynote/plenary/invited talks. Published the first functional/in vivo photoacoustic tomography, 3D photoacoustic microscopy, photoacoustic endoscopy, photoacoustic reporter gene imaging, and compressed ultrafast photography (world's fastest camera). Served as Editor-in-Chief of J. Biomed. Optics. Received NIH Director's Pioneer Award, NIH Director's Transformative Research Award, NIH/NCI Outstanding Investigator Award, OSA Mees Medal, IEEE Technical Achievement and Biomedical Engineering Awards, SPIE Chance Award, IPPA Senior Prize, OSA Feld Biophotonics Award, and an honorary doctorate from Lund Univ., Sweden. Fellow of AAAS, AIMBE, COS, IEEE, NAI, OSA, and SPIE. Inducted into the National Academy of Engineering.

UPDATE ON ULTRAFAST KERR ELECTROMAGNETIC MODEL FOR HHG AND SUPERCONTINUUM GENERATION FOR EUV AND X RAYS - IN VARIOUS STATES OF MATTER FOR INTENSE FS VISIBLE AND NIR PULSES FOR VARIOUS KERR RESPONSE TIMES

Robert Alfano
IUSL, Physics Dept City College of New York, USA
Discoverer, White-light supercontinuum laser, Initiator, Optical Biopsy, SPIE Gold Prize Awardee, 2019, Founding Director, The Institute for Ultrafast Spectroscopy & Lasers, The City College of New York, USA
Conference Chief, LOPS Annual Conferences

An universal electromagnetic theory is presented to explain the higher harmonic generation and supercontinuum generation based on Kerr index n = no + E(t) 2 response time arise from ultrafast electronic cloud distortion , molecular redistribution and plasma model using the carrier-envelope phase at the optical cycle response for gases, liquids, and solids. This theory and simulations explains the experimental Higher Harmonic Generation (HHG) and Supercontinuum (SC) Generation from the interaction of high-intensity ultrafast pulses. The theory reveals the salient experimental features observed from the HHG in the form of the three characteristic regimes for different states of matter. In this presentation , we uses 50 fs laser pulse at intensities of 1012 to 1015 W/cm2 to simulate and experimentally compare the salient features of HHG and supercontinuum about each harmonic from various materials such as gases , liquids and ,solids supporting the EM model. The outcome from the model is a supercontinuum background superimposed with the sharp HHG which was experimentally observed before in various forms of matter. HHG depends critically on different Kerr material response times τ from the ultrafast on the order of 100 attoseconds for electronic cloud distortion to fast ~ 1 to 10 femtoseconds from plasma and molecular redistribution and to the slower picoseconds rotational and vibrational molecular processes. HHG fand SC are ideal for Table Top microscope in EUV and X ray spectral regions for various applications in Physics, Chemistry, Biology, and Engineering.

Biography

In 2019, Robert Alfano received SPIE (Society of Photo-Optical Instrumentation Engineers) Gold Medal Award, the highest honor bestowed by the society. Robert Alfano is an Italian-American experimental physicist. He is a Distinguished Professor of Science and Engineering at the City College and Graduate School of New York of the City University of New York, where he is also the founding Director of the Institute for Ultrafast Spectroscopy and Lasers (1982). He is a pioneer in the fields of Biomedical Imaging and Spectroscopy, Ultrafast lasers and optics, tunable lasers, semiconductor materials and devices, optical materials, biophysics, nonlinear optics and photonics; he has also worked extensively in nanotechnology and coherent backscattering. His discovery of the white-light supercontinuum laser is at the root of optical coherence tomography, which is breaking barriers in ophthalmology, cardiology, and oral cancer detection (see "Better resolution with multibeam OCT," page 28) among other applications. He initiated the field known now as Optical Biopsy

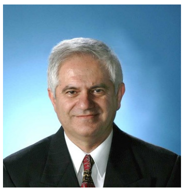
He recently calculated he has brought in $62 million worth of funding to CUNY during his career, averaging $1.7 million per year. He states that he has accomplished this feat by "hitting the pavement"; he developed a habit of aggressively reaching out to funding partners and getting them interested in his work. Alfano has made discoveries that have furthered biomedical optics, in addition to fields such as optical communications, solid-state physics, and metrology. Alfano has an outstanding track record for achievements regarding the development of biomedical instruments. His contributions to photonics are documented in more than 700 research articles, 102 patents, several edited volumes and conference proceedings, and well over 10,000 citations. He holds 45 patents and published over 230 articles in the biomedical optics area alone. His discovery of the white-light supercontinuum laser is at the root of optical coherence tomography, which is breaking barriers in ophthalmology, cardiology, and oral cancer detection (see “Better resolution with multibeam OCT,” page 28) among other applications. Alfano has trained and mentored over 52 PhD candidates and 50 post-doctoral students. For the past ten years, he has trained innumerable high school students in hands on photonics.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA



HIGH SPEED LASER BASED INTERSATELLITE LINK SYSTEMS FOR HARSH ENVIRONMENT OF SPACE

Alex Kazemi
CEO and President of ARK International LLC
Co-Chairman LOPS 2023 and Chairman LOPS 2021
Developer of the Lightest Fiber Optic Cable in Aviation History
Architect and Developer of World 1st Fiber Optic Sensor for Rocket Engine
Chairman SPIE International Conferences
(Photonics Applications for Fiber Optic Sensors & Lasers for 8 years)
Chairman LOPS2021, Co Chairman LOPS2023

This paper will focus on the trends for the space-based lasers, optics and terminals used in the intersatellite networks. Reviewed and evaluate the recent development in the space-based laser technologies and the critical parameters that are employed for successful high-speed inter-satellite communications systems.

Fiber optics and photonics technology including lasers increasingly being used in aerospace applications and many challenges are involved, since designing for aerospace is very different than for the earth environment. Satellites are much more challenging and for their intersatellite solutions have to contemplate more specific requirements such as space radiation attacks, operation in harsh environment of space and achieving weight, power requirements and reliability for space are few to consider. Therefore it is important to design a system to defend against the radiation from ionizing, gamma, and other attacks. There are numerous methods to protect them from radiation, including shielding, error correction, and using radiation resistance shielding and radiation hardening.

Building laser for high speed communications network for the harsh environment of space using optical links in space has proven to be complicated task and many such schemes were tried without success in the past. Space-based optical communications using satellites in low earth orbit (LEO) and Geo-synchronous orbits (GEO) hold great promise for the proposed Internet in the Sky network of the future. However in the last few years, there has been impressive progress made to bring the concept of laser-based intersatellite systems to fruition in civilian and government-non classified projects. Laser communications offer a viable alternative to established RF communications for inter-satellite links and other applications where high performance links are a necessity. High data rate, small antenna size, narrow beam divergence, and a narrow field of view are characteristics of laser-based systems and they are just few numbers of potential advantages for system design over radio frequency communication.

Keywords: Laser, Intersatellite, Laser Communications, Harsh Environment, Space

Biography

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

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

Martin Richardson

Director Laser Plasma Laboratory, Director, Center for Directed Energy, CDE. Founding Director, Townes Laser Institute, Pegasus Professor, Northrop Grumman Professor, Professor of Optics, Physics and Electrical & Computer Engineering, College of Optics and Photonics, University of Central Florida

Founding Director of the Townes Laser Institute, University Trustee Chair, UCF, USA

Biography

Martin Richardson graduated from Imperial College, London, in Physics (1964) and gained his Ph.D in Photon Physics from London University in 1967 as the first student to graduate in lasers under the advisement of the late Daniel Bradley. For his thesis he studied the spectral characteristics of laser modes, investigated non-linear optical processes in dense plasmas and developed a new high power dual frequency laser. Although lasers were then still considered 'a solution looking for a problem', after the award of the 1964 Nobel Prize to Townes, Prokhorov and Basov for inventing the concept of the laser, many new laser research teams were being created worldwide. Richardson joined one of the first laser groups investigating laser and plasmas in the Division of Gerhardt Herzberg at the National Research Council Laboratories in Ottawa. Mode-locking as a technique for creating ultrashort laser pulses had just been invented, and he was the first to create plasmas in gases by amplified single ultrashort laser pulses. He stayed at NRC until 1979, making contributions to the development of new lasers, including patents on the discharge-pumped CO2 laser that launched the Lumonics corporation, nonlinear optics, mid-IR laser selective dissociation of molecules, the precursor to laser isotope separation, and the development of ultra-fast optical diagnostics. His work on laser-produced plasmas lead to the creation of the first Canadian team focused on laser fusion. Collaborations with the Lebedev Institute resulted in the development of the picosecond streak camera. In 1974 Richardson spent five months in the Soviet Union in the laboratories of Alexandr Prokhorov at the Lebedev Institute. In 1980 he joined the University of Rochester where he worked for nine years as group leader for laser fusion experiments for the then new 24-beam OMEGA laser system at the Laboratory for Laser Energetics. He also held an adjunct faculty in the Institute of Optics. While at Rochester he was also involved in x-ray laser and laser-plasma x-ray spectroscopy investigations. In 1990 he and William Silfvast established the Laser Plasma Laboratory at CREOL, the Center of Research in Electro-Optics & Lasers at UCF, developing research programs in ultrafast laser development, laser-plasma studies, EUV/X-ray lithography and microscopy and laser materials processing. These research activities expanded to include femtosecond laser structuring of materials, laser spectroscopy and sensing and high-intensity laser filamentation studies in the atmosphere. In 2003 he was appointed the Northrop Grumman Professor of X-ray Photonics as part of major $24M donation to UCF. He was made a Trustee Chair of the University in 2006, and appointed as the first and founding director of the Townes Laser Institute in 2007. Professor Richardson has throughout his career taken an intense interest in the education of his students. In Canada he introduced schemes through which students from Canadian universities could study for their Ph.D's at NRC-Canada. He directs an NSF International REU program, and has initiated an Atlantis program for students to obtain a international MS degree between UCF and the universities of Bordeaux, Jena and Clemson. Some of his students gain co-tutelle Ph.D degrees with the University of Bordeaux. He is particularly interested in advancing science in under-developed countries, and in enabling equal rights for women through science. Professor Richardson has held visiting scientific positions at the Max Born Institute in Berlin, the Institute for Laser Engineering (ILE) Osaka University, the Max Planck Institute for Quantum Optics in Garching, and other institutions in Australia, Canada, France, Qatar and the former Soviet Union. He has published over 400 scientific articles in professional scientific journals, and has presented numerous invited and plenary talks. He holds ~ 20 patents, with several pending and has chaired many international conferences including IQEC, ICHSP, and several SPIE meetings. He is a former Associate Editor of JQE, a recipient of the Schardin Medal, and a Fellow of OSA.

NOVEL LENSLESS IMAGING USING DIGITAL HOLOGRAPHY, FEMTOSECOND LASER-BASED 3D PRINTED HOLOGRAMS, OPTOGENETICS, AND DEEP LEARNING FOR BIOMEDICINE

Juergen W Czarske
Founding Chair Holder of Measurement Systems
Director of Institute for Circuits and Systems
Director of center BIOLAS
(Biomedical Computational Laser Systems)
School of Electrical and Computer Engineering
Coopted Professor for Physics School of Science
TU Dresden, Dresden, Germany
2022 Chandra S Vikram Award of SPIE
2020 Laser Intrumentation Award of IEEE
2019 Joseph Fraunhofer Award/Robert M Burley Prize of OPTICA
2008 Berthold Leibinger Innovation Prize of Trumpf Laser

Light has the potential to recognize the origins of diseases, enabling to prevent them, or to cure them early and gently. The early diagnosis is the key to improve the survival rate and cure rate of patients.

Endoscopy plays an important role in the early stages of diagnosis by a guiding biopsy. However, conventionally it takes several hours to a few days for the surgeon to know the results of the diagnosis. Optical histopathology offers real-time intraoperative diagnosis without tissue removal. The well-trained resolution enhancement network helps improving tumor recognition rate. It is promising for minimally invasive intraoperative treatment of cancer in neurosurgery.

We demonstrate lensless imaging using deep neural networks, and wavefront shaping with femtosecond laser-based 3D printed holograms. Advanced manufacturing of organoid from human induced pluripotent stem cells represents a promising avenue to study retina, cardiomyocytes and neurons. Holographic optogenetics has elucidated the connectivity of neuronal networks. Laser-based rotation of organoids allows 3D quantitative phase imaging (QPI). Age-related macular degeneration (AMD) of retinal organoids results in distinct changes of the holographic transmission matrix, which is interesting as a biomarker. The Cambrian explosion of advanced smart laser endomicroscopy towards paradigm-shifts for biomedicine is discussed.

Biography

Juergen W Czarske (Fellow EOS, OPTICA, SPIE, IET, IOP, Senior Member IEEE) is director, full chair professor and senator of the Excellence University TU Dresden, Germany. He is director of Competence Center Biomedical Computational Laser Systems (BIOLAS) and advisor of SPIE-OPTICA-Student Chapter Dresden. Juergen is an international prize-winning inventor of laser-based technologies. His awards include the 2008 Berthold Leibinger Innovation Prize of Trumpf Laser, 2019 OPTICA Joseph-Fraunhofer-Award/Robert-M.-Burley-Prize, 2020 Laser Instrumentation Award of IEEE Photonics Society, 2020 and 2021 SPIE Community Champion for volunteer activities, and 2022 SPIE Chandra S Vikram Award. Juergen has conducted more than 800 talks and papers, including more than 250 papers in peer-reviewed journals, over 150 invited talks and over 30 patents. He is Vice President of International Commission for Optics, ICO, and was the general chair of the world congress ICO-25-OWLS-16-Dresden-Germany-2022 with 3 Nobel laureates and participants from over 55 countries.

List of Selected Awards:

- SPIE Chandra S Vikram Award in Optical Metrology, awarded in San Diego, CA, USA, 8/2022
- Fellow Award (FInstP) of Institute of Physics (IOP), London, UK, 7/2022
- Fellow Award of Institution of Engineering and Technology (IET), formerly IEE, London, UK, 7/2021
- SPIE Community Champion 2020, highlighted by SPIE Director Nelufar Mohajeri, WA, USA, 5/2021
- Inaugural Laser Instrumentation Award of IEEE Photonics Society, IEEE, New York City, USA, 7/2020
- SPIE Community Champion 2019 for outstanding volunteerism, awarded by SPIE President, Arizona/USA, 1/2020
- OPTICA Joseph Fraunhofer Award / Robert M. Burley Prize, awarded in

Washington DC, USA, 9/2019
- Best Paper Awards, 2nd and 3rd, Imaging and Applied Optics Congress of OSA, Orlando, FL, USA, 6/2018
- Best Paper Prize of the 118th Annual Conference of DGaO-German Branch of EOS, 6/2017
- Fellow Award, EOS (European Optical Society), Joensuu, Finland, awarded in Berlin, 8/2016
- Best Paper Prize of the 18th VDI / ITG Symposium Sensors and Measuring Systems, Nuremberg, 5/2016
- Fellow Award, SPIE - The International Society for Optics and Photonics, San Francisco, USA, 12/2015
- Fellow Award, OSA (The Optical Society), Washington, DC, awarded in San Jose, USA, 10/2015
- Award on Precision Measurement of Institute of Physics - IOP, London, UK, 6/2015
- Reinhart Koselleck-Project in systems engineering, German Research Foundation, Bonn, 7/2014
- Selected paper - Highlights of 2013, Journal of Physics D - Applied Physics, IOP, Bristol, UK, 1/2014
- Excellent paper, awarded at 33. Annual meeting of the Japan Laser Society, Tokyo, Japan, 5/2013
- Best Paper Award Instrumentation of American Soc. of Mech. Engineers, Vancouver/Canada, 6/2011
- Nomination Award for Kaiser-Friedrich-Research-Prize-2009 (final three), Goslar, 9/2009
- International Berthold Leibinger Innovation Prize, awarded at Trumpf Laser, Ditzingen, 9/2008
- Highly commended article of Measurement Science and Technology (MST), IOP, Bristol, UK, 12/2001
- Measurement Technique Prize of Association of University Professors (AHMT), awarded at TU Munich, 9/1996
- Young Researcher Prize, awarded by the education minister Peter Bendixen, Kiel Castle, Kiel, 4/1984

SOLAR AND LASER DRIVEN LIGHT SAILS FOR IN-SPACE PROPULSION

Grover Swartzlander
Chester F. Carlson Center for Imaging Science
Rochester Institute of Technology Rochester, NY

Google Scholar Profile: https://scholar.google.com/citations?user=uEV5WZoAAAAJ&hl=en

Researcher Interests:

Optical Vortices, Radiation Pressure, Solar Sailing, Laser Propulsion, Radiation Protection, Optical Vortex Coronagraph, Optical Lift, Holographic Optical Elements, Diffractive Light Sails, Optical Tweezers, Exoplanet Imaging, Solar Polar Orbiter, NASA Innovative Advanced Concepts NIaC, Satellite Attitude Control by Radiation Pressure, Optical Beam Rider and Imaging Science

We are entering an era when spacecraft are increasingly being designed to make fuller use of radiation pressure from sunlight and laser light. Solar sailing is a type of in-space propulsion that benefits from an inexhaustible energy source and a low launch mass. Owing to continuous acceleration, a sun-driven sailcraft can reach destinations are difficult or impossible to reach with existing rocket propulsion.
Nano- and micro-fabrication techniques may in principle afford the design of highly optimized light sails have low mass-to-area densities and high photon momentum transfer efficiencies. The key objective of our work is to directionally scatter light at a large angle at all wavelength across the solar spectrum. This talk will describe the optomechanics of solar sailing and efforts to create advanced and efficient light sails to mature the technical readiness of a solar polar orbit mission.

Biography

Grover Swartzlander is an associate professor at the Chester F. Carlson Center for Imaging Science at the Rochester Institute of Technology. He is a fellow of the Optical Society (OSA) and serves the society in various capacities, including as current editor-in-chief of the Journal of the Optical Society of America B. As a NASA NIAC Fellow, he has served on two teams (Steering of Solar Sails Using Optical Lift Force and Orbiting Rainbows). His research has been cited roughly 2,500 times in areas related to radiation pressure and torque, laser beam propagation phenomena, nonlinear optics, advanced optical coronagraphs and advanced imaging. He has been an educator for over 20 years, at locations including the Rochester Institute of Technology in Rochester, New York; the University of Arizona in Tucson; and the Worcester Polytechnic Institute in Worcester, Massachusetts. After earning a B.S. in physics at Drexel University, he pursued a M.S.E.E. at Purdue University, and from there moved with his advisor to complete his Ph.D. at the Johns Hopkins University. Before moving to academia, he spent a postdoctoral fellowship at the U.S. Naval Research Laboratory in Washington, D.C. In addition to the pleasures of theoretical and experimental research, he finds enjoyment in photography and reading the New York Times.

HEAD-TO-TOE REALTIME DEEP TISSUE OPTICAL TOMOGRAPHIC IMAGING

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

Deep tissue optical tomographic imaging (DOTI) seeks to obtain functional information about tissues to assist in the diagnosis, monitoring, and treatment of various diseases. 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, and more, can be obtained. Over the last decade, considerable progress has been made towards clinically viable DOTI systems that assess brain function, cancer (for example, breast, prostate, and skin), peripheral artery disease, diabetes and joint diseases. In addition to providing insights on hardware design and latest AI-based real-time image reconstruction software, the presentation will focus on recent results obtain in clinical studies involving breast cancer, peripheral artery disease in diabetics, and lupus arthritis. Moreover, 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 Andreas H. Hielscher received his PhD degree in Electrical and Computer Engineering from Rice University, Houston, Texas. After a postdoctoral fellowship at the Los Alamos National Laboratory in New Mexico, he moved to Columbia University in New York City, where he became the Director of the Biophotonics and Optical Radiology Laboratory. In 2020, he accepted an offer to head the newly formed Department of Biomedical Engineering at New York University. His work focuses on the development of state-of-the-art systems for clinical optical tomographic imaging that make use of the equation of radiative transfer. He applies this technology to diagnose and monitor arthritis, vascular diseases, breast cancer, brain activity, and more. He has published over 300 scientific articles, several book chapters, and holds over 20 patents. His work has been funded by various institutes at National Institutes of Health (NIAMS, NIBIB, and NCI), DARPA, and other funding agencies

BIO-MEDICAL METROLOGY WITH POLARIZATION-ENTANGLED PHOTONS

Enrique J. Kiko Galvez
Department of Physics and Astronomy, Colgate University, USA
Charles A. Dana Professor of Physics and Astronomy Chair,
Department of Physics and Astronomy Colgate University, USA
2020 Jonathan F. Reichert and Barbara Wolff-Reichert Award

Photon pairs produced by spontaneous parametric down conversion can be prepared in a state where they are entangled in their polarization. As such they exhibit non-local correlations that can be harnessed for a number of purposes, such as tissue diagnosis or imaging. In this work we use this entanglement to quantify the interaction of biomedical tissue with polarized light at the quantum level. I will present our recent work that shows that brain tissue with Alzheimer's disease can be distinguished from healthy tissue. We have also developed a non-local form of Mueller polarimetry. Biomedical studies can take advantage of these techniques since the photon light source has very low powers, at the femtowatt level, which can be used where light-induced damage or bleaching are a concern.

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.

OPTICAL BLOOD FLOW MEASUREMENTS IN DEEP TISSUES

Arjun Yodh
James M. Skinner Professor of Science
University of Pennsylvania, USA

Fluctuation and correlation optical spectroscopies enable measurements of blood flow in deep tissues (located centimeters below the surface). As a result, biomarkers of tissue blood flow, tissue oxygen metabolism, and tissue flow autoregulation have been demonstrated in the clinic. I will give examples of some of these achievements and will discuss the exciting future prospects for diffuse optics.

Biography

Arjun Yodh received his B.Sc. degree from Cornell, and his Ph.D. degree from Harvard in Atomic Physics under the guidance of Tom Mossberg. He carried out postdoctoral research at AT&T Bell Laboratories, working with Steven Chu and Harry Tom.

Yodh joined the Department of Physics and Astronomy at the University of Pennsylvania as an Assistant Professor in 1988. Today, he is the James M. Skinner Professor of Science at Penn. He has taken on various leadership roles during this time. Notably, he was Director of Penn's Laboratory for Research on the Structure of Matter (LRSM) and its NSF-funded Materials Science and Engineering Research Center (MRSEC) for 11 years from 2009-2020. Currently, he is the Chair of Penn's Department of Physics and Astronomy.

Yodh's research is multi-faceted. He is a pioneer in the field of biomedical optics. He was recently recognized by the Optical Society in 2021 with the Feld Prize in Biophotonics for his contributions to the development of the theoretical framework and clinical translation of diffuse optical spectroscopy and tomography technologies. He and his group were among the first to predict and experimentally demonstrate wave-like propagation properties of diffuse photon density waves, and to develop the image reconstruction algorithms needed to generate 3D tomographic images based on diffuse optical and diffuse correlation measurements. His more recent work includes demonstrating and clinically translating light diffusion concepts for noninvasive imaging and monitoring of tissue blood flow, hemodynamics, metabolic responses, and therapeutics in cancer and brain. Finally, Yodh is a dedicated mentor, advising and having advised more than 100 Ph.D. students and postdoctoral associates, and playing an influential role in several educational outreach programs that promote STEM activities at all levels.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

LASER AND NANOPLASMONICS: NOVEL APPROACHES FOR BIOSENSING, DIAGNOSTICS AND PHOTO-IMMUNOTHERAPY

Tuan Vo-Dinh
Fitzpatrick Institute for Photonics
Departments of Biomedical Engineering and Chemistry
Duke University
Durham, North Carolina, USA

This lecture provides an overview of recent developments in our laboratory for a nanoparticle-based technology based on interactions of laser radiation with metallic nanoparticles for use in biosensing, medical diagnostics and treatment of cancer. This process, called 'plasmonic enhancement', produces the surface-enhanced Raman scattering (SERS) effect that could enhance the Raman signal of molecules on these nanoparticles more than a million times. Our nanosensing platform is based on gold nanostars (GNS) having multiple long thin branches, which exhibit intense SERS emission. We have developed several biosensing technologies, including 'Inverse Molecular Sentinel' and 'Nanorattle' probes that can be used to detect microRNAs and mRNAs that are important cancer biotargets for various diseases, including cancers (e.g., breast, gastrointestinal, head & neck cancer) and infectious diseases (e.g., malaria, dengue). Our novel molecular sensing technology allow detection of multiple biotargets and represents a unique innovation that has the transformative potential in rapid diagnostics and screening of various diseases at the point of care, especially for global health applications.

Our nanoparticle-based technology has also been developed to address a critical clinical need for novel approaches for effective treatment of cancer, especially unresectable metastatic tumors. We have developed the GNS technology for use in SYnergistic iMmuno PHOtothermal NanotherapY (SYMPHONY), a novel therapy that integrates nanotechnology, biophotonics, and immunotherapy. The results of our research demonstrated that nanoparticle therapy and immunotherapy with PD-1/PD-L1 immune checkpoint blockade can be synergistically combined to produce an antitumor systemic response far superior to either single therapy alone. The data show that SYMPHONY triggers an extremely potent systemic response that cures both primary and distant lesions in a murine model and produce a 'vaccine' effect to prevent future cancer recurrences.

Biography

Dr. Vo-Dinh is R. Eugene and Susie E. Goodson Distinguished Professor of Biomedical Engineering, Professor of Chemistry, and Director of the Fitzpatrick Institute for Photonics at Duke University. After high school in Vietnam, he pursued studies in Europe, receiving a B.S. in physics at EPFL-Lausanne, Switzerland (1970) and a Ph.D. in physical chemistry at ETH- Zurich, Switzerland (1975). Before joining Duke University in 2006, he was Director of the Center for Advanced Biomedical Photonics and a Corporate Fellow, one of the highest honors for distinguished scientists at Oak Ridge National Laboratory (ORNL). His main research goal is focused on developing advanced technologies to protect the environment and human health. His research has centered on the development, integration and application of biophotonics, molecular spectroscopy, molecular biology and nanotechnology for biomedical diagnostics, photoimmunotherapy, precision medicine, and global health. Dr. Vo-Dinh has received seven R&D 100 Awards for Most Significant Advance in Research and Development; the Gold Medal Award, Society for Applied Spectroscopy (1988); the Languedoc-Roussillon Award (France) (1989); the Scientist of the Year Award, ORNL (1992); the Thomas Jefferson Award, Martin Marietta Corporation (1992); two Awards for Excellence in Technology Transfer, Federal Laboratory Consortium (1995, 1986); the Lockheed Martin Technology Commercialization Award (1998); the Distinguished Inventors Award, UT-Battelle (2003); the Distinguished Scientist of the Year Award, ORNL (2003); the Exceptional Services Award, U.S. Department of Energy (1997); the Award for Spectrochemical Analysis, American Chemical Society (2011); the Sir George Stokes Award, Royal Society of Chemistry, United Kingdom (2019); and the SPIE's President Award, SPIE The International Society for Optics and Photonics (2022). He has authored over 500 publications, is a Fellow of the U.S.

National Academy of Inventors and holds over 60 patents. President's Award. SPIE. 2022 Sir George Stokes Award. Royal Society of Chemistry. 2019 Elected Fellow. National Academy of Inventors. 2017 Award on Spectrochemical Analysis. American Chemical Society, Division of Analytical Chemistry. 2011 Fellows. American Institute for Medical and Biological Engineering. 2004 Director's Award for Outstanding Accomplishments in Science and Technology. UT-Battelle. 2003 Distinguished Inventors Award. Battelle Memorial Institute. 2003 Distinguished Scientist of the Year Award. Oak Ridge National Laboratory. 2003 Fellow. International Society for Optics and Photonics. 2000 RD-100 Award for Most Technologically Significant Advance in R&D (Multifunctional Biochip). R&D Magazine. 1999 Lockheed Martin Commercialization Award. Lockheed Martin Corporation. 1998 AMSE Award, American Museum of Science and Technology (BiOptics Technology). American Museum of Science and Technology. 1997 BER-50 Award for Exceptional Service for a Health Citizenry. US Department of Energy. 1997 Inventor of the Year Award. Tennessee Inventors Association. 1996 RD-100 Award for Most Technologically Significant Advance in R&D (SERS Gene Probe). R&D Magazine. 1996 Award for Excellence in Technology Transfer (SERODS Technology). Federal Laboratory Consortium. 1995 RD-100 Award for Most Technologically Significant Product of the Year (PCB Spot Test). R&D Magazine. 1994 Inventors International Hall of Fame Award. Inventors Clubs of America. 1992 RD-100 Award for Most Technologically Significant Product of the Year (SERODS Technology). R&D Magazine. 1992 Scientist of the Year. Oak Ridge National Laboratory. 1992 Thomas Jefferson Award. Martin Marietta Corporation. 1992 Languedoc-Rousillon Medal. University of Perpignan (France). 1989 Gold Medal Spectroscopy Award. Society for Applied Spectroscopy. 1988 RD-100 Award for Most Significant Technological Advance in R&D (Fluoroimmunosensor). R&D Magazine. 1987 Award for Excellence in Technology Transfer. Federal Laboratory Consortium. 1986 RD 100 Award for Most Significant Technological Advance in Research & Dev (PNA Dosimeter). R&D Magazine. 1981 COURSES TAUGHT BME 493: Projects in Biomedical Engineering (GE) BME 555: Advances in Photonics (GE, IM) BME 567: Biosensors (GE, IM, MC) BME 791: Graduate Independent Study CHEM 393: Research Independent Study CHEM 394: Research Independent Study CHEM 601: Biosensors CHEM 630: Advances in Photonics (GE, IM)

3rd Edition of Annual Conference

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

JUNE 02-05, 2023

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

KEYNOTE PRESENTATIONS

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

CHIP SCALE OPTICAL FREQUENCY COMBS FOR APPLICATIONS IN COMMUNICATIONS AND SIGNAL PROCESSING

[1]Delfyett, Peter J., Shirpurkar, C., Percherla, S. V., Trask, L.,

[1]delfyett@creol.ucf.edu, CREOL, The College of Optics & Photonics, College of ECE, Dept of Physics,
University of Central Florida, Orlando, Florida 32816, USA

Chip scale optical frequency comb sources are garnering significant attention, owing to their unique optical output characteristics comprised of a set of optically coherent, phase locked optical frequencies on a periodic frequency grid. Their compact size and excellent power consumption efficiency can positively impact a broad range of applications, ranging from metrology, imaging, communications, and signal processing. This talk will present our most recent work on using chip scale combs for both data communications and precision timing applications. For data communications, we use chip scale combs as a WDM source for short length data links. We also incorporate space-domain multiplexing techniques to increase the overall spectral efficiency, to realized data links > 1 Tb/s.

Our second application uses chip scale based optical frequency combs sources to transfer both timing and frequency stability from one chip scale source to another. Our results will show successful time-transfer and synchronization between 2 chip scale comb sources using a technique called multi-tone harmonic injection locking. In these experiments, we coherently link an optical frequency comb generated from a 300 GHz SiN micro-ring resonator with to a 10 GHz chip scale mode-locked semiconductor diode laser. The resulting regenerated 10 GHz signal is detected and it’s fractional frequency stability is measured and shown to be better than 10 mHz.

These results suggest that chip scale comb sources may be useful for ultrawide band communications and signal processing, and as sources in low SWAP precision timing and navigation applications, as well.

Biography

Peter Delfyett is currently University Distinguished Professor, University Trustee Chair Professor and Pegasus Professor at the University of Central Florida, CREOL, The College of Optics & Photonics. He received his PhD from The City University of New York in 1988 and was a MTS at Bellcore. from 1998 to 1993. In 1993, he joined CREOL as an Associate Professor, and now also serves as Director of the Townes Laser Institute. He is a Fellow of the APS, AAAS, IEEE, NAI, NSBP, Optica, and SPIE. He is also the recipient of the NSF PECASE Award, the APS Edward Bouchet Award, the IEEE Photonics Society’s William Streifer Scientific Achievement Award, and the APS Arthur L Schawlow Prize in Laser Science. Most recently, he was elected to the National Academy of Engineering (NAE). He has over 800 scientific publications, conference proceedings and invited presentations, and 45 US patents.

RAMAN SPECTROSCOPY: AN INDISPENSABLE TOOL FOR RESEARCH AND ROUTINE MATERIAL ANALYSIS

Heinz W. Siesler
EAS NIR Award: 1994
Tomas Hirschfeld PITTCON NIR Award 2000, Buechi NIR Award: 2003
Department of Physical Chemistry, University Duisburg-Essen
Schuetzenbahn 70, D 45117 Essen, Germany
Conference Chairman, LOPS 2022, 2023

Raman spectroscopy is – in combination with light-fiber optics, novel in-line and on-line probes, imaging accessories, and chemometric evaluation procedures – one of the most powerful and efficient analytical methods for material research, analysis and process control /1-3/. Comparable to mid-infrared and near-infrared spectroscopy it provides information on the chemical (constitution, configuration) and physical (conformation, state of order and orientation) structural details of the investigated materials. However, due to the different instrumental procedure and excitation mechanism, it provides some distinct experimental advantages (for example easier sample preparation/presentation and higher lateral resolution in imaging applications to name but a few) which will be addressed in more detail in the presentation.

Furthermore, the significant progress in miniaturization over the last decade and the intro-duction of novel, handheld Raman spectrometers /4,5/ has launched Raman spectroscopy into a new era of on-site and in-the-field measurements primarily for routine analytical applications. This instrumental development and its advantages of decreased time-to-result measurements will be demonstrated using selected examples of material identification and authentication.

1. N. J. Everall, J. M. Chalmers, P. R. Griffiths (eds.), Vibrational Spectroscopy of Polymers, John Wiley & Sons, Chichester, UK (2007).
2. H. W. Siesler, Vibrational Spectroscopy. In: Saleem Hashmi (ed.), Reference Module in Materials Science and Materials Engineering. Oxford: Elsevier; pp. 1-51 (2016).
3. R. Salzer, H. W. Siesler (eds.), Infrared and Raman Spectroscopic Imaging, Wiley-VCH, Weinheim, Germany (2014).
4. H. Yan, H. W. Siesler, Handheld Raman, mid-infrared and near infrared spectrometers: State-of-the-art instrumentation and useful applications. Spectroscopy 33 (11): 6–16 (2018).
5. D. Sorak, L. Herberholz, S. Iwascek, S. Altinpinar, F. Pfeifer, H. W. Siesler, New Develop-ments and Applications of Handheld Raman, Mid-Infrared, and Near-Infrared Spectrometers Applied Spectroscopy Reviews, 47(2), 83-115, (2012).

Biography

Heinz Wilhelm Siesler is a Professor of Physical Chemistry at the University of Duisburg-Essen, Germany, with expertise in vibrational spectroscopy in combination with chemometric data evaluation for chemical research, analysis and process control. He has 240+ publications (4 monographs) and presented more than 300 lectures worldwide. Since 2012 he is a Fellow of the Society for Applied Spectroscopy and received several awards (1994 EAS NIR Award, 2000 Tomas Hirschfeld PITTCON NIR Award, and 2003 Buechi NIR Award). Prior to his academic position he gained industrial experience as section head in molecular spectroscopy and thermal analysis in the R&D Department of Bayer AG, Germany. He also worked as lecturer (University of the Witwatersrand, Johannesburg, South Africa) and Post-Doc (University of Cologne, Germany), after receiving his PhD in Chemistry (University of Vienna, Austria). The test and application of miniaturized handheld vibrational spectrometers is a special research focus over the last ten years.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

COMBINING OPHTHALMIC DIAGNOSTIC MODALITIES BY MEANS OF AN OPEN-FRAME RBS SYSTEM

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

Retinal birefringence scanning (RBS) has recently been used to detect central fixation and proper eye alignment in ophthalmic diagnostics. It utilizes the property of the Henle fibers surrounding the human fovea to change the polarization state of light in a double-pass polarization-sensitive optical system. This principle has been successfully employed in a series of vision screeners developed in our lab so far. They allow eye tracking and detection of central fixation using anatomical information directly from the fovea and without calibration, unlike other eye tracking methods that employ mainly the less accurate pupillary light reflex methods. There also is a growing need to add a fast fixation-detection system like RBS to various diagnostic and some therapeutic ophthalmic technologies, such as optical coherence tomography (OCT), Doppler OCT, polarization-sensitive OCT, OCT angiography, fluorescein angiography, and others. However, combining RBS with ophthalmic imaging technologies is not trivial, in the first place because RBS employs polarized light and polarization-sensitive optics, while most ophthalmic imaging systems do not. This talk addresses a several possible design issues and describes an open-frame RBS system that allows for combining with other imaging modalities. Several design principles are also discussed.

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.

TISSUE DIAGNOSIS WITH THE STRUCTURED VORTEX LASER BEAM

Igor Meglinski[1,2]

[1]Optoelectronics and Measurement Techniques, University of Oulu, Oulu, Finland

[2]College of Engineering and Physical Sciences, Aston University, Birmingham, UK

Session Chair, LOPS Conferences

We explore the potential of structured vortex laser beams, known also as shaped light with orbital angular momentum (OAM), for diagnosis of cells and cells cultures, as well as for quantitative characterization of biological tissues. The structured vortex beams contains a spin contribution, conditioned by the polarization of the electromagnetic fields and an orbital contribution, related to their spatial structure. When the shaped light propagates in a homogeneous transparent medium, both spin and orbital angular momenta are conserved. In the medium with complex structure and anisotropic scattering the spin and orbital angular momenta are changed significantly that leads to spin-orbit interaction. Such a spin-orbit interaction leads to the mutual influence of the polarization and the trajectories of twisted photons propagating in the medium. We, first, present the results of spin angular momentum (SAM) of the shaped light in diagnostic application. We demonstrate a notable increase of the visibility contrast and penetration depth when imaging through the homogeneous scattering media with vector laser beam. We also present the results of our most recent studies – how the spin-orbit interaction leads to the mutual influence of the shaped light beam propagation within turbid tissue-like medium, and how sensitive the OAM to subtle alterations in biological tissues and cells

Biography

Igor Meglinski is Professor in Biophotonics and Biomedical Engineering at Aston University (UK) and University of Oulu (Finland). His research interests lie at the interface between physics, biomedical engineering, medicine and life sciences, focusing on the development of new non-invasive imaging/diagnostic techniques. His recent main contributions include a number of pioneering studies/results on propagation and localization of light in biological tissues, use circularly polarized light and since recently vortices and twisted light for optical biopsy/histopathology, and the study of light scattering in non-ergodic tissue-like scattering medium. He published over 350 papers in peer-reviewed scientific journals (185), proceedings of conferences (161), book chapters (17) and 4 books, and delivered over 750 presentations at the major international conferences, symposia and workshops, including 30 keynotes and 187 invited lectures, and 88 invited lectures/seminars at the world leading research centres and the universities for students and young researchers. He is the Node Leader in Biophotonics4Life Worldwide Consortium (BP4L), Senior Member of IEEE, Chartered Physicist (CPhys), Chartered Engineer (CEng), Fellow of Institute of Physics and Fellow of SPIE.

SRS MICROSCOPY AND ITS BIOMEDICAL APPLICATIONS

Lingyan Shi
Shu Chien-Gene Lay Department of Bioengineering, UC San Diego, La Jolla, CA USA
Discoverer, Heavy water labeling a relatively new imaging method, stimulated Raman scattering microscopy
Discoverer, Golden Optical Window, UCSD Bioengineering, USA

Stimulated Raman scattering microscopy (SRS) have revolutionized modern biomedical science and technology. It directly visualizes chemical bonds of biomolecules with specific Raman spectrum profiles. The video-rate imaging speed, molecular selectivity, and high spatial resolution are making an increasingly broad impact in biomedical applications. In this talk we will introduce the physical principle of Label free SRS and isotope-probed SRS for imaging metabolic activities in living organisms. Then we will discuss how it can be utilized in biomedical research areas such as aging and diseases, including (1) biorthogonal metabolic imaging with heavy water (DO-SRS platform) or deuterated glucose (STRIDE platform) for studying cancer metabolic heterogeneity, (2) A-POD enhanced SRS for visualizing lipid droplet metabolic dynamics in female and male brain during aging processes, and (3) PRM-SRS for multiple molecular detection for studying diabetic kidney diseases.

Biography

Dr. Lingyan Shi's pioneering work in developing and applying novel optical techniques has led to a number of significant breakthroughs in biophotonics with major implications for the fields of neuroscience and cancer research and is allowing us to visualize the mechanisms underlying everyday processes and disease. One of Dr. Shi's most significant discoveries has been the development of a new experimental technique that combines heavy water labeling and a relatively new imaging method, stimulated Raman scattering microscopy, to probe the metabolic activities of living tissues at subcellular resolution in situ. This discovery facilitates the visualization of tumor boundaries, embryonic development, and even aging in biological tissue. Another significant scientific contribution is her discovery of the "Golden Optical Window" – a unique band of infrared wavelengths that can penetrate deeper into biological tissues than other wavelengths of light during imaging, thereby dramatically increasing the imaging depth possible in brain tissue by as much as 50%. In addition, Dr. Shi has developed an early-detection spectral technique that could provide doctors with a tool for the early-stage detection of Alzheimer's disease.

PRECISE MONITORING OF HUMAN SKIN CELLULAR CHANGES IN VIVO AT THE SAME MICRO-LOCATION OVER A LONG PERIOD OF WEEKS USING MULTIPHOTON MICROSCOPY

Haishan Zeng
Photomedicine Institute, Department of Dermatology and Skin Science
and Imaging Unit, Integrative Oncology Department, BC Cancer Research Institute
University of British Columbia, Vancouver, BC, Canada

Background: Serial analysis of cellular dynamics over time offers insights into human skin responses to external agents such as solar radiation and cosmetic products. However, most previous studies are based on biopsy ex vivo analysis approaches that preclude monitoring of the same cells and sites over time. Optical in vivo microscopy enables the possibility of real-time live cell imaging. Here we report a robust non-invasive method to achieve repeated access to the same micro-location over a long period with unprecedented precision.

Methods: The technique is based on a non-invasive temporary "surface marker" as landmark applied at baseline to help locate the same cells or microstructures between imaging sessions. The tracking period is limited by landmark degradation, however, can be extended up to four weeks by applying a second ring-shaped "surface marker". Using this method, we precisely revisited the same cells in human skin over four weeks. Skin microscopic responses was studied with a multimodality in vivo microscopy system capable of co-registered video-rate reflectance confocal microscopy (RCM) imaging, two-photon fluorescence (TPF) imaging and second harmonic generation (SHG) imaging.

Results: Example application on non-invasive monitoring skin responses to UVB radiation will be presented. The quantitative analysis of TPF signal revealed that melanin distribution pattern changed with time after UVB exposure, suggesting that melanin migrates towards the skin surface. Blood flow was monitored in the same capillary. Multimodal analyses enabled accurate calculation of epidermis, stratum corneum thickness and cell density variations over time, demonstrating the time points of tissue edema and cell proliferation.

Biography

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

Edgar Mendoza
Redondo Optics Inc. United States
Session Chair, LOPS Conferences

Biography

Dr. Ed Mendoza leads the technology and business strategy vision for Redondo Optics, with over thirty years of experience as a senior executive, strategic business development, and technology innovation in fast-growth star-up companies focus on emerging markets in aviation & aerospace, smart structures, renewable energy, life sciences, oil & gas, and defense and security. Ed received his Ph.D. from the City University of New York. Currently works in fields ranging from fiber optics sensors, silicon photonics, smart wearable fabrics, optical metrology, remote sensing, Lab-on-Chip opto-fluidics, diffractive and refractive optics, and nanomaterials.

QUANTUM DOT SEMICONDUCTOR AMPLIFIERS AND THEIR APPLICATION TO HIGH-SPEED OPTICAL LOGIC SYSTEMS

Niloy K.Dutta
Department of Physics, University of Connecticut, Storrs, CT 06268

Semiconductor optical amplifiers with quantum dot (QD) active region have fast gain and phase recovery times due to the presence of the wetting layer which acts as a reservoir of carriers. A rate equation model for gain and phase response has been developed which includes nonlinear dynamics including carrier heating, spectral hole-burning, carrier relaxation, and wetting layer.

All-optical Boolean logic functions AND, XOR and NOT using Mach-Zehnder interferometers with semiconductor optical amplifiers with quantum-dot (QD) active layers is studied at 80Gb/s. The results show that the QD excited state and wetting layer serve as reservoir of carriers, and, the ultra fast carrier relaxation from these layers, results in high speed Boolean logic operations. Logic operation can be carried out up to speed of 250 Gb/s. The performance of a pseudo-random bit stream generator (PRBS) will be presented. Optical encryption and decryption circuits have been studied.

Biography

Niloy Dutta is a professor of physics at the University of Connecticut, Storrs, CT. He was Director of Optoelectronic Device Research at AT&T Bell Laboratories, Murray Hill, NJ. He is a Life Fellow of the Institute of Electrical Engineers (IEEE), a Fellow of the Optical Society of America, a Fellow of the International Society of Optical Engineers (SPIE), and, a Member of the Connecticut Academy of Science and Engineering. He received the Photonics Society Distinguished Lecturer Award in 1995 and Bell Laboratories President's Award in 1997.

NEW FRONTIERS IN REPROGRAMMABLE METAPHOTONICS ENABLED BY PHASE-CHANGE MATERIALS

Sajjad Abdollahramezani, Hossein Taghinejad, Tianren Fan, Mahmoozreza Marzban, Mohammad R. Tavakol, Ashkan Zandi, and Ali Adibi
School of Electrical and Computer Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0250

With great advances in the field of metaphotonics (e.g., realization of metalens with a large range of properties), new horizons have been envisioned for using flat optics to address the challenges in a wide range of applications including imaging, displays, AR/VR, and quantum photonics. A major requirement for next-generation metaphotonic devices is reconfigurability with high spatial resolutions. Thanks to their large change in the optical properties upon transformation between different phases (e.g., amorphous and crystalline), phase-change materials are promising candidates to enable a unique opportunity to control amplitude, phase, and polarization of an optical wave with subwavelength resolution. This talk is dedicated to demonstration of a new platform for miniaturized programmable nanophotonics through integration of dielectric, semiconductor, and plasmonic materials with volatile and nonvolatile phase-change materials. This platform enables reconfigurable metaphotonic building blocks with subwavelength features. Two groups of reconfigurable devices based on integrated photonic structures and metasurfaces along with their unique features for state-of-the-art applications will be discussed. Design, fabrication, and application of this platform for state-of-the-art applications will be covered.

Biography

Ali Adibi is the director of Bio and Environmental Sensing Technologies (BEST) and a professor and Joseph M. Pettit chair in the School of Electrical and Computer Engineering, Georgia Institute of Technology. His research group has pioneered several structures in the field of integrated nanophotonics for information processing, sensing, and quantum photonic applications. He is the author of more than 230 journal papers and 550 conference papers. He is the editor-in-chief of the Journal of Nanophotonics, and the nanophotonic program track chair of the Photonics West meeting. He is the recipient of several awards including Presidential Early Career Award for Scientists and Engineers, Packard Fellowship, NSF CAREER Award, and the SPIE Technology Achievement Award. He is also a fellow of OSA, SPIE, and AAAS.

ELECTRON CREATION BY PHOTON ANNIHILATION, ACCORDING TO TWIN PHYSICS

Backerra, Anna,
Institute of Theoretical and Applied Micro Magnetism, Maastricht, The Netherlands

After an introduction of twin physics without going deep into the theoretical basics, the description of a plasma electron and its transformation into a photon will be shown. Using these results, the generation of laser light will be explained and the reason why it stays focused over a long distance.

Twin physics is a new physical model in which the basic features of quantum mechanics and relativity theory are combined to a manageable, complementary description, reaching from sub-atomic to astronomic phenomena. The most important characteristics are the consideration of space as a finite physical item, the use of an elementary unit of potential energy and the use of geometry to make the results more accessible. The developed formalism is based on the concept that determinate and indeterminate aspects of phenomena are mutually independent. They occur joined in nature such, that one of both dominates an observation and the other occurs as a small disturbance. The laws of Maxwell emerge from these basics but, different from the classical view, the obtained magnetic fields are in the physical reality restricted to finite spaces.

The resulting descriptions could be identified with elementary particles, the four forces of nature and many other well-known phenomena. In particular we found descriptions of four distinct types of electrons, having features being unknown in classical physics. The first is a free electron; the second is a ground electron being one of the first two in a molecule; the third is a chemical electron being the most regular one in molecules; the fourth is a plasma electron.

The description of a plasma electron changes into that of a photon by taking a mirrored time description. The photon consists of a four-dimensional magnetic vector, attached to a point of space existing asymmetrically in a spherical magnetic space. In the center of this magnetic space, a potential electron is located. As soon as a mass approaches this system close enough, the photon will be annihilated and the potential electron will appear as an actual electron. So, the absorption of the photon does not speed up an already existing electron, as is supposed in classical physics, but the photon transforms into a massless electron. Thus, as soon as a photon comes close enough to a proton, the proton will be transformed into an elementary solar cell.

Biography

Backerra has graduated in theoretical physics at the Eindhoven University of Technology in The Netherlands and worked for three years at Philips Research Laboratories. She continued independently, making a search for complementary physics. To develop a way of complementary thinking she studied composition at the Conservatory in Enschede and in Saint Petersburg (Russia). After that she constructed a complementary mathematical language and applied this on physics, obtaining twin physics. The surprisingly diverse results are published in 13 papers in Physical Essays, Applied Physics Research, Advances in Nanoscience and Nanotechnology, Int. J. of Nanotechnology & Nanomedicine and Nano Progress. They may be downloaded at www.itammagnetics.com. The most recent article is titled 'Electron creation by photon annihilation'. The results are combined in the book 'Twin physics, the complementary model of phenomena', Lambert Academic Publishing, www.morebooks.shop; soon it will appear in a revised and updated form.

LIFE CYCLE MONITORING OF COMPOSITE AIRCRAFT STRUCTURE WITH DISTRIBUTED FIBRE OPTIC SENSORS

[1]Valentin Buchinger, [2]Zahra Sharif Khodaei

Structural Integrity and Health Monitoring group, Department of Aeronautics, Imperial College London

Life cycle monitoring of aircraft structures has the potential to considerably improve the sustainability of composite components. With the recent developments in new manufacturing technologies such as out of autoclave composite manufacturing, there is a need to monitor and optimise the manufacturing parameters in order to have high quality manufactured parts. Each new material and new manufacturing methods require a substantial trial to result in parts that pass aircraft acceptance criteria. This qualification process along with any remaining manufacturing uncertainty produces considerable amount of scrap. However, if the manufacturing parameters could be monitored and optimised in real time, the sustainability of new materials and methods would be significantly improved.

Fibre optic sensors (FO) are an ideal candidate for monitoring manufacturing processes due to their ability to provide distributed sensing, light weight and electromagnetic immunity. Together with their relatively high flexibility, they can be integrated within the composite structures and provide valuable information during the manufacturing phase. Subsequently, the same sensors can be used for monitoring the integrity of the structure in service and identify the health state of the composite component.

This work proposes a novel solution of integrating distributed fibre optic sensors (FO) within a composite U-beam manufactured by resin infusion for process monitoring as well as structural health monitoring (SHM). The FO sensors provided insight into the vacuum conditions within the bag during the process monitoring phase, and successfully identified an interruption in the resin flow which affected the vacuum level within the resin infusion set up. After the part was cured, the same sensing system was used to monitor in-service loading of the structure (three-point bending test) followed by detecting artificially created damage induced on the beam to assess the SHM capabilities of the system. The presence of artificial damage led to local changes in the strain field which in turn could be detected using the FO. A non-linearity in the optical frequency shift was evident exactly in the location of the damage. The results demonstrate a great potential for FOS system to provide a full life-cycle monitoring of composite structures, from manufacturing to in service monitoring.

Biography

Zahra Sharif Khodaei is a Professor in Aerospace structural durability and health monitoring. She obtained her PhD from Czech Technical University in Prague in numerical modelling of functionally graded materials in 2008. Prior to her lectureship post in 2014, she was a research associate at Imperial College London, department of Aeronautics since 2009 where she conducted research in fatigue modelling and analysis of metallic and Fibre Metallic Laminates (FML) and more significantly in developments of technologies and methodologies for Structural Health Monitoring (SHM) of composite structures. Her work in SHM includes development of technologies and methodologies for process monitoring (composite manufacturing) as well as damage detection (diagnosis) and remaining useful life assessment (prognosis). The technological advances include both sensor development as well as design and manufacturing of miniaturised data acquisition units. She has developed various SHM technologies utilising fibre optic sensors, piezoelectric transducers and multi-functional sensors within several collaborative projects involving UK industries and academia, EU projects (SHERLOC CleanSky II) and more recently with the European Space Agency (ESA) for space application. She is a member of the steering committee of CleanSky II. She has numerous publications and book chapters, see google scholar for the complete list. She is a Fellow of Royal Aeronautical society and Women's Engineering Society and a Fellow of Women in engineering society.

RANGE RESOLVED INTERFEROMETRY: DYNAMIC MEASUREMENTS IN CHALLENGING ENVIRONMENTS

Stephen James
FInstP, Professor of Applied Optics
Centre for Engineering Photonics, UK

Range resolved interferometry (RRI) is a robust, cost-effective means for the measurement of optical path length changes at multiple locations along an optical beam path. RRI employs the sinusoidal injection current modulation of a cw laser diode, and the concomitant output wavelength modulation, to facilitate the interrogation of multiple interferometers using a single laser source and photo detector. The interferometers can be formed in free space, between partially reflective surfaces, or within optical fibres, between in-fibre reflectors, and FPGA-based signal processing allows measurements with high resolution at high bandwidths. Diverse applications of the approach, including the real time measurement of layer heights in wire + arc additive manufacturing, the measurement of dynamic pressure on a high-lift wing in a wind tunnel, and the measurement of strain and shape of a helicopter rotor blade during a full speed ground run will be presented.

Biography

Professor Stephen James leads the optical fibre sensors research theme within the Centre for Engineering Photonics at Cranfield University, UK. He undertook his PhD at the University of Southampton, studying optical phase conjugation in photorefractive materials, and joined Cranfield University in 1993 as a post-doctoral researcher to develop 3D laser velocimetry instrumentation. As his academic career at Cranfield progressed, he worked on a number of optical measurement techniques, including speckle interferometry and optical fibre sensors. His current work encompasses the development, design and application of optical fibre based sensors and instruments for sensing physical and chemical measurands, with a strong focus on their practical deployment. The instrumentation and sensors designed by the Centre have been field trialled in applications including flight testing on fixed wing aircraft and rotor craft, tramway component health monitoring, composite material production process monitoring, foundation pile characterization, and measurements of transient loading in superconducting magnets.

ADVANCES IN OPTICAL COHERENCE ELASTOGRAPHY

Zhongping Chen
Beckman Laser Institute, Department of Biomedical Engineering
University of California Irvine, Irvine, CA 92617

Optical coherence elastography (OCE) is one of the fastest growing areas of functional OCT technology with many potential clinical applications. Tissue mechanical properties can provide valuable information in the diagnosis of many ophthalmic diseases such as keratoconus, myopia, presbyopia, age related macular degeneration, and glaucoma. There is a close correlation between tissue elasticity and pathology. We have demonstrated the first in vivo OCE imaging of retina and lens in an animal model. Recently, we extended the OCE applications to image posterior ocular layers such as retina and optical nerve head. We demonstrated, to the best of our knowledge, the first in vivo OCE imaging of retina and optical nerve head. These studies verify the feasibility of using OCE to provide quantified elasticity maps of various ocular tissues, and are critical steppingstones to the clinical translation of such a technology. The OCE technology will have a broad range of clinical applications, including imaging and evaluating ophthalmic diseases such as keratoconus, myopia, presbyopia, age-related macular degeneration, and glaucoma. The challenges and opportunities in translating this technology for clinical applications in the field of ophthalmology will be discussed.

Biography

Dr. Zhongping Chen is a Professor of Biomedical Engineering and Director of the OCT Laboratory at the University of California, Irvine. He is a Co-founder and Chairman of OCT Medical Imaging Inc. Dr. Chen received his B.S. degree in Applied Physics from Shanghai Jiao Tong University in 1982, his M. S. degree in Electrical Engineering in 1987, and his Ph.D. degree in Applied Physics from Cornell University in 1993. Dr. Chen and his research group have pioneered the development of Doppler optical coherence tomography, which simultaneously provides high resolution 3-D images of tissue structure and vascular flow dynamics. These functional extensions of OCT offer contrast enhancements and provide mapping of many clinically important parameters. In addition, his group has developed a number of endoscopic and intravascular rotational and linear miniature probes for OCT and MPM imaging and translated this technology to clinical applications. He has published more than 300 peer-reviewed papers and review articles and holds a number of patents in the fields of biomaterials, biosensors, and biomedical imaging. Dr. Chen is a Fellow of the American Institute of Medical and Biological Engineering (AIMBE), a Fellow of SPIE, and a Fellow of the Optical Society of America.

NEU(T)RALMC: A CONCEPT OF UNIFIED POWER-EFFICIENT METHOD FOR PHOTON TRANSPORT IN SCATTERING MEDIA

Alexander Doronin
Victoria University of Wellington, New Zealand

High quality optical diagnostics, sensing and 3D photorealistic computer graphics applications requires accurate modelling of optical radiation propagation and interactions with complex materials e.g. human skin. For a number of years, the unbiased Monte Carlo (MC) method of photon migration has been a gold standard for simulating light transport therein. Modern MC computations significantly benefit from nearly real-time acceleration on Graphics Processing Units (GPUs) and provide flawless browser-based access to the models. However, due to its statistical nature, the MC method is still computationally inefficient and requires significant amount of time/resources to achieve precision. Apart from the huge hardware (GPU servers) and environmental (energy) costs, the method cannot be used with emerging, power-efficient platforms (e.g. Apple M1/M2, etc.). In this talk, we present a concept and practical implementation of an open, intelligent family of computational models and tools which we will call neu(t)ralMC. The MC is revamped with the newest computational paradigms in Artificial Intelligence and Machine Learning (AIML) such as sample reconstruction and differentiable simulation in order to create next generation of smart, highly optimized light transport algorithms. We perform a rigorous validation and formal comparison of the developed techniques with existing methods, known analytical solutions and data obtained during in vivo studies with the light's most salient features such as spectral and coherent properties, spin and the orbital angular momentum of light.
By incorporating all aspects of light-tissue interaction, the algorithms will empower development of the "green" optical diagnostics modalities of tomorrow with unprecedented sensitivity, specificity and efficiency while considerably reducing carbon footprint of high-performance computing.

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.

RESONANT PHOTONIC LATTICES: PRINCIPLES, DESIGN, FABRICATION, AND APPLICATIONS

Robert Magnusson
Chair in Nanoelectronics, Department of Electrical Engineering, University of Texas at Arlington, USA

We discuss principles, properties, design, fabrication, and applications of resonant leaky-mode lattices. We review elementary facts related to diffractive optical elements as these constitute the original basis for periodic metamaterials. We show that perfect reflection is obtainable in 1D and 2D lattices and that its occurrence is immune to particle shape. We review the leaky-mode band structure and emphasize that its origin lies in the periodic assembly as opposed to particle resonance. The relation of lattice geometry to the leaky, resonant band edge and the nonleaky, bound-state band edge is discussed. Realizable 1D and 2D photonic lattices exhibit attractive features such as compactness, minimal interface count, high efficiency, and potential monolithic fabrication with attendant robustness under harsh conditions. Applications include various optical components and bio- and chemical sensors. The governing resonance effects hold across the spectrum, from visible wavelengths to the microwave domain, by simple scaling of wavelength to period and proper materials choice.

Biography

Professor Magnusson received the Ph.D. degree in Electrical Engineering from the Georgia Institute of Technology. He spent several years in industry and then joined the faculty of UT-Arlington. He served as Professor and Chair of the Department of Electrical Engineering from 1998-2001, and he was Professor and Head of the Electrical and Computer Engineering Department at the University of Connecticut from 2001-2006 and Professor from 2006-2008. In 2008, he returned to UT-Arlington to accept positions as the Texas Instruments Distinguished University Chair in Nanoelectronics and as Professor of Electrical Engineering. He currently directs the UT-Arlington Nanophotonics Device Group. He has published 500 journal and conference papers and holds 40 patents. He is a Fellow of the Optical Society of America and SPIE, a Life Fellow of IEEE, and a Charter Fellow of the National Academy of Inventors. He is the Co-founder and Chief Technical Officer of Resonant Sensors Incorporated, a company that provides next-generation optical sensor systems for pharmaceutical and biotech customers. He founded Tiwaz Technologies LLC in 2011. The company provides consulting services in optical engineering, laser design, and nanophotonics technology. The company has capability and resources to design, fabricate, and test device prototypes. Current theoretical and experimental research addresses periodic nanostructures, nanolithography, nanophotonics, nanoelectronics, nanoplasmonics, nanolasers, and optical bio- and chemical sensors.

COMPARISON OF TECHNIQUES FOR ANALYSIS OF CAFO WASTE

Daniel Struk, Wael Al Ghanami, Christopher Heist, Peter Hesketh, Odamari Mbuya*, Matthew Siebecker, Jie Xi*****
Department of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30323;
* College of Agriculture and Food Sciences, FAMU, Tallahassee, FL 32307
** Department of Plant and Soil Science, TTU, Lubbock, TX 79409
*** Georgia Tech, GTRI, Atlanta, GA 30332.

Macronutrients in the form of nitrogen, phosphorus, and potassium are necessary for healthy plant growth. Concentrated animal feed operations (CAFO) and wastewater treatment plant (WWTP) waste are promising source for fertilizer to apply to soils in agriculture. However the overapplication of nutrients is just as much of a problem as underapplication [1,2]. Therefore there is a need to analyze these waste sources for their macronutrient levels to ensure farms have enough to grow without being oversaturated. Capillary electrophoresis (CE) and inductively coupled plasma optical emission spectroscopy (ICP-OES) are two analytical techniques for determining the makeup of the complex mixture of compounds found in CAFO and WWTP.
CE works by separating ions based on their electrophoretic mobility in a conductive solution whereas ICP-OES works by ionizing the individual elements with a plasma then measuring the emitted spectra as the atoms return to their ground state. CE as just a separation method but can be paired with various detectors, such as mass spectrometers, UV-visible absorbance, or capacitively coupled contactless conductivity detection. Thes are laboratory instruments, although some development of portable instruments has been undertaken by NASA/JPL and other groups [3]. Capillary Electrophoresis methods have been applied to analysis of lake water [4], biological samples [5], food [6], agricultural products [7] providing a rapid analysis at lower cost than laboratory tests. Both ICP-OES and CE are effective methods for the analysis of CAFO waste samples, however ICP-OES is limited by its inability to distinguish molecules providing an elemental analysis. CE worked well on 10X diluted samples, and the future work to be done designing, building and automating a mobile, modular CE system that can be used in agricultural applications. This work was supported by the National Science Foundation under Grant No. 2133576.

References

[1] Goyal, Sham S., and Ray C. Huffaker. "Nitrogen toxicity in plants." Nitrogen in crop production (1984): 97-118.

[2] Rashid, Ghazunfar, et al. "Influence of Nitrogen Fertilizer on Nitrate Contents of Plants: A Prospective Aspect of Nitrate Poisoning in Dairy Animals." Pakistan Journal of Zoology 51.1 (2019).

[3] R. D. Kidd,et al., "Ion Chromatography-on-a-Chip for Water Quality Analysis," 45th International Conference on Environmental Systems ICES, 12-16 July 2015, Bellevue, Washington, paper # 2015-141.

[4] C. B. Freitas, R. C. Moreira, M. G. de Oliveira Travares, W. K. T. Coltro, " Monitoring of nitrite, nitrate, chloride and sulfate in environmental samples using electrophoresis microchips coupled with contactless conductivity detection," Talanta, Vol. 147, pp. 335-341 (2016).

[5] E. Morcos, N. P. Wiklund, "Nitrite and nitrate measurement in human urine by capillary electrophoresis," Electrophoresis, Vol. 22, pp. 2763-2768 (2001).

[6] N. Oztekin, M. S. Nutku, F. B. Erim, "Simultaneous determination of nitrite and nitrate in meat products and vegetables by capillary electrophoresis," Food Chemistry, Vol. 76, pp. 103-106 (2002).

[7] M. Timm, B. M. Jorgensen, "Simultaneous determination of ammonia, dimethylamine, trimethylamine, and trimethylamine-N-oxide i

Biography

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

Distinctions & Awards

Satish Dhwan Visiting Chair Professor, Indian Institute of Sciences, Bangalore, INIDA, 2019

Thank a Teacher Award for ME4766 Micro/Nano-Scale Devices (2018)

Georgia Institute of Technology Outstanding Achievement in Research Program Development Award, 2017

Thank a Teacher Award for ME3345 Introduction to Heat Transfer (2017)

Outstanding Achievement in Research Program Development Award, jointly with M. Bakir, S. Graham, S. Sitaraman, M. Swaminathan, M. Tentzeris (2017)

Editorial Board of Journal published by Nature: Microsystems and Nanoengineering (2015)

President of the Georgia Tech Chapter of Sigma Xi (2014-16)

Outstanding Achievement Award of the Sensor Division of the Electrochemical Society (2014)

Sigma Xi, Vice President of Georgia Tech Chapter, 2012-2014
Chair of Honors and Awards Committee, Electrochemical Society, 2011-2013

Georgia Tech Center for Enhanced Teaching and Learning Tech to Teaching Mentor Award, 2010

Thank a Teacher Certificate, 2008 and 2010

Class of 1969 Teaching Fellow, 2002

American Society of Mechanical Engineers Fellow, 2009

The Electrochemical Society (ECS)

Fellow, 2009

Chairman Sensor Division, 1998-2000

Guest Professor of Huazhong University of Science and Technology, 2005-2007

Artech House, Inc. MEMS Series Editor, 2003-2005

American Association for the Advancement of Science Fellow, 2004

Whitaker Foundation Biomedical Engineering Research Grant Award, 1994-98

Patents

A. Lotfi, M. Navaei, P. J. Hesketh, "Balanced Thermal Conductivity Gas Sensor Provisional patent Application number 62852615, May 24th 2019

S. Hanasoge, P. J. Hesketh, A. Alexeev, "System and Methods to Produce Metachronal Motion of Artificial Magnetic Cilia" U.S. Patent Application No. 62/748,641 October 22nd 2018 Single Substrate Electromagnetic Actuator, U. S. Patent 7474180, with J. Sutano-Bintro, issued January 6, 2009 Apparatus for Fluid Storage and Delivery at a Substantially Constant-Pressure, U. S. Patent 7,471,337, with R. Luharuka and C.-F. Wu, issued January 27, 2009

Miniature Optically Coupled Electrically Isolated Ultrasensitive Dynamic Pressure Detector, U.S. Patent 7,392,707, with Lid Wong and Sangkyung Kim, July 1, 2008

Porous Gas Sensors and Method of Preparation Thereof, U.S. Patent 7,141,859, with J. Gole, J. DeBoer, and S. Lewis, November 28, 2006

Porous Gas Sensors and Method of Preparation Thereof, U.S. Patent 6,893,892 B2, with J. Gole and S. Lewis, May, 17, 2005

Microfabricated Porous Silicon Gas Sensor, U.S. Patent 6,673,644, with L. T. Seals and J. L. Gole, January 6, 2004

Pin Array Assembly and Method of Manufacture, U.S. Patent 6,455,352, with Joel Pikarsky and Gennadiy Yershov, September 24, 2002

Miniature Electrically Operated Diaphragm Valve, U. S. Patent 6,328,279, with Douglas R. Adkins, Barry L. Spletzer, Chungnin C. Wong, Gregory C. Frye-Mason, and Gary J. Fisher, December 11, 2001

Antibody Covalently Bound Immunobiosensor, U. S. Patent No. 5,567,301, with J. Stetter, S. Gendel, and G. J. Maclay, October 22, 1996

Miniature Pressure Sensor and Pressure Sensor Arrays, U. S Patent No. 5,277,067, with C. E. Holland, January 11, 1994
Miniature Pressure Sensor and Pressure Sensor Arrays, U. S Patent No. 5,163,328, with C. E. Holland, November 17, 1992
Thermopile Having Reduced Thermal Noise, U. S. Patent 5,087,312, with Martin T. Gerber, February 11, 1992

OPTICAL INTERROGATION OF NEUROVASCULAR COUPLIN

Ramin Pashaie
I-SENSE Fellow, Florida Atlantic University, USA

Biography

Ramin Pashaie (M'07) received the Ph.D. degree in electrical and systems engineering from the University of Pennsylvania, Philadelphia, PA, USA, in December 2007, under the supervision of Prof. N. H. Farhat.,After Ph.D. degree, he joined Karl A. Deisseroth lab as a Postdoctoral Scholar in the Bioengineering Department at Stanford University. During his postdoctoral training, he focused on technology development for optical modulation of neural activities using the tools of photonics and molecular genetics. In September 2009, he joined the Electrical Engineering Department at the University of Wisconsin-Milwaukee, Milwaukee, WI, USA, as an Assistant Professor and the Director of the Bioinspired Sciences and Technology Laboratory where the research is about optical interrogation of the dynamics of large-scale neural networks mostly in the brain cortical regions. In particular, he is currently interested in the implementation of neuroprosthetic devices to extract details of information processing in cortical networks and the nonlinear dynamics of cortical columns. This information can be used for reverse engineering and realization of brain–machine interface mechanisms.,Dr. Pashaie received the NARSAD (Brain and Behavior Research Foundation) Young Investigator Award in 2013 and the National Science Foundation Career Award in Biophotonics in 2015

Martin Lavery
University of Glasgow, UK

Biography

Prof Lavery is a Full Professor and leader of the Structured Photonics Research Group at the University of Glasgow (UofG). His dynamic research group has a track record in investigating fundamental developments in Physics and successfully applying them to industry inspired engineering challenges. Since joining the School of Engineering in September 2014, he has successfully attracted almost £5m in research funding as Principle Investigator (PI) and is coordinator of the H2020 Future and Emerging Technologies (FET-Open) consortium project named SuperPixels. He has been recognised as a leader in the academic community, having been awarded the 2013 Scopus Young Scientist of the Year for Physical Sciences. In 2018 he became the Mobile World Scholar Gold Medal winner for his accomplishments in high dimensional optical communications. For his contributions to field of optics he was further awarded the 2019 Royal Acamdemy of Edinburgh Sir Thomas Makdougall Brisbane Medal. Leading a team of world-leading research to develop a road map for deploying highspeed network provision for developing countries (Lavery et. al, N. Photon. 12(5), 249-252, 2018) supported by the EPSRC Global Challenges Research Fund.

3rd Edition of Annual Conference

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

JUNE 02-05, 2023

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

DRS DAYLIGHT SOLUTIONS

INDUSTRIAL PRESENTATION

DRS DAYLIGHT SOLUTIONS DEVELOPS MOLECULAR DETECTION AND IMAGING SYSTEMS FOR USE IN SCIENTIFIC RESEARCH, LIFE SCIENCES, INDUSTRIAL PROCESS CONTROL, AND DEFENSE APPLICATIONS. THE COMPANY IS THE WORLD LEADER IN MID-INFRARED LASER-BASED SOLUTIONS, WITH A LINE OF BROADLY TUNABLE AND FIXED WAVELENGTH LASER SOURCES, SENSORS, AND MICROSCOPES THAT UTILIZE MID-INFRARED SPECTROSCOPY AND IMAGING.

Daylight Solutions:
The World Leader in Quantum Cascade Laser Technology

Taylor Stathopoulos
Manager, Sales & Marketing, DRS Daylight Solutions, 16465 Via Esprillo, San Diego, CA 92127 USA
taylor.stathopoulos@drs.com | daylightsolutions.com

Our Mission: Our mission at DRS Daylight Solutions is to be the leading provider of best-in-class, mid-infrared sources and systems for defense, commercial, and research markets. Our global leadership position in advanced, mid-IR technology means that DRS Daylight customers benefit from a sustainable, competitive advantage in molecular detection and imaging applications.

Company Overview: In 2005, three high-tech entrepreneurs founded DRS Daylight Solutions in San Diego, California, with the goal of developing breakthrough technologies and products around the company's core technology: mid-IR quantum cascade lasers (QCLs). Since then, the company has introduced three groundbreaking products:

- The world's first broadly tunable, mid-IR laser system for scientific research
- The world's first semiconductor-based laser for protecting aircraft against shoulder-fired missiles
- The world's first mid-IR, laser-based microscope for real-time biochemical imaging and materials analysis

QCL technology provides a versatile platform for product development, enabling DRS Daylight to serve a wide range of industries. DRS Daylight Solutions and its wholly-owned subsidiary, DRS Daylight Defense, which delivers classified, military-hardened products to the defense industry, are both advanced in manufacturing capabilities.

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.

3rd Edition of Annual Conference

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

JUNE 02-05, 2023

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

SPEAKER PRESENTATIONS

Mahsa Ranji

Biophotonics Lab Director, Florida Atlantic University, USA

Biophototonics lab at FAU implements optical tools that have enabled probing tissue redox state and energy homeostasis in organs such as eyes, lungs, and kidneys ex vivo, in vivo and over time. In collaboration with colleagues at the College of Medicine, we have studied hyperoxia, ischemia and irradiation injuries as well as diabetes. We perform spectrofluorometry, fluorescence imaging, 3D cryoimaging, and near infrared spectroscopy (NIRS) to study cell metabolism and tissue vasculature in different disease models. In addition, we develop image processing tools to quantify injuries and therapies' effectiveness as well as image cytometry tools to study live and fixed cells.

Biography

Mahsa Ranji, Ph.D. is an Associate Professor of Computer and Electrical Engineering & Computer Science department and I-SENSE institute at the Florida Atlantic University (FAU). Dr. Ranji has received her PhD in electrical engineering from University of Pennsylvania followed by a postdoctoral training at Sanford-Burnham medical research institute in La Jolla. Specializing in biomedical optics, Dr. Ranji's focus is in developing non- invasive tissue diagnostic tools. She is the director of the Biophotonics Laboratory, which focuses on optical imaging particularly fluorescence imaging, instrumentation design, and image processing tool development for biomedical applications. Dr. Ranji collaborates with researchers at Medical School and I-Brain to study tissue metabolism and oxidative stress in disease models such as diabetes and cancer using optical imaging. Her recent research is funded by national institute of health (NIH) and ISENSE seed funding.

LOPS 2023
3rd Edition of Annual Conference
LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS
JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

COLLAGEN ORGANIZATION IN THE UTERINE CERVIX DURING PREGNANCY

Jessica Ramella-Roman[1,2*], Ajmal Ajmal[1]
[1]Biomedical Engineering Department, Florida International University, Miami FL
[2]Herbert Wertheim College of Medicine, Florida International University, Miami, FL, USA

Preterm birth (PTB) presents a serious, worldwide medical health concern. The incidence of PTB in both developed and developing countries ranges from 11% to 18%. Despite ongoing research into the causes and treatments, the incidence of PTB has not shown any significant decline in the past decade. Part of the lack of treatment for PTB is due to a paucity of accurate and quantifiable methods for predicting time to labor onset. We utilize a polarization-sensitive optical imaging approach to specifically assess cervical collagen changes during pregnancy, which are hallmarks associated with PTB. Collagen organization at various time points was analyzed in a mouse model showing a direct relation between loss of collagen organization and pregnancy timeline. This work responds to the critical need of the general healthcare community for a minimally invasive modality to monitor cervical remodeling during pregnancy as a readout of preterm birth risk.

Biography

Dr. Ramella-Roman, a world expert on optical imaging, who is working on ocular diseases associated with diabetes, is joining the department September 2013.

Jessica Ramella-Roman, a researcher in the area of bio-optics has joined Florida International University as an associate professor in the Department of Biomedical Engineering.

Research Areas

Development of novel and non-invasive technologies for the diagnosis of disease, with particular emphasis on retinal disease and conditions that are caused by diabetes

INTRAOPERATIVE IMAGING OF BREAST TUMOR MARGINS WITH ULTRAVIOLET LIGHT

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

Up to two-thirds of women diagnosed with breast cancer undergo breast-conserving surgery (BCS) or lumpectomy. Women with cancer cells found at the surface of the lumpectomy specimen (positive margins) after BCS are at a substatially higher risk of cancer recurrence and are recommended to undergo additional surgery to achieve negative margins. Re-excision rates are around 14-18% but vary significantly among surgeons. Additional surgery is associated with tremendous emotional, cosmetic and financial burdens for patients and their caregivers. While radiographic examination and MarginProbe are available for intraoperative margin assessment, their accuracies are low. Frozen section and touch prep are more accurate, but they are time- and labor-intensive and not routinely used or available. Because the size of lumpectomy specimens varies and positive margins often include multiple sites/ foci, a device with both variable margin coverage and microscopic resolution that can rapidly evaluate all 6 margins of a specimen is highly desirable, but no such device exists. While new technologies have been proposed, they are either point (e.g., spectroscopy devices) or high resolution devices with a very small field-of-view (e.g., OCT and confocal microscopes) that require excessive time to scan a specimen, or wide-field devices (e.g., fluorescence and SFDI) with low resolution and poor sensitivity. None has demonstrated the capability of analyzing an entire lumpectomy specimen with both adequate resolution and time efficiency in a clinical setting. Microscopy with ultraviolet surface excitation (MUSE) penetrates only a few micrometers deep in tissue, and thus can easily achieve a spatial resolution sufficient to visualize cell nuclei at the specimen surface and sharp contrasts with a low magnification objective (4x), providing considerable information about tissue surface status which is highly desirable for detecting positive margins. This presentation will review our recent progresses in MUSE imaging of lumpectomy specimens and the development of various image processing methods, including visual inspection, quantitative nucleus-to-cytoplasm ratio (N/C), texture analysis (TA) and deep-learning (DL), for accurate and automated detection of breast tumor margins during BCS.

Biography

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

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

UNIQUE OPTICAL PROPERTIES OF AROMATIC AMINO ACID LATTICES IN MICROTUBULE PROTEIN STRUCTURES: THEORY AND EXPERIMENT

Travis J.A. Craddock[1,2]

[1]Institute for Neuro-Immune Medicine, Nova Southeastern University, Fort Lauderdale, FL 33314, USA

[2]Departments of Psychology & Neuroscience, Computer Science, and Clinical Immunology, Nova Southeastern University, Fort Lauderdale, FL, USA

Microtubules are self-assembling biological helical nanotubes made of the protein tubulin that are essential for cell motility, cell architecture, cell division and intracellular trafficking. The unique mechanical properties of microtubules give rise to a high resilience and stiffness due to their quasi-crystalline helical structure. It has been theorized that this hollow molecular nanostructure may support optical transitions in photoexcited tryptophan, tyrosine, or phenylalanine amino acid lattices to function as a light-harvester similar to photosynthetic units, or like a quantum wire. Theoretical work of energy transfer between amino acids in tubulin via dipole excitations coupled to the surrounding thermal environment is presented yielding the potential of these lattices to support energy migration and superradiance. Recent tryptophan autofluorescence lifetimes measurements probing inter-tryptophan energy hopping in tubulin and microtubules are also presented.

Biography

Travis J.A. Craddock, Ph.D. (Physics) is an Associate Professor in the Departments of Psychology & Neuroscience, Computer Science and Immunology at Nova Southeastern University (NSU) in Fort Lauderdale, Florida. He is the Director of the Clinical Systems Biology group at NSU's Institute for Neuro-Immune Medicine where he applies computational biophysics methods towards the purpose of identifying novel diagnostics and treatments for illnesses involving neuroinflammation. Dr. Craddock received his Ph.D. in biophysics at the University of Alberta where his graduate research activities focused on biomolecular information processing, and nanoscale descriptions of memory, and cognitive dysfunction in neurodegenerative disorders. His current research activities are focused on using a theory driven approach to understand the underlying molecular regulation of chronic illness resulting from exposure to neurotoxins, such as anesthesia and nerve agents, in order to improve diagnosis and treatment strategies. This work is primarily funded by the U.S. Department of Defense. Travis J.A. Craddock, Ph.D. (Physics) is an Associate Professor in the Departments of Psychology & Neuroscience, Computer Science and Immunology at Nova Southeastern University (NSU) in Fort Lauderdale, Florida. He is the Director of the Clinical Systems Biology group at NSU's Institute for Neuro-Immune Medicine where he applies computational biophysics methods towards the purpose of identifying novel diagnostics and treatments for illnesses involving neuroinflammation. Dr. Craddock received his Ph.D. in biophysics at the University of Alberta where his graduate research activities focused on biomolecular information processing, and nanoscale descriptions of memory, and cognitive dysfunction in neurodegenerative disorders. His current research activities are focused on using a theory driven approach to understand the underlying molecular regulation of chronic illness resulting from exposure to neurotoxins, such as anesthesia and nerve agents, in order to improve diagnosis and treatment strategies. This work is primarily funded by the U.S. Department of Defense.

MULTIMODAL PHOTOACOUSTIC, OCT, AND FLUORESCENCE STEM CELL IMAGING OF THE RETINA

Yannis M. Paulus, Van Phuc Nguyen, Wei Qian, Xueding Wang

Purpose | Stem cell therapy offers a promising method for the treatment of currently incurable diseases such as geographic atrophy in macular degeneration. However, a major challenge of stem cell therapy is to evaluate the treatment outcome and to track the distribution of cells after transplantation. In this study, an advanced non-invasive multimodality photoacoustic microscopy (PAM), optical coherence tomography (OCT), and fluorescence microscopy (FM) imaging system is developed to monitor stem/progenitor cells in vivo.

Methods | A high resolution multimodal PAM, OCT, and FM imaging system is developed for tracking transplanted cells in living rabbit retina. Ultrapure functionalized chain-like gold nanoparticle (CGNP) clusters were synthesized and used to label human retinal pigment epithelial (ARPE-19) cells prior to injecting them in the subretinal space in rabbits (n=12) having localized RPE damage via photocoagulation lesions. The biodistribution and migration of the transplanted cells were monitored using multimodal imaging, including color fundus photography, ICGA, PAM, OCT, and FM for up to 90 days.

Results | PAM images were obtained at two different optical wavelengths of 578 nm to visualize vasculature and 650 nm to visualize ARPE-19 cells and were overlaid on the same image plane and on the OCT images. Transplanted ARPE-19 cells injected into the subretinal space can be selectively identified by PAM at 650nm with high contrast. The laser energy used to perform PAM is 80 nJ, or half of the ANSI safety limit. Co-registration of B-scan OCT with PAM provides information on the anatomic layers in which the ARPE-19 cells are found, which is in the RPE and adjacent layers. ARPE-19 cells localize focally to the grid pattern photocoagulation lesion locations and persist for up to 90 days after injection. Bare CGNP clusters injected into control eyes do not selectively localize and are rapidly cleared after 14 days. FM co-localized to the PAM location with significantly faster loss of contrast. Histology and immunohistochemistry confirm the ARPE-19 cells localize to the regions demonstrated on OCT and PAM at 650nm.

Conclusion | Multimodal PAM, OCT, and FM imaging using CGNP clusters can allow for an imaging and nanoparticle system that can be used for labeling and tracking of cell-based regenerative therapies in the retina.

Biography

Development of novel retinal imaging systems and therapeutic techniques and technologies, including photoacoustic imaging, molecular imaging, restorative retinal laser therapy, and surgical techniques. The goal of my research is to allow physicians in real time to determine cellular markers for earlier diagnosis, improved treatment monitoring, and more individualized precision medicine tailored to each patient's unique molecular markers.

My research seeks to allow physicians to diagnose diseases earlier, improve treatment monitoring, and practice more individualized precision medicine tailored to each patient through molecular imaging. My interest is in applying physics, bioengineering, and mathematical modeling to develop novel retinal imaging systems and laser therapies.

I have co-developed a novel, inexpensive system for providing tele-ultrasound, co-founded a retinal imaging company, and investigate pattern scanning laser photocoagulation (PASCAL), laser-tissue interactions, and restorative retinal laser therapy to create minimally traumatic retinal laser therapy. I am interested in developing more targeted laser therapy through modulation of pulse duration, wavelength, beam characteristics, and physical modulators.

I study photoacoustic and molecular imaging of the retina and choroid for retinal ischemic diseases, including macular degeneration, diabetic retinopathy, vein occlusions, and sickle cell retinopathy. The photoacoustic effect uses light absorption to induce slight local temperature changes, producing ultrasound waves. The imaging device detects these ultrasound waves to create a high-resolution, 3-D image of the retina, choroid, and optic nerve. This allows for non-invasive functional imaging including tissue oxygenation and blood distribution. Through the use of contrast agents targeting neovascularization, I can achieve molecular imaging of the eye for early diagnosis of macular degeneration, prognostication, and determination of response to therapy.

Clinical Interests

Diseases and surgery of the retina and vitreous, including diabetic retinopathy, age-related macular degeneration, retinal vascular disease, retinal detachments, ocular trauma, ocular inflammation, macular and submacular surgery, and surgical management of complex retinal detachment

Subspecialty: Retina

Honors & Awards

2018

Grant, Real-time In Vivo Visualization of the Molecular Processes in Choroidal Neovascularization, NIH/NEI K08 Grant, Precisely Removing Microvessels by Photo-Mediated Ultrasound Therapy, NIH/NEI R01 Grant, Swept Source Optical Coherence Tomography Angiography, University of Michigan Office of Research

2017

Grant reviewer, Great Ormond Street Hospital Children’s Charity, United Kingdom Credentials Undergraduate, Chemistry and Physics, Harvard University, 2005 Medical School - Stanford University School of Medicine, 2009 Internship - Memorial Sloan-Kettering Cancer Center, 2010 Residency - Ophthalmology, Stanford University School of Medicine,

2013

Fellowship - Surgical and Medical Retina, Wilmer Eye Institute, Johns Hopkins University,

2015

Board Certification - American Board of Ophthalmology

TRILAYER PLASMONIC METAL NANOMESH: LASER ABLATION-INDUCED HIGHLY TRANSPARENT MICROELECTRODES IN PEROVSKITE SOLAR CELLS

Kavya S. Keremane[1] , Mohan Sanghadasa[2], Kai Wang[1*], Shashank Priya[1*]

[1]Materials Research Institute, The Pennsylvania State University, University Park, PA, 16802, USA

[2]U.S. Army Combat Capabilities Development Command Aviation & Missile Center, Redstone Arsenal, AL, 35898, USA

At present, the photovoltaic (PV) market is dominated by silicon solar cells owing to their high-power conversion efficiency (PCE), proven long-term stability, and high throughput as well as large-scale and low-cost manufacturing methods. The current record PCE of crystalline silicon solar cells is 27.6%, very close to their intrinsic limit of 29.1%. The best choice to further improve the efficiency is to develop tandem solar cells with the ideal bandgaps of ~1.7 eV and ~1.1 eV for top and bottom solar cells (Perovskite+Si). The main key parameter for a tandem device is to get optimum transparency and high conductance for the top electrode of the top cell. This transparent top solar cell (perovskite) is required to employ (i) a high transparency electrode to allow the near-infrared photons to be effectively transmitted into the silicon bottom cell. In addition, the electrode for the perovskite top devices needs to have (ii) good conductivity to facilitate charge collection. However, the trade-off correlation between transmittance and conductivity of the top electrode remains challenging in this field. Traditional methods such as ultrathin metal nanolayers, transparent conductive oxide deposition, or thin carbon conducting materials are insufficiently quantified for high-performance perovskite/Si tandem solar cells, due to an inferior balance between transmittance and conductivity. Breakthroughs can be sought from proper photonic management with regard to wavelength, photon numbers, and their coupling effect on nanostructured metal electrodes where plasmonic, photoelectronic effect and quantum tunneling mechanisms can take effect. Here, we propose heterojunction nanometal structures as functional transparent electrode for perovskite solar cells. This non-trivial performance is achieved by leveraging an optimized trilayer plasmonic metal nanomesh structure guided by laser-assisted fabrication of micropatterned transparent electrodes. We used a picosecond laser scribing technique for patterning metallic Ag/Au/Cr electrodes to obtain high transmittance without compromising its electrical conductance. This cost-effective process for producing high-performance trilayer plasmonic metal nanomesh as transparent electrodes were developed by optimizing their focus, power, speed, linewidth, pitch, and height. The simple and cost-effective fabrication of transparent Ag/Au/Cr nanomesh electrodes with tunable optoelectronic properties paves the way for the design and realization of specialized transparent electrodes in tandem solar cells.

Keywords: Picosecond Laser; metal electrode; Transparent; Perovskite solar cells; Efficiency

FLEXIBLE PHOTONICS AND THEIR OPPORTUNITIES IN ENGINEERED STRUCTURES

Christopher Holmes[1], Shahrzad Zahertar[1], Bruno Moog[1], Michael Godfrey[2], Timothy Lee[1], Andrea Annunziato[3], Francesco Anelli[3], Bo Shi[1], Martynas Beresna[1], Matthew Whitaker[1], Francesco Prudenzano[3], Richard Day[4], Janice Dulieu-Barton[5]

[1] Optoelectronics Research Centre, Zepler Institute, University of Southampton, Southampton UK
[2] School of Engineering, University of Southampton, Southampton, UK
[3] Dept. of Electrical and Information Engineering, Politecnico di Bari, Bari, Italy
[4] Composites Centre, Wrexham Glyndwr University, Wrexham, UK
[5] Bristol Composites Institute, University of Bristol, Bristol, UK

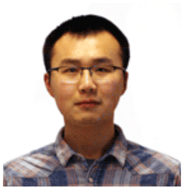
TOPOLOGY, SKYRMIONS, AND SUPEROSCILLATION OF STRUCTURED LIGHT

Yijie Shen
Optoelectronics Research Centre and Centre for Photonic Metamaterials, University of Southampton, Southampton SO17 1BJ, UK

Topological complex electromagnetic waves give access to nontrivial light-matter interactions and provide additional degrees of freedom for information transfer. An important example of such electromagnetic excitations are space-time non-separable single-cycle pulses of toroidal topology. Here we introduce an extended family of super-toroidal electromagnetic excitation, which exhibit skyrmionic structure of the electromagnetic fields, multiple singularities, and fractal-like energy backflow. By further introducing bandlimited effect into super-toroidal pulses, we show that space-time non-separable band-limited light fields can exhibit superoscillations simultaneously in the spatial and temporal domains, i.e. can oscillate faster that the highest harmonics of their spectra. The super-toroidal pulses with space-time superoscillation are of interest for transient light-matter interactions, ultrafast optics, spectroscopy, and toroidal electrodynamics.

Biography

Dr. Yijie Shenis currently a Senior Research FellowofNanophotonics & Metamaterials Group(Nikolay I. Zheludev group) inOptoelectronics Research Centre(ORC), UniversityofSouthampton, Southampton, UK, funded byMarie Skłodowska-Curie MULTIPLY Fellowship. He received the Ph.D. degree in optical engineering at the DepartmentofPrecision Instrument, Tsinghua University, Beijing, China. He received the B.S. degree in mechanical engineering and automation from South China UniversityofTechnology, Guangzhou, China. During Mar. 2019 to Jun. 2019, he was invited as a visiting researcher in SchoolofPhysics:StructuredLightLaboratory(Andrew Forbes group), Universityofthe Witwatersrand (Wits University), Johannesburg, South Africa, and also invited as a visiting researcher in National Laser Centre, Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa.He is a memberofthe Chinese Optical Society (COS) andChinese SocietyofTheoretical and Applied Mechanics, and an invited memberofthe Optical SocietyofAmerica (OSA), specially a fellow member in the Systems and Instrumentation Group in which. He won the Wang Da-Heng Optics Award (COS, China) in 2019. He is a national first-grade computer aided designer and cartographer in China. He won the IOP and OSA Outstanding Reviewer Awards in 2020. He is a member in theJournalofOpticsAdvisory Panel. He is a guest editor inFrontiers in Photonics. He has published more than 50 papers in high-impact journals includingNat. Commun.,Light: Sci. & Appl., Optica, Nanophotonics, Laser Photonics Rev., ACS Photonics, Phys. Rev. Res., Phys. Rev. Appl.,etc., with over one thousand citations (Google Scholar).



AN NIR OPTICAL DEVICE FOR REAL-TIME MONITORING OF ENDOTRACHEAL TUBE DISPLACEMENT FOR PEDIATRIC PATIENTS

[1]Tongtong Lu, [2]Pawjai Khampang, [2]Wenzhou Hong, [2]Joseph E. Kerschner, and [1]Bing Yu,
[1]Joint Department of Biomedical Engineering, Marquette University and Medical College of Wisconsin, Wisconsin 53233, USA
[2]Departments of Microbiology and Otolaryngology, Medical College of Wisconsin, Wisconsin 53226, USA

Endotracheal tube (ETT) intubation is an important airway management procedure to enable appropriate ventilation and gas exchange in the lungs of critically ill patients or patients recovering from a major surgical intervention. The occurrence of ETT misplacement is particularly high in pediatric patients due to their shorter trachea.

Because anesthesia or substantial sedation is usually administered, unnoticed migration of the tube from head rotation, flexion or extension of the neck, and other movements may cause moderate to severe complications or even life-threatening situations. These complications include tracheal bleeding, unplanned extubation, perforation, and endobronchial intubation. Currently, there is no clinical system that can be utilized to provide accurate and real-time information to care teams about the appropriate position of the ETT and no previous studies have proposed a system that is easily employed in an efficient and inexpensive manner.

We report the development of a novel near-infrared (NIR) optical device for noninvasive and continuous assessment of ETT position. The proposed device uses a 200-um diameter side-firing fiber embedded in the ETT for trachea-illumination. A mini PCB detection board equipped with five phototransistors is taped on the skin for light detection. A customized software captures data and displays the estimated ETT position in real-time and care teams can be immediately notified if the ETT displacement happens.

In vivo studies with ten piglets at different ages have achieved low errors for real-time tube position estimation. The NIR device may provide a cost-effective solution for real-time ETT displacement detection.

Biography

Tongtong Lu is a postdoctoral fellow in the Joint Department of Biomedical Engineering of Marquette University and Medical College of Wisconsin. He received his Ph.D. degree in biomedical engineering from Marquette University in 2022. Before that, he received his B.Eng. degree in information engineering from Zhejiang University in 2016.

ULTRA-FAST SUPER-WIDE-FIELD PHOTOACOUSTIC MICROSCOPY OF FUNCTIONAL BRAIN ACTIVITIES

Junjie Yao
Duke University, Durham, NC 27708, USA

Acoustically detecting the optical absorption contrast, photoacoustic microscopy (PAM) has become an enabling tool in small-animal brain studies, with its unique capability of single-cell spatial resolution, intrinsic sensitivity to functional information, and relatively deep penetration in tissues. However, previous PAM techniques cannot achieve simultaneously a high imaging speed, a high spatial resolution, and/or a large field of view, impeding the study of highly dynamic physiologic and pathophysiologic brain processes over a large region of interest. Here we have developed a high-speed PAM system with an ultra-wide field of view, enabled by an innovative water-immersible polygon-mirror scanner and a high-speed two-color Raman laser source. The new PAM has achieved a cross-sectional frame rate of as high as 5 kHz over a 10-mm scanning range, which is more than 5000 times faster than previous motor-scanner-based PAM system. Such a high scanning speed and scanning range are highly desired for imaging a large field of view of the mouse brain. Using this high-based PAM system, we have imaged, for the first time, epinephrine-induced vasoconstriction in the whole mouse brain, vascular reperfusion after ischemic stroke and cardiac arrest, and functional brain response in response to electrical stimulations, with a spatial resolution of 10 μm and a volumetric imaging speed of 3 Hz. We have systematically studied the brain's functional responses to cardiac arrest and the potential adverse impact of epinephrine to the brain microvessels during this process. We expect that the high-speed PAM system will become a powerful tool for small animal brain imaging where the hemodynamic responses over a large field of view are of particular interest.

Optical-resolution photoacoustic microscopy (OR-PAM) has become a popular tool in small-animal studies. However, previous OR-PAM techniques variously lacked a high imaging speed, a high spatial resolution, and/or a large field of view. Here we report a high-speed OR-PAM system using an innovative water-immersible polygon-mirror scanner, which has achieved a cross-sectional frame rate of as high as 2400 Hz over a 12-mm scanning range. Using this polygon-scanner-based OR-PAM system, we have performed various studies on mouse models with stroke and cardiac arrests. We expect that the new OR-PAM system will become a powerful tool for imaging hemodynamics and neuronal functions.

Biography

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

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

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

POLARIZATION INDEPENDENT LIQUID CRYSTAL ON SILICON PHASE MODULATOR

Mao, Chongchange
The Ohio State University, USA

A liquid crystal on silicon (LCOS) phase modulator is composed of a liquid crystal (LC) layer sandwiched between a transparent electrode on the cover glass substrate and the electrode in a 2-dimensional array configuration on the silicon backplane surface. The current LCOS phase modulator can only realize polarization dependent phase modulation due to the elongated shape and ordered orientation of nematic LC molecules, resulting in either large optical power loss or requiring a complicated polarization manipulating system for unpolarized incident light. Recent years, development of polarization independent LCOS (PI-LCOS) phase modulators has attracted strong attention from researchers and engineers, but there are no commercial products on the market yet due to the requirement of complicated technology development. We have developed a novel and practical PI-LCOS phase modulator, in which one thin-film quarter-wave plate (QWP) is added on the surface of the silicon backplane. The QWP operates in double-pass manner so it behaves as the half-wave plate (HWP), so an incident light beam has its polarization rotated to the orthogonal orientation after passing through the QWP two times. Therefore, the output light has the same phase modulation for both the polarization states. The addition of one dielectric layer between silicon backplane electrode and LC layer results in relatively large voltage drop across the dielectric layer. Therefore, a general LCOS silicon backplane cannot fully drive LC element and the frame buffer pixel circuit based silicon backplane is developed for PI-LCOS phase modulators. In my talk, I will introduce the development of both the QWP and silicon backplane technologies. I will also briefly discuss applications of PI-LCOS phase modulators, including wavelength selective switch (WSS) for telecom networks, wavefront correction for astronomical observation, beam shaping and aberration correction for free-space optical communication in 6 generation (6G) networks, and holographic displays.

Biography

Dr. Chongchang Mao received his Ph. D. degree in 1989 from University of Colorado at Boulder. After that, he has been working in academia institutes and industry companies for technology and product development in optics, electronics, and software fields. He and his teams have successfully developed advanced technologies and products for optical telecommunication networks, adaptive optics, liquid crystal phase modulators, display systems, and biomedical devices. He also had experience on technology transfer from universities to industry and successfully commercialized several advanced technologies developed by university researchers. He is now the research professor in Ohio State University, leading a team to develop liquid crystal technologies for applications of fiber networks, astronomical observation, and VR/AR displays.

OPTICAL NANO-ANTENNA FOR LIGHT MODULATION

Shweta Sharma[1] , Kavya Keremane[1] , Mohan Sanghadasa[2] , Bed Poudel[1] , Kai Wang[1] , Shashank Priya[1]

[1]Department of Material Science and Engineering, The Pennsylvania State University, University Park, PA, 16802, USA
[2]U.S. Army Combat Capabilities Development Command Aviation & Missile Center, Redstone Arsenal, AL, 35898, USA

Optical antennas are nano-scale devices that are analogous to radio and microwave antennas but designed to operate at frequencies within the visible range (hundreds of THz). Optical nanoantennas can efficiently confine free-propagating light into subwavelength scale and induce strong local electric-field enhancement. In recent times, metallic optical nanoantennas that rely on surface plasmons (SPs) have attracted considerable attention due to their remarkable capability to modulate light at nanoscale. They enhance local light-matter interactions, and act as fundamental building blocks of nanophotonic systems [1]. Due to this, they can be used in developing wide range of devices for light harvesting (like photodetectors and solar cells), light enhancement (like surface-enhanced spectroscopy), as well as light emission [2]. The present work investigates the influence of nanoantennas on the optical response of perovskite material. Metallic nanoantennas of various dimensions were fabricated using electron beam lithography, and later integrated with perovskites. The results showed that the size and shape of the nanoantennas had an interesting effect on both the frequency and amplitude of the emitted light. The work explores how factors such as nano metallic configurations, localized plasmonic confinement, and phonon perturbation can affect the properties of perovskite materials. Understanding these impacts can ultimately lead to the development of tunable visible light emitter for THz optical transmission, with potential applications in communication, imaging, diagnostics, material science, and environmental monitoring

2. References

[1] L. Lin, Y. Zheng, Optimizing plasmonic nanoantennas via coordinated multiple coupling, Nat. Publ. Gr. (n.d.) 1–11.

[2] H. Li, S. Xu, Y. Gu, H. Wang, R. Ma, J.R. Lombardi, W. Xu, Active plasmonic nanoantennas for controlling fluorescence beams, J. Phys. Chem. C. 117 (2013) 19154–19159.

[3] B. Ai, Z. Fan, Z.J. Wong, Plasmonic–perovskite solar cells, light emitters, and sensors, Microsystems Nanoeng. 8 (2022).
[4] C. Redondo-Obispo, I. Suárez, S.J. Quesada, T.S. Ripolles, J.P. Martínez-Pastor, A.L. Álvarez, A. De Andrés, C. Coya, Enhanced Nonlinear Optical Coefficients of MAPbI3 Thin Films by Bismuth Doping, ACS Appl. Mater. Interfaces. (2020) 2188–2194.

EVALUATION OF CHEMOTHERAPEUTIC RETINOIC ACID EFFECTS ON BREAST CANCER CELLS USING NATIVE FLUORESCENCE SPECTROSCOPY AND MACHINE LEARNING

Binlin Wu

Southern Connecticut State University, United States

Native fluorescence spectra of retinoic acid (RA)-treated and untreated human breast cancer cells were measured using selective wavelengths of 300 nm and 340 nm for excitation. The spectral data of the two types of cells were analyzed using unsupervised machine learning algorithms including principle component analysis (PCA) and nonnegative matrix factorization (NMF) for linear unmixing. The native fluorescence spectral data were analyzed and compared to single wavelength data. Supervised machine learning algorithm support vector machine (SVM) was used for classification. The results show that the concentrations of the native fluorophores such as tryptophan, NADH and flavins in the human malignant breast cells change when they are treated with RA. The results also indicate that there was a decrease of adenosine triphosphate (ATP) in the RA-treated cells. The study shows the native fluorescence spectroscopy with selective excitation wavelengths aided by machine learning is promising for potential clinical applications in drug development and chemotherapeutic studies.

Biography

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

LOPS 2023
3rd Edition of Annual Conference
LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS
JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

SUSTAINABLE ADDITIVE NANOMANUFACTURING PATHWAYS FOR PHOTONICS AND THE HETEROINTEGRATION OF QUANTUM OPTICAL SYSTEMS

Devin MacKenzie,[1,2,3] Greg Guymon,[1] Rayne Anderson,[2] and Holly Brunner[3]
[1]Department of Mechanical Engineering
[2]Department of Materials Science and Engineering
[3]Washington Clean Energy Testbeds University of Washington, Seattle

Photonic metasurface prototyping and scalable manufacturing across scales and the emerging areas of quantum optical emitter-based optical devices are compelling candidates for innovation with sustainable additive fabrication. In the case of custom photonic and metasurface designs, current state-of-the-art fabrication processes include electron beam lithography and subtractive etching processes. These techniques generally have low throughput, produce problematic waste streams and have high depreciated capital costs for large-area processing. There has been work with more scalable techniques such as imprint lithography but, to date, many of these approaches rely on less robust scattering media that is not suitable for high-durability applications in mobile electronics and energy applications. The emerging area of quantum emitters and even single photon emitters for integration into quantum optical systems face even more significant scalability and heterointegration challenges. Since these systems often involve the integration of conventionally incompatible materials and processing e.g. epitaxy of III-V and II-VI quantum dots and the integration of these with optical dielectric materials sometimes in three dimensional optical MEMs configurations to form quantum emitters in optical cavities, couplers and modulators.

Additive manufacturing and printing technologies of solution-based functional materials presents the opportunity of fully-additive, wasteless low capital manufacturing in optoelectronics that can allow complex hetero-integration of dissimilar materials. To date, however, these approaches have only been effective for critical dimensions and positioning accuracies in applications such as OLED display processing that are orders of magnitude too large for most IR and visible range optical applications. At the University of Washington, we have been developing additive manufacturing pathways based on multinozzle-scalable electrohydrodynamic (EHD) printing and novel solution-based precursor materials for optical structures and semiconductor quantum dot emitters. By using high electric fields to extract and direct femtoliter and attoliter scale droplets, patterning resolutions at the nanoscale have been demonstrated. Using EHD techniques, we have shown the ability to additively deposit, print-on-demand functional IR metasurface lenses with no vacuum or subtractive lithography. Also, EHD has been employed to directly integrate quantum dot emitters with wavelength-matched photonic resonators and air-suspended fully released cavities with fully-additive processing. To create these metasurfaces and quantum emitter integrations, customized precursor inks for optical dielectrics such as $TiO2$ and printed emitter inks from dilute perovskite semiconductor nanocrystals and II-VI quantum dots. Although this technology is still in its early stages, it promises and is beginning to deliver capabilities that conventional semiconductor and optical fabrication approaches may not be able to deliver. In this talk, we will introduce this manufacturing and materials approach and present our latest results as well as future developments in additive nanomanufacturing of photonic and quantum optical materials and devices.

Biography

Dr. Devin MacKenzie is the Washington Research Foundation Professor of Clean Energy and an Associate Professor of Materials Science and Engineering and Mechanical Engineering at UW. Devin is a scientist, research leader and seed stage entrepreneur with over 17 years of experience in printable and flexible electronic materials and integrated systems. He is currently the CEO of Imprint Energy, a UC Berkeley spin-out developing flexible, high energy batteries based on large-area print manufacturing. Previously, as the CTO of Add-Vision, Inc., Dr. MacKenzie led R&D of materials and processing for roll-to-roll printed flexible OLED displays. Prior to Add-Vision, he initiated and led printed Si GHz RF device, laser processing and product engineering at Kovio, Inc., an MIT Media Lab spinout.

Dr. MacKenzie also co-founded the first ink jet printed electronics company, Plastic Logic, from the University of Cambridge while he was in the Dept. of Physics as a post doc and later a visiting scientist researching solution-processed photovoltaics, phase separation in optoelectronic polymer blends and surface-directed self assembly of device nanostructures. Prior to that he worked in InGaAsP defect analysis at AT&T Bell Labs in Murray Hill.

Dr. MacKenzie has over 110 patents and publications and doctorate, master's, and undergraduate degrees in Materials Science and Engineering from the University of Florida and MIT. He has received numerous awards including being elected to the Cleantech 100 two years in a row as well as being recognized for leading one of the Top 50 Smartest Companies of 2015 by the MIT Technology Review.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

Indu Fiesler Saxena

Innoveyda, United States

Biography

Indu Fiesler Saxena, Ph.D., Principal Scientist at Innoveyda, indufs@gmail.com, received her Ph.D. in Applied Optics at the University of Alabama at Huntsville in 1991, an M.Sc. in Physics at the Indian Institute of Technology (Kanpur, India) in 1984, and a B.Sc. in Physics from Delhi University in 1982. Dr. Saxena is an expert in optical metrology, especially optical fibers for acoustics and ultrasound, and in spectral analytic techniques including non-linear optical phenomena. Dr. Saxena's first flightworthy fiber optic rocket payload instrument measured small magnetic fields via polarimetric changes in coiled optical fiber. The first time-sampled automated ellipsometer for fiber systems was also concurrently demonstrated during her doctoral dissertation. Current density measurements with magneto-optic effect in glass fibers were studied and a compact, dedicated polarimetric hardware for rocket-borne ionospheric measurements was implemented. At the Dalle Molle Institute for Artificial Intelligence and Perception (IDIAP) in Martigny, and Institut de Microtechnique in Neuchatel, Switzerland, Dr Saxena worked on liquid crystal light valve implementation in optical processors. In her tenure at Intelligent Optical Systems, Inc. she initiated Brillouin sensor development, phase mask base bragg grating inscription, and led the optical fiber sensor group to investigate fluorescence of bacteria and human tissue, gamma-radiation dosimetry, novel integrated optical electro-optic, interferometric, and polarimetric devices. Her publications include optical fiber stress/strain, and temperature sensing with fiber Bragg gratings and non-linear Brillouin scattering, polarimetry, ellipsometry, and magneto-optical sensing, as well as luminescence/scintillation, fluorescence- and Raman-based detection. Dr. Saxena has 4 patents awarded: 2 on ultrasound detection with FBGs for NDE of composites ; on high-temperature-resolution medical hyperthermia sensor and fiber optic bacterial biofilm sensing. Dr. Saxena is developing fiber optic acousto-ultrasonic applications at Innoveyda for medical and industrial applications and the energy sector.

TOWARDS CHARACTERIZATION AND COMPENSATION OF ANTERIOR-SEGMENT TRANSPARENCY IMPERFECTIONS AND LOSS

[1,2]Irsch, Kristina

[1]Vision Institute – CNRS, INSERM, Sorbonne University, Paris, France

[2]The Wilmer Eye Institute, The Johns Hopkins University School of Medicine, Baltimore, MD

The eye has long been recognized as having the potential to serve as a window into the body, to visualize internal structures and study pathophysiological mechanisms. Much of this promise however has been unfulfilled because we still have not taken into account the human factor. Apart from inevitable patient and ocular motion, another major obstacle to high-grade ophthalmic imaging has been the imperfect transparency of intervening ocular media, notably that, in older individuals, of the cornea and crystalline lens (anterior segment). Imperfect anterior-segment transparency is also a leading cause of blindness worldwide as a result of increased scattering of light secondary to scarring caused by infections, other pathology, trauma, aging, or surgery. Despite its significance, clinical means to assess anterior-segment transparency are extremely limited and usually involve a subjective and qualitatively observation of opacities by means of slit-lamp biomicroscopy. This talk shall address ongoing work to meet this issue, the need for an objective means to quantify anterior-segment transparency, and to enable compensation for loss of ocular media transparency (e.g., imaging the retina through corneal and/or cataract opacities).

Biography

Kristina Irsch is a physicist specializing in ophthalmic instrument development. She received her PhD from Heidelberg University under the mentorship of Josef F. Bille, PhD. During her graduate studies she also worked at the Johns Hopkins Wilmer Eye Institute where she followed up with a postdoctoral research fellowship in ophthalmology under the supervision of David L. Guyton, MD. She was then appointed to Assistant Professor of Ophthalmology at the Johns Hopkins University School of Medicine, where much of her research interest has focused on the development and translation of a diagnostic screening device for remote detection of vision disorders in young children. In 2014, while on Professional Leave from Johns Hopkins, she came to the Vision Institute / Quinze-Vingts National Eye Hospital in Paris to work in collaboration with the Langevin Institute to help develop high-resolution ocular imaging methods. She is now also a permanent researcher at the French National Center for Scientific Research (CNRS). Her current scientific work is focused on solving problems inherent to ophthalmic imaging in patients, as well as on turning these problems, such as eye movements and light scattering, to potential advantage. The overall goal is to exploit the potential of the cornea and the eye to serve as a window into systemic processes within the body.

3rd Edition of Annual Conference

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

JUNE 02-05, 2023

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

YOUNG RESEARCHERS PRESENTATIONS

ATOMICRELATIVITY,AHOLISTIC APPROACH INTEGRATING QUANTUM TUNNELLING AND ENTANGLEMENT INTO THE EVOLUTION OF ATOMIC STRUCTUREINTHEBIOLOGYOF LIFE AND THE UNIVERSE.

Dr. Ilirjana Anna Sino Toptani[1], Dr. Keryn Johnson[2]
[1]Scientific Advisor and LOPS International Annual Conferences, Canada
[2]QBRI and CEO and Founder at Quantum Technologies Limited, New Zealand

The quantum perspective represents the universe as a set of energy fields in continuous interaction. Biomedicine is in crisis because it does not recognize the complexity of the intercommunication between matter and the energy fields that make up the whole. The observation of light as a light with no mass and no charge places it outside of the materialism's domain. Therefore, it is made impossible for materialism to describe light, because it is unable to describe the atomistic view of light. A new model a Physics Singularity mode, SUSY inversion model predicts that quantum tunneling and entanglement processes are responsible for the creation of both mass and charge in the formation of stable atomic structures that creates a quantum coherent system of atomic light in the atomic structure. The feature of the equation provides contextualized relationships between c (speed of light) and v (velocity of alpha particle decay) in terms of the formation of mass via the expansion and contraction of the electromagnetic fields through the tunneling and entanglement process of the two photons of light to generate the proton and the electron and the neutron and positron. The flow of information in the quantum universe is holistic, and the elements of the cell are intertwined in a complex web of communicative loops as shown by the studies on mapping interactions between atoms in the cell demonstrating the physical presence of these complex holistic pathways. In the complexity of the biological landscape the evolutionary properties of atoms are not considered. While Standard Model of Particle Physics for atoms includes protons, neutrons and electrons the new model, SUSY inversion model, a non-Standard approach, predicts a way to revise quark charge calculations providing charge parity with positron and electron pairs, a way to explore e new theoretical atomic framework, which includes positions. It also provides a model to identify electromagnetism in orbital layers of atoms through rearranging Einstein's mass energy equivalence equation from E=mc2 to c2 = E/M providing a relationship between E and M at right angles to one another and the photons generated in the Z dimension.

The discovery of the quantum landscape in terms of atomic selection pressure showed that the universe is selected to contain a set of functional fields that generate a set of atomic species that are placed under the selective pressure of the quantum field. This pressure of the early universe created ideal conditions for the formation of dark energy, dark matter that arose from helium Bose Einstein condensate 100%. After 13,8 billion years the cause of the change of the cosmological composition is predicted to be an alpha particle emission from the He-BEC isotropic singularity. The SUSY inversion model provides a new atomic framework which includes positrons in atomic orbital layers so that s orbitals have also two positrons whose inclusion gives a negatively charged neutron. This new geometry allows exploration of more fundamental aspects of atoms including the formation of mass based on proximity to the singularity in a linear relationship to the decay system operating in atoms that generates three generations of particles. The generation of unstable atoms (isotopes in the aromatic ring of neurotransmitters and phenolic ring systems provides the identification of a quantum biological process associated with neurotransmitter function. The unstable atom physics model based on SUSY inversion provides the basis for the application of single atom physics to human biology and a framework for the inclusion of quantum gravity into GR at the Planck scale through an inverse square law framework.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

MULTIMODE EXPERIMENTAL BAND DYNAMICS IN THE PRESENCE OF A VARIABLE INTERFACE

Nasrin Razmjooei
University of Texas at Arlington, USA

In this research, we demonstrate band dynamics in one-dimensional optical lattices presenting numerical and experimental results. In subwavelength periodic lattices, depending on the lattice geometry and material composition, leaky-edge state and non-leaky edge state appear. The leaky edge corresponds to highreflectivity guided-mode resonance, whereas the non-leaky edge represents a bound-state in the continuum (BIC). Here, we design three optical lattices consisting of Si3N4 gratings on glass. Applying refractiveindex matching oil on these lattices, we demonstrate band dynamics by calculating zero-order reflectance with respect to wavelength and incident angle. Adding the index-matching oil results in the excitation of higher electromagnetics modes showing the effect of the new interface. The experimental and numerical results pertinent to the proposed device are compared showing perfect agreement

Biography

I am a Ph.D. student at the University of Texas at Arlington, specializing in designing and fabricating periodic sub wavelength structures for meta surfaces and meta materials. My research has resulted in several publications and has been supported by the National Science Foundation. I have collaborated with various optics and photonics journals as a peer reviewer and have received awards and fellowships for my work. Before my Ph.D., I worked as a research assistant at the University of Victoria, where I focused on optical manipulation and trapping using nanostructured metals. I earned my master's in Optics and Laser Physics and have experience using advanced simulation software tools such as COMSOL MULTIPHYSICS, CST Microwave Antenna, and Lumerical. My goal is to continue my research in nanophotonics and develop innovative methods for use in healthcare, defense, and renewable energy applications

STUDY ON PHOTOSENSITIZERS FOR THE TREATMENT OF NEURODEGENERATIVE DISEASES USING COMPUTATIONAL MODELING AND THEORETICAL ANALYSIS

Rachel Kim
United Nations High School, USA

Photodynamic therapy (PDT) is a treatment that involves the use of photosensitizing molecules and light, causing a reaction that results in the destruction of the targeted cells. While PDT is usually used to treat cancer, there is some research being done to explore the potential of this therapy in the treatment of neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, and multiple sclerosis. While the use of PDT for neurodegenerative diseases is still in the experimental stage, there is some promising early evidence that this approach may be effective in slowing the progression of these conditions and improving the quality of life for patients.

In this paper, computational and theoretical research was conducted on a variety of molecules used in the treatment of neurodegenerative diseases. Fullerene-porphyrin complexes were modeled and analyzed regarding their thermodynamic stability, activity, and suitability as photosensitizers. Optimization energy and other physicochemical properties of the nano-scaled complexes were found using a molecular editing program. Using this software allows the biomedical analysis of the Fullerene-porphyrin complexes that differ in chemical composition and structure.

References

1.https://en.wikipedia.org/wiki/Neurodegenerative_disease

2.Wang Y, Huang L, Huang X, et al. Photodynamic therapy with protoporphyrin IX alleviates Alzheimer's disease by inhibiting β-amyloid aggregation and enhancing microglial phagocytosis. Acta Biomater. 2020;101:603-615.

3.Cui H, Zhang Y, Wang J, et al. Porphyrin-loaded albumin nanoparticles for targeted photodynamic therapy in a rat model of Alzheimer's disease. Biomater Sci. 2021;9(5):1817-1825.

4.Kim T, Kim D, Kim H, et al. Porphyrin derivatives alleviate cognitive deficits and reduce amyloid-β plaques in an Alzheimer's disease mouse model. J Photochem Photobiol B. 2019;201:111654. doi: 10.1016/j.jphotobiol.2019.111654

5.DeRosa MC, Crutchley RJ. Photosensitized singlet oxygen and its applications. Coord Chem Rev. 2002;233-234:351-371. doi: 10.1016/s0010-8545(02)00057-6

6.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2783742/

7.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5551541/

8.https://pubchem.ncbi.nlm.nih.gov/compound/Porphyrin

9. Https://www.futuremedicine.com/doi/10.2217/nnm.09.111

Biography

Rachel Kim is currently a rising junior at the United Nations High School. She is interested in Pharmacology and Biochemistry. Her research focused on photosensitizers for the treatment of neurodegenerative diseases using computational modeling and theoretical analysis. Her future goal is to become someone who has the ability to help people with genetic, mental, and physical disorders.

NOVEL 3-D VASCULAR METABOLIC IMAGING TO ASSESS EFFECTS OF IRRADIATION IN LUNGS AND KIDNEY OF RATS

Parisa Nategh[1*], Mehrnoosh Neghabi[1*], Soudeh Mostaghimi[2], Buse Nur Ceyhan[1†], Shalaka Konjalwar[1†], Brian Fish[3], Meetha Medhora[3], Mahsa Ranji[1]

Biophotonics Laboratory, Department of Electrical Engineering & Computer Science at Florida Atlantic University, Boca Raton[1], Department of Biomedical Engineering,University of California, Irvine[2], Medical College of Wisconsin, Milwaukee[3]

* These authors contributed equally to the work
† These authors contributed equally to this work

Introduction: Ionizing radiation induces vascular regression by mechanisms that remain unknown. Therefore, the assessment of vasculature by imaging techniques can function as a valuable tool to study the mechanism of regression in rat models of radiation–induced injury. Autofluorescent optical- and cryo-imaging have been used to evaluate naturally occurring mitochondrial metabolites (NADH and FAD), which are abundant in tissues but not in the blood.

Goal: 1) To obtain 3-D digital images of the vascular tree as well as record the redox state of rat organs by inverting fluorescence signal obtained from NADH and FAD 2) to use this technique as a tool to assess vascular regression and redox changes induced by ionizing radiation.

Methods: Rats (WAG/RijCmcr, ~12-week-old females) were given a single dose of 7.5, 10 or 12.5 Gy X-rays with one hind leg shielded (leg-out PBI) or no irradiation (controls, (n>3/group). After 100 days the lungs and kidneys were harvested. The lungs were infused with fluorescein isothiocyanate–dextran (FITC-dextran) via the trachea and frozen in isopentane. A 3-D fluorescence cryo-imager was used to capture intrinsic NADH (λex350/em460 nm) and FAD (λex437/em537 nm) signal from both organs and FITC signal (λex545/em645 nm) from lungs to delineate the airway. Algorithms were developed to map the vascular tree by inverting the metabolic signals. The kidney vascular tree was confirmed using genetically engineered rats expressing endothelial-specific TdTomato (λex535/em645 nm).

Results: 3-D rendered images of NADH, FAD, airways, vasculature, and combined images revealed a robust vascular network typical of the lung and kidney. In the lung, the vascular tree did not overlap with the airways (Dice coefficient < 0.001). In the kidney, co-registration with TdTomato was primarily with blood vessels (Dice coefficient of 0.91). The vascular trees obtained by this novel technique displayed regression of vessel networks after PBI, which became more pronounced with increasing doses of radiation. In addition, irradiated organs displayed a more oxidized mitochondrial redox state.

Conclusion: In summary, we have developed and validated a novel 3D-vascular segmentation technique to monitor redox changes and vessel regression in irradiated rats to study mechanisms of vascular regression in the lungs and kidneys. Vascular metabolic imaging produces both metabolic redox state and vascular information at the same time, which is a feature that is unattainable with current imaging techniques. It proves to be a useful biomedical research tool with many potential clinical applications.

Keywords: 3D-vasculature, FAD/NADH fluorescence, quantified vascular parameters

Grants: NIH EY031533 (Dr. Ranji), AI107305, AI133594, and AI101898 (Dr. Medhora)

Biography

Shalaka Konjalwar

Shalaka received her BS in Biology and BA in Spanish from the University of Florida in Gainesville, Florida in 2020. She assisted graduate students in the Brain Mapping Laboratory, where students use electrophysiology and bioimaging to understand behavior and effects of stimulation in neurological disorders. Her research interests include wound imaging, vessel segmentation, signal processing, and using fluorescence spectroscopy in cancer and disease diagnoses.

Parisa Nategh:

Parisa Nategh received her M.Sc. degree in Electrical Engineering, Electronics from the University of Tehran, Tehran, Iran, in 2020 and her B.Sc. degree in Electrical Engineering from Khajeh Nasir University of Technology, Tehran, Iran, in 2017. She worked as a graduate researcher on a new way of designing and fabricating an active microfluidic system with application in biomedical engineering. She designed and implemented an RGB detector using Raspberry Pi 4, its camera, and OpenCV Library in Python to recognize a wide array of chemicals in blood and other fluids. She spent her bachelors period learning about Neural Systems physiology and Brain Imaging techniques, including EEG, and continued to do her project on designing and implementing an 8-channel EEG (Brain-Computer Interface). Her research interests include biomedical imaging, biological image and signal processing, and biomedical instrumentation.

Mehrnoosh Neghabi:

Mehrnoosh received her B.Sc. and M.Sc. degrees in Biomedical Engineering from University of Isfahan, Isfahan, Iran in 2015 and 2018. She was a researcher at Isfahan Neuro Technology Laboratory from 2015 to 2018. She also worked as a research expert at Isfahan University of Medical Sciences between 2018 and 2020. In her master thesis, she focused on feature extraction algorithms in SSVEP-based BCI systems. Her research interests include biological image processing, biological signal processing, brain- computer interfaces, pattern recognition, and biomedical instrumentation.

SELECTIVE COATING REMOVAL FROM COMPOSITES SURFACE BY APPLICATION OF UV LASER TECHNOLOGY

R . Kozera[1*], B. Przybyszewski1, M. Gloc[1], A. Boczkowska[1]
[1]Warsaw University of Technology, Faculty of Materials Science and Engineering, ul. Woloska 141, 02-507 Warsaw, Poland

In nowadays, many specialized maintenance and servicing companies remove paint and coatings from e.g. aircraft by using methods such as aggressive chemicals, abrasive sanding, or the newest methodology like plastic media blasting. These methods are costly, time consuming, ergonomically unsafe, and produce large amounts of hazardous waste and emissions. Composite structures in new aircrafts and the application of complex primers no longer allow the use of chemicals which can damage the surface of treated area while mechanical removal also possess high risk for components. Coating systems require more accurate and controlled techniques that allow for selective removal of layers of paint without damaging the underlying layers. In the present study UV laser device with 355 nm wavelength was applied in order to verify efficiency of laser cleaning process and potential to remove a painting system from epoxy matrix composites reinforced with glass fibres and containing copper mesh. The results showed that the number of scans directly influences the efficiency of coating removal and surface structure. The efficiency of laser cleaning in aircraft applications was evaluated by SEM and optical microscopic observations of the cross sections and surface, as well as additionally by profilometer of resulted surface.

Biography

Dr. Eng. Rafał Kozera has a university degree in Materials Engineering obtained at the Faculty of Materials Science and Engineering of the Warsaw University of Technology. For his doctoral dissertation written in English, he was awarded the first prize in the 18th edition of the Fiat Chrysler competition for the best doctoral dissertation. In the last 5 years he has participated in 6 projects, including three international ones financed by e.g. EU. Dr. Eng. Rafał Kozera is the author and co-author of 29 publications in domestic and foreign journals, including the co-author of several book chapters. He completed many scientific internships in Germany, Spain, Canada and Switzerland. Over the last 5 years, he has carried out 36 documented expert opinions and research commissioned by the industry in the field of e.g. research on polymer materials. He is fluent in advanced methods of preparation and characterization of polymer and metal matrix composite materials in various forms.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

ACTIVITIES AND STABILITIES OF DIAMAGNETIC SUPERCONDUCTING MATERIALS USED IN MAGNETIC LEVITATION TRAIN

JeongWon Moon
Saint Johnsbury Academy Jeju, Korea

Superconducting materials play an important role in the operation of magnetic levitation trains, also known as maglev trains. Superconducting materials are used in the construction of the train's electromagnets. These enable levitation and propulsion by generating extremely strong magnetic fields with minimal energy loss due to the lack of friction between the train and the track.

The superconducting materials used in maglev trains are known as high-temperature superconductors (HTS), and the HTS materials maintain superconductivity at relatively higher temperatures. These materials are typically made of Barium, Copper, and Oxygen, such as yttrium barium copper oxide (YBCO).

This paper studies the Activities and Stabilities of those nano-scaled compounds in the magnet using electrical and computational simulations. The superconducting bulk magnet, specifically, (LRE)Ba2Cu3O7-x generates a very strong magnetic field. Thus,, a few light rare earth bulk superconducting magnets including Neodymium Barium Copper Oxide and Gadolinium Barium Copper Oxide are chosen for the thermodynamic and computational analysis. Recent research shows that rare-earth (RE)Ba2Cu3O7-x and light rare-earth (LRE) Ba2Cu3O7-x superconductors have a high critical-current density at high temperatures and high magnetic fields.

References

1.Rosenzweiga S et al. 2012 A superconducting levitation transport model system for dynamical and didactical studies Phys. Proc. 36 1037

2.Chen, L., Hu, X., & Sun, R. (2015). Research on Magnetic Levitation Technology of High-Temperature Superconducting Maglev Trains. Advances in Materials Science and Engineering, 2015, 825925.

3.Nariki, S., Kajikawa, K., & Yoshida, Y. (2016). Superconducting Levitation Technology Applied to Maglev Trains and Flywheels. IEEE Transactions on Applied Superconductivity, 26(4), 1-4.

4.Liu, Y., Chen, Q., Li, G., & Zhang, Y. (2020). Design and Performance Analysis of a High-Temperature Superconducting Maglev System for Urban Transportation. IEEE Transactions on Applied Superconductivity, 30(4), 1-5.

5.Han, Z., Zheng, J., Fang, J., & Liu, Y. (2020). Development and Application of Superconducting Maglev Systems in China. IEEE Transactions on Applied Superconductivity, 30(4), 1-5.

6.Zou, J., Fang, J., Wu, S., Zhang, H., & Zhang, Z. (2016). Progress in Research on Key Technologies for Superconducting Maglev Systems. IEEE Transactions on Applied Superconductivity, 26(4), 1-5.

7.Amemiya, N., & Funaki, K. (2019). Superconducting Maglev Systems: Technological Overview and Future Perspectives. Applied Sciences, 9(6), 1196.

8.Zhang, L., Fang, J., & Zheng, J. (2019). Progress in superconducting maglev transportation in China. Superconductor Science and Technology, 32(6), 063003.

9.https://scmaglev.jr-central-global.com/about/

https://www.energy.gov/articles/how-maglev-works

Biography

JeongWon Moon, a rising junior at St.Johnsbury Academy Jeju, is passionate about Physics and Mathematics. She takes great pleasure in communicating and collaborating with others to achieve a common goal. JeongWon aspires to develop into an individual who cooperates with teammates to reinforce the community and help people with difficulty.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

EFFECTIVENESS OF UV LASER ABLATION DEVELOPED FOR COATINGS REMOVAL FROM COMPOSITES SURFACES

B. Przybyszewski [1*], R . Kozera [1], M. Gloc [1], A. Boczkowska [1]

[1]Warsaw University of Technology, Faculty of Materials Science and Engineering, ul. Woloska 141, 02-507, Warsaw, Poland

Coatings on aircrafts fulfil important role for the safety of flights. Thus, they need to be regularly controlled and periodically repainted. Removal of the coatings from the aircraft surfaces by means of the laser techniques possess at least few potential advantages in comparison to standard mechanical coatings removal. For those belongs among others significant reduction of wastes, often hazardous for environment, possibility for selective coatings or coatings layer removal as well as high efficiency and process control. In this study efficiency of laser cleaning was analysed on a coated epoxy matrix composites reinforced with glass fibres and copper mesh. The research was performed in two stages. In the first stage composite substrates were coated with wide variety of painting systems including two different coating systems, with different total thickness and colour pigmentation. The main aim of this procedure was to determine and optimize the UV laser cleaning parameters for removing a different primer and topcoat combinations. This stage was also an attempt to establish most universal parameters as a starting point for further more detailed analysis. The presented results indicated that the number of scans directly affect the efficiency of coating removal and surface structure. The efficiency of UV laser cleaning process in aircraft was studied by SEM and optical microscopic observations of the cross sections and surface, as well as additionally by profilometer in order to find out how roughness of the surface is changed.

Acknowledgements: This research was financially supported by the National Centre of Research and Development under Grant MAZOWSZE/0211/19

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

ARTIFICIAL INTELLIGENCE ENABLED, "ON-CHIP" ANALYSIS OF DIFFUSE REFLECTANCE SPECTROSCOPY DATA FOR CANCER DETECTION

Allison Scarbrough[1], Keke Chen[2], Bing Yu[1]

[1] Marquette University & Medical College of Wisconsin, Biomedical Engineering Department

[2] Marquette University, Computer Science Department

Corresponding Mail: 1515 W. Wisconsin Ave Room #338C, Milwaukee, WI, 53233

Cancer is a major global health problem, with those living in lower-to-middle-income countries left especially vulnerable to late-stage diagnosis. This is largely due to a lack of low-cost, point-of-care screening devices for cancer that can provide reliable results, without an internet or cellular connection.

Diffuse reflectance spectroscopy (DRS) is a compelling technology towards addressing this issue. In addition to being low-cost and easily incorporated into portable devices, it can detect the changes in tissue hemoglobin (Hb) concentrations and tissue morphology that occur in carcinogenesis. This is because Hb is a major biological absorber of visible light (λ=450-700 nm). During cancer progression, the tumor microenvironment experiences heightened Hb concentration, and experiences other changes in tissue morphology. This in turn increases the absorption coefficient, μ_a, and changes the reduced extinction coefficient, μ_s', of cancerous tissue, versus normal tissue.

Artificial intelligence (AI) has been leveraged to extract optical properties from DRS data, as a more efficient alternative to the computationally cumbersome inverse Monte Carlo model. Previous groups accomplished this through training and testing algorithms on simulated data, which severely limits its clinical reliability. This is because simulations are incapable of capturing the complex factors that can impact clinical data. To bridge this gap, we have developed two AI regression models using 989 diffuse reflectance spectra from 190 tissue-mimicking phantoms. These spectra were collected by two copies of a previously published, portable diffuse reflectance spectroscopy system, over a 2-year span, and across 12 experiments. This data was used to develop random forest (RF) and XGboost regression models, where 70% of the data was used for training and 30% used for testing. The median absolute errors in predicting μ_a of the phantoms was 6% (RF) and 7% (XGboost). The median absolute error of predicting μ_s' for the phantoms was 4% for both algorithms. 75% of the testing data achieved an absolute percent error of <15% between predicted and actual optical properties for both algorithms. This process lends itself well to real-time analysis, with the average time to preprocessing & extract phantom optical properties being <0.25 seconds/spectrum, all without the need for an internet connection.

Biography

Allison Scarbrough received her B.S. degree in biomedical engineering from the Milwaukee School of Engineering, Milwaukee, WI, in 2019. She is currently pursuing a Ph.D. in biomedical engineering through the Joint Biomedical Engineering Department at Marquette University and the Medical College of Wisconsin.

PARALLEL PHASE ESTIMATION IMPROVEMENTS TO THE WELL OPTIMIZED LINEAR FINDER (WOLF) ATMOSPHERIC TURBULENCE COMPENSATION (ATC) METHOD USING FIELD PROGRAMMABLE GATE ARRAY

Timothy Coon
Florida Institute of Technology, USA

The Well Optimized Linear Finder (WOLF) method is a novel, non-iterative deconvolution method implemented to correct atmospheric and system phase disturbances in optical systems using diversity incoherent image irradiance data. The WOLF method addresses the real-time problem of spatial resolution limitations caused by turbulent atmosphere in long-range optical imaging systems having sufficiently large entrance pupil plane apertures such as those in telescopic imaging systems. Developed by Dr. William Arrasmith at the Florida Institute of Technology, the WOLF method recognizes symmetries and entrance pupil plane phase redundancies inherent in the discrete convolution of the generalized pupil function calculation of the Optical Transfer Function (OTF) to estimate the optimal solution. Simultaneously, the generalized pupil function of the system and the aberration-free object radiant emittance are estimated. The WOLF method leverages parallel processing capabilities of computers to significantly reduce the time required to solve the OTF estimation problem. This speed advantage is essential to realize real-time ATC systems. The research herein establishes practical temporal advantages of parallel calculations in a Field-Programmable Gate Array (FPGA) microprocessor platform, specifically. The FPGA architecture is optimized to enable simultaneous calculations of the WOLF solution method and we demonstrate significant reduction in time to compute the OTF over traditional ATC solution methods. Demonstrating an ATC method using FPGA architecture is practical as FPGAs are field-deployable hardware proven to operate effectively in the same environments and situations which find increased performance with real-time ATC capability added. Furthermore, the FPGA is particularly suited for this stage of technology development, boasting heritage application from system prototyping through integrated final design.

LOPS 2023
3rd Edition of Annual Conference
LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS
JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

LIGHT UP CANCER CELLS IN BREAST AND ORAL TISSUES BY DEEP ULTRAVIOLET LIGHT

Tianling Niu[a], Tongtong Lu[a], Julie M. Jorns[b], Mollie Patton[b], Tina Yen[c], Bing Yu[a]
[a]Marquette University & Medical College of Wisconsin, Biomedical Engineering Department, Milwaukee, Wisconsin, United States
[b]Medical College of Wisconsin, Department of Pathology, Milwaukee, Wisconsin, United States
[c]Medical College of Wisconsin, Department of Surgery, Milwaukee, Wisconsin, United States
Corresponding Mail: 1515 W. Wisconsin Ave Room #338C, Milwaukee, WI, 53233

Surgery is the most effective treatment option for early-stage solid tumors. Positive margin (cancer cells found on the surface of the excised tumor specimen) is a strong indicator of high risk for cancer recurrence, which may lead to additional surgeries and significant physical and financial burdens to the patients. The re-excision rates for lumpectomy (or breast conserving surgery) and partial glossectomy (removing a portion of a tongue) are both above 20%. The most common method to perform postoperative assessment is histopathology, which often takes overnight or longer for the surgeons to receive the results. Therefore, there is a critical need for an effective intraoperative tool that can detect positive margins during the surgery with high resolution. Our group recently reported a fluorescence scanning microscope (DUV-FSM) based on microscopy with ultraviolet surface excitation (MUSE) for intraoperative imaging of breast tumor margins and a texture analysis (TA) method for automated detection of positive margins from the fluorescence images. Our device and algorithm have achieved high accuracy in differentiating malignant tissues from their normal/benign counterparts. In this poster presentation, we compare the optical contrasts in breast and tongue tissues that are revealed by topical staining of the tissue by Proprium Iodide, which stains DNA inside of the apoptotic cells, and Eosin Y, which stains cytoplasm and connective tissues. The outcome of the comparison will be used to make an informed decision to adopt the DUV-FSM for imaging more surgical tissues from oral surgery and re-train our TA algorithms for margin assessment during glossectomy.

Biography

Tianling Niu received her B.S. degree in physics from the Sichuan University, China, in 2021. She is currently a Ph.D. student in the Joint Department of Biomedical Engineering Department at Marquette University and the Medical College of Wisconsin.

APPLICATION OF THE WELL-OPTIMIZED LINEAR FINDER (WOLF) ATMOSPHERIC TURBULENCE COMPENSATION METHOD TO HYPERSPECTRAL IMAGING SYSTEMS

W. Arrasmith[1] , E. He[2]
[1]Florida Institute of Technology, Melbourne, FL, USA
[2]Florida Institute of Technology, Melbourne, FL, USA

The Well-Optimized Linear Finder (WOLF) high-speed transfer function estimation method has been shown to apply to diversity-based imaging systems for atmospheric turbulence compensation (ATC) purposes. Thus far, the WOLF methodology has been applied to only monochromatic imaging systems with the understanding that the extension to colored imagery such as those that use the RGB color cube (or some other color mapping scheme) are straight forward once the ATC is accomplished at a single wavelength. In this work, we investigate the application of the WOLF algorithm to hyperspectral imaging (HSI) systems and show that there is a benefit not only to the achievable spatial resolution of the HSI system at any given wavelength, but also a benefit to the achievable per-pixel signal-to-noise ratio (SNR) across all wavelengths where a detectable amount of signal is present. In the latter case, the increase in the per-pixel SNR will permit better discrimination of spectral signatures. A notional conceptual optical layout is presented to provide a platform agnostic means to illustrate our approach. The use of a representative variable entrance pupil plane mask, such as can be achieved with the employment of a spatial light modulator (SLM) or rotating reticle, can be used in concert with the WOLF algorithm to generate high-speed ATC results for HSI imagery. The benefits of using the SLM to imprint a known entrance pupil plane phase offset in the detected HSI imagery is also presented. An example of the WOLF methodology applied to a "push-broom" HSI system is given for a diversity-based imaging system, along with a platform agnostic speed comparison of the WOLF with representative traditional ATC methods.

NON-DIVERSITY BASED, SOFTWARE-ONLY, ATMOSPHERIC TURBULENCE COMPENSATION (ATC) OVER MULTIPLE ATMOSPHERIC REALIZATIONS USING THE WELL-OPTIMIZED LINEAR FINDER (WOLF) METHODOLOGY

W. Arrasmith[1], E. He[2]

[1]Florida Institute of Technology, Melbourne, FL, USA

[2]Florida Institute of Technology, Melbourne, FL, USA

The Well Optimized Linear Finder (WOLF) atmospheric turbulence compensation (ATC) methodology is currently a fast, software-dominant, diversity-based means to remove atmospheric turbulence from optical imagery and spectral imaging systems. One current drawback is that the WOLF ATC has been optimized to work with diversity-based imaging systems that require the simultaneous capture of both an in-focus image, and a diversity image that has its entrance pupil plane phase related in a known way to the in-focus image. Typically, the optical path length of the diversity image is changed relative to the in-focus image to generate this determinable phase difference at each entrance pupil plane sampled phase location. In this work, we present a method to use the WOLF ATC method using no extra hardware and eliminating the requirement for the simultaneously captured diversity image. This adaptation to the WOLF methodology provides a software-only ATC capability but instead requires multiple atmospheric realizations to determine the ATC image. Consequently, our WOLF adaptation is not considered real-time capable (faster than 30 Hz). In our software-based approach we first estimate the magnitude of the un-aberrated object spectrum, and subsequently estimate the associated object spectrum phase. This adaptation of the WOLF methodology can be directly extended to multi-spectral and/or hyperspectral imaging systems to generate spatial resolution and per pixel signal-to-noise ratio improvements for imagery at chosen wavelengths. Apart from providing an ATC capability for future imaging systems (both hyperspectral and high spatial-resolution imaging systems), the implication is that existing collected image data sets for general incoherent imaging systems that satisfy key collection requirement presented here, can potentially be retroactively corrected for atmospheric turbulence effects. We present the conceptual layout, technical approach, and provide simulated results. Although only two distinct narrow-bandwavelengths are required for this WOLF adaptation, we demonstrate our results with a representative Hyperspectral Imaging (HSI) ‘push-broom” imaging system application to show the generalization of our approach. Even thoughe this WOLF adaptation may not be real time capable, it is highly scalable and dramatically benefits from general purpose parallel processing (GPPP) technology.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

STUDY ON THE JAMES WEBB TELESCOPE: TECHNOLOGICAL REVOLUTION AND IT'S ASTRONOMICAL MECHANICS

Eddie Yeo
Herricks High School, USA

The James Webb Space Telescope(JWST) is an advanced telescope compared to the Hubble telescope. The James Webb Telescope had a lot of technological advancements and the telescope's instruments are designed to capture infrared light to study every phase in cosmic history. The light has longer wavelengths and it can pass through dense regions of gas in space with less scattering so that an observation of the very distant objects is available. The JWST aims to address a variety of scientific questions, such as the formation and evolution of galaxies, the birth of stars and planetary systems, the detection and characterization of exoplanets, and the study of objects within our own solar system, including planets, moons, asteroids, and comets. Thus the research goals of the James Webb Space Telescope can be grouped into four main themes:

- Alien worlds, from those in our own Solar System to exoplanets.
- Galaxies through time.
- The life cycle of stars, from their birth to their death;
- The early Universe as it was only 200 to 300 million years after the Big Bang.

We performed a study about the orbit of the James Webb Telescope that moves around the sun, 1.5 million kilometers away from the Earth at what is called the second Lagrange point 2 or L2. The L2 location is stable so that it can provide better communication with Earth and protection from gravitational effects, heat from the sun, and other disturbances.

In this paper, the missions and performances of the James Webb Space Telescope were stated and the author's opinions on the recent trend of the telescopes were described based on the extensive research on the related technologies. Also, the location L2 of the telescope was observed and analyzed using astronomical mechanics to figure out how the James Webb

Telescope maintains its stable position in relation to the two large rotating bodies around it.

References

1. JWST Mission Overview Paper: The mission overview paper titled "The James Webb Space Telescope" provides a detailed overview of the JWST mission, its science objectives, and the observatory's capabilities. The paper was published in the journal Space Science Reviews and can be accessed at: https://doi.org/10.1007/s11214-017-0424-5
2. NASA's James Webb Space Telescope Website: The official website of the JWST provides comprehensive information about the mission, science goals, technology, instruments, launch, and updates. You can access it at: https://www.jwst.nasa.gov/
3. European Space Agency (ESA) JWST Website: The ESA also provides information on its involvement in the JWST project. You can find details about the ESA's contributions, scientific goals, and related news at: https://www.esa.int/Science_Exploration/Space_Science/Webb
4. Canadian Space Agency (CSA) JWST Website: The CSA's website offers information about Canada's involvement in the JWST project and its contributions. You can visit it at: https://www.asc-csa.gc.ca/eng/webb/index.asp
5. "The James Webb Space Telescope: Science Guide": This comprehensive guide, prepared by the Space Telescope Science Institute (STScI), provides an in-depth look at the scientific goals, instrument capabilities, and expected discoveries of the JWST. It can be found at: https://www.stsci.edu/content/346/stsci-publication-the-james-webb-space-telescope-scie nce-guide
6. JWST on NASA's HubbleSite: The HubbleSite, maintained by the Space Telescope Science Institute, has a dedicated section on the JWST. It offers articles, videos, and interactive features that provide insights into the mission and its significance. You can explore it at: https://hubblesite.org/contents/news-releases/2021/news-2021-04

Biography

Eddie is a typical high school student and is currently a rising senior at

Herricks High School. He is mainly interested in Mathematics and Computer Programming. His research mainly focused on the technological advancements of the James Webb Telescope compared to its prior model, the Hubble Telescope, and its impact on the field of astronomy. His future goal is to contribute to astronomy and enhance technology further.

LOPS 2023
3rd Edition of Annual Conference
LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS
JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

OPTICAL IMAGING DEMONSTRATES METABOLIC DYSFUNCTION IN MBLAC1 KNOCKOUT MOUSE MODEL OF ALZHEIMER'S DISEASE RISK

Busenur Ceyhan[1*], Parisa Nategh[1*], Jacob LaMar[2*], Mehrnoosh Neghabi[1], Shalaka Konjalwar[1], Maureen K. Hahn[2], Randy Blakely[2], Mahsa Ranji[1]

Biophotonics Laboratory, Department of Electrical Engineering and Computer Science at Florida Atlantic University, Boca Raton[1], Department of Biomedical Science, Charles E. Schmidt College of Medicine and Stiles-Nicholson Brain Institute, Florida Atlantic University, Boca Raton[2]

* Co-first author, † Corresponding author

Introduction: The Mblac1 gene was implicated as a risk factor in Alzheimer's Disease (AD) mitochondrial dysfunction. Reduced MBLAC1 protein expression in mice models proposes a link to metabolic alterations and the progression of AD. This study examines how the mitochondrial respiration is affected in Mblac1 knockout (KO) mice. Mitochondrial coenzymes, NADH, FAD, and their redox ratio (NADH/FAD, RR) in the livers of wild type (WT) mice and their homozygous KO littermates, are quantified using 3D optical cryo-imaging.

Goal: We employed an optical cryo-imaging method to analyze metabolic state and their dynamic changes by quantifying NADH and FAD, and the resulting RR in tissue for WT and littermate Mblac1 KO mice.

Methods: The cryo-imager is an automated image acquisition tool utilizing a CCD camera to capture sequential slices of mice models, wild type (WT) and knockout (-/-) (KO), in two fluorescent channels (NADH and FAD). 3D rendered images were obtained with image processing techniques and report fluorescent intensity in NADH, FAD channels and RR, NADH/FAD.

Results: Three-dimensional fluorescent images of WT and KO mice are displayed in Figure 1. KO mice display an oxidized redox state (blue) versus oxidized WT (red). Figure 2 presents histogram plot for the mean values of WT and KO groups. The mean values demonstrate a 46.32% difference between KO (oxidized) and WT (reduced). Statistical analysis was carried out using Student's T-test and p value was set at $p<0.05$. The calculated p value, 0.021, proves significant difference (Figure 3).

Conclusion: Our results show Mblac1 mutation disrupts liver mitochondrial redox state. Our optical metabolic imaging provides quantitative measurements of metabolic biomarkers and reveal oxidized RR. Oxidized redox reports an inability to maintain normal metabolism indicative of ROS production.

Metabolic dysfunction suggests a model where risk for AD with cardiovascular comorbidity arises from diminished MBLAC1 expression.

Keywords: Optical Metabolic Imaging, Metabolic Redox State, Alzheimer's Disease

Grants: NIH EY031533 (Dr. Ranji) and an award from the Florida Department of Health (RDB) and FAU I-SENSE pilot grant (MR and RDB).

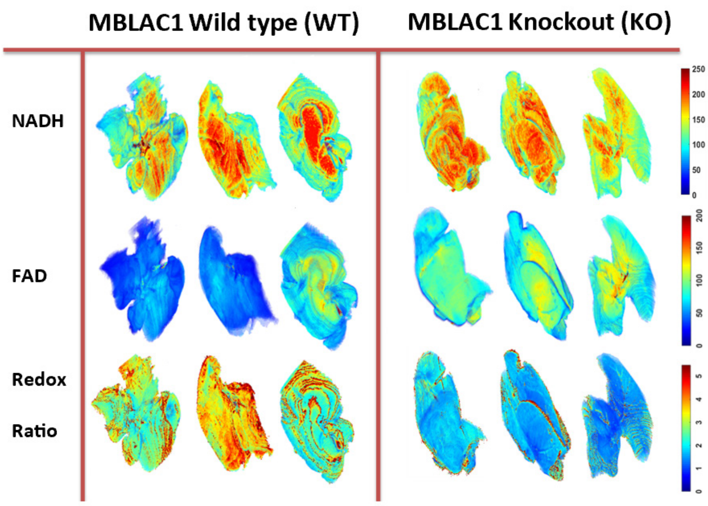


Figure 1. Panels present representative NADH, FAD and RR 3D rendered liver images of WT and KO.

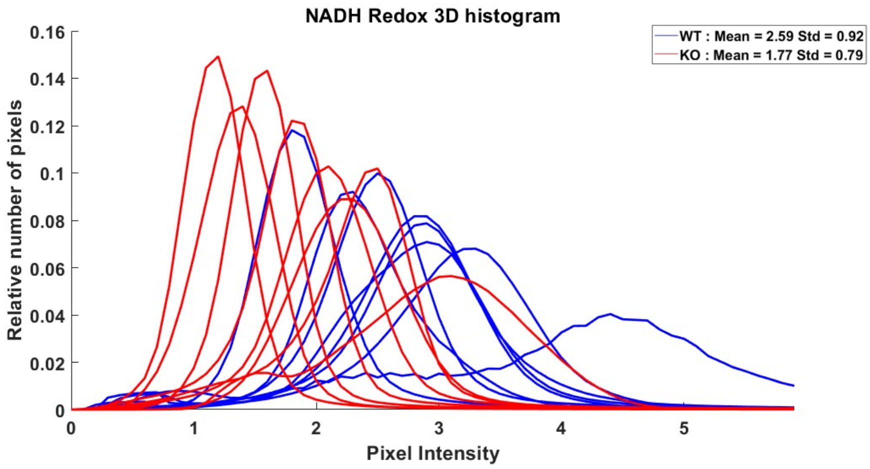


Figure 2. Plotted histograms of RR for 16 livers, WT and KO.

Biography

In 2019 Buse Nur completed her Bachelor of Science in Genetics and Bioengineering at Istanbul Bilgi University. For her senior design project, she designed an RPM to test the effects microgravity has on the growth of cancer cells. In addition, she has participated in research on protein supercomplexes with different structural and functional properties. Her interests include metabolic imaging, image reconstruction, signal processing and biomedical instrumentation.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

GENERALIZING THE WELL-OPTIMIZED LINEAR FINDER (WOLF) ATMOSPHERIC TURBULENCE COMPENSATION (ATC) METHODOLOGY TO NON-DIVERSITY BASED IMAGING SYSTEMS USING ENTRANCE PUPIL PLANE APERTURE MASKS

W. Arrasmith[1], E. He[2]

[1]Florida Institute of Technology, Melbourne, FL, USA

[2]Florida Institute of Technology, Melbourne, FL, USA, 321-674-8818

The currently developed Well Optimized Linear Finder (WOLF) atmospheric turbulence compensation (ATC) methodology potentially provides one of the most accurate, fastest, real-time, software-dominant, diversity-based transfer function estimation capabilities available. This has been shown in previous studies through theoretical complexity analysis, computer simulations, and confirmed via experimentation on various laptop computers with different types of Graphical Processor Units (GPUs). At the core of the WOLF algorithm is a unique virtual point method that may be extended, through either hardware or software means, to eliminate the requirement for a directly measured and simultaneously captured diversity image in removing atmospheric turbulence from collected imagery. A hardware approach using entrance pupil plane aperture masks is presented and is directly extendable to hyperspectral imaging systems at desired wavelengths. This can potentially benefit both the spatial resolution aspects of the hyperspectral imaging system, as well as the per pixel signal to noise ratio for spectral data. We present the technical approach, expected results, along with an articulation of the key collection requirements. A speed comparison between this new entrance pupil plane aperture mask approach and previous versions of the WOLF ATC method shows gains of up to 3 orders of magnitude. The WOLF methodology is highly scalable and dramatically benefits from general purpose parallel processing (GPPP) technology such as the GPU on computers, field programmable gated arrays, and/or other GPPP methods.

LOPS 2023
3rd Edition of Annual Conference
LASERS, OPTICS, PHOTONICS, SENSORS, BIO PHOTONICS & ULTRAFAST NONLINEAR OPTICS
JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

STUDY ON NANOPARTICLES IN PHOTODYNAMIC REACTION FOR WATER PURIFICATION USING DENSITY FUNCTIONAL THEORY AND COMPUTATIONAL SIMULATIONS

Junhyuk Lee[1], Richard Kyung[2]
[1]American Embassy School India
[2]RISE-NJ, Cresskill, NJ, USA
(2023 LOPS Winner of the Outstanding Team Research Award)

Recently, water purification technology with a photodynamic reaction as a photosensitizer has become an innovative approach that holds promise for improving water treatment processes.

Nanoparticles have a high surface area and unique properties that make them suitable for water purification.

In the photodynamic reaction, a light and a photosensitizer are used to generate reactive oxygen species (ROS) that can destroy contaminants or pathogens in water. Since they have strong oxidizing properties, the ROS attack and degrade contaminants, including organic pollutants and microorganisms, in the water. The photodynamic reactions with nanoparticles for water purification involve complex chemical processes, which can be studied through quantum chemistry and density functional theory (DFT) methods.

In this paper, selected nanoparticles were functionalized in different ways so that the activated photosensitizers generate ROS, such as singlet oxygen. The use of specific photosensitizers allows for the selective targeting of particular contaminants, tailoring the process to address specific water quality issues. In the context of water purification using nanoparticles and photodynamic reactions, quantum chemistry plays a crucial role in understanding the electronic interactions, energy levels, and reactivity of the nanoparticles and photosensitizers involved.

DFT calculations can provide insights into the reaction pathways involved in photodynamic processes, including the generation of reactive oxygen species and their interactions with contaminants.

This paper used Quantum chemistry and the DFT method to optimize nanoparticle design by modeling the electronic structure of nanoparticles. Specific properties, such as surface reactivity and energy levels, were examined to enhance their performance in photodynamic reactions. (2023 LOPS Winner of the Outstanding Team Research Award)

References

1. El-Toni, A. M., & Al-Warthan, A. (2017). Synthesis and applications of photoluminescent nanoparticles with controlled morphologies. Nanomaterials, 7(6), 129.
2. Zhang, J., Jiang, C., & Liu, Q. (2017). Green synthesis of noble metal nanoparticles decorated graphene and their applications in the detection and removal of pollutants. Nanomaterials, 7(4), 77.
3. Gao, W., Li, Q., & Wang, Y. (2017). Controllable preparation of hierarchical structured nanoparticles and their applications in water treatment. Nanomaterials, 7(9), 276.
4. Bae, J., & Mulchandani, A. (2017). Carbon nanotube-based sensors for detection of heavy metal ions in water. Nanomaterials, 7(2), 28.
5. Vankayala, R., Lin, C. C., & Kalluru, P. (2015). Gold nanoshells-mediated bimodal photodynamic and photothermal cancer treatment using ultra-low doses of near infra-red light. Biomaterials, 42, 121-134.
6. Zhang, H., Li, H., & Song, X. (2015). Nanostructured materials for photocatalytic water purification. Nanomaterials, 5(4), 1974-2002.
7. Pizzutilo, E., Palombo, F., & Gallo, V. (2019). Nanoparticles for water purification: The next generation of additives for enhancing membrane separation processes. Membranes, 9(1), 8.
8. Kong, B., Seog, J. H., & Graham, L. M. (2011). Nanomechanical study of the adhesion-dependent mechanical properties of Staphylococcus aureus biofilms. Langmuir, 27(21), 13025-13031.

9. Simsek, E., & Seog, J. H. (2014). Solvation effect on the electron detachment energies of microhydrated hydroxide and fluoride ions: A combined experimental and theoretical study. The Journal of Physical Chemistry A, 118(42), 9832-9838.
10. Yang, H. M., Cho, S. Y., & Seog, J. H. (2019). Density functional theory study of arsenic adsorption on TiO2 surfaces: Mechanistic insights into arsenic removal from water. The Journal of Physical Chemistry C, 123(22), 13831-13838.

Biography

Junhyuk is a dedicated and passionate student in the field of chemistry, with a strong focus on using nanotechnology to address the pressing issue of water pollution in India. His academic journey has been shaped by a deep interest in the intersection of science, environmental sustainability, and economics. He reads various articles and newspapers related to India's environmental pollution frequently.

LOPS 2023

3rd Edition of Annual Conference

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

JUNE 02-05, 2023 | DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA

THE HOLISTIC APPROACH IN THE BIOLOGY OF LIFE AND UNIVERSE IS SUPPORTED BY A NEW MODEL OF ATOM

Dr. Ilirjana Anna Sino Toptani[1], Dr. Keryn Johnson[2]

[1]Scientific Advisor and LOPS International Annual Conferences, Canada

[2]QBRI and CEO and Founder at Quantum Technologies Limited, New Zealand

The quantum perspective represents the universe as a set of energy fields in continuous interaction. Biomedicine is in crisis because it does not recognize the complexity of the intercommunication between matter and the energy fields that make up the whole. The observation of light as a light with no mass and no charge places it outside of the materialism's domain. Therefore, it is made impossible for materialism to describe light, because it is unable to describe the atomistic view of light. A new model a Physics Singularity mode, SUSY inversion model predicts that quantum tunneling and entanglement processes are responsible for the creation of both mass and charge in the formation of stable atomic structures that creates a quantum coherent system of atomic light in the atomic structure. The feature of the equation provides contextualized relationships between c (speed of light) and v (velocity of alpha particle decay) in terms of the formation of mass via the expansion and contraction of the electromagnetic fields through the tunneling and entanglement process of the two photons of light to generate the proton and the electron and the neutron and positron.

The flow of information in the quantum universe is holistic, and the elements of the cell are intertwined in a complex web of communicative loops as shown by the studies on mapping interactions between atoms in the cell demonstrating the physical presence of these complex holistic pathways. In the complexity of the biological landscape the evolutionary properties of atoms are not considered. While Standard Model of Particle Physics for atoms includes protons, neutrons and electrons the new model, SUSY inversion model, a non-Standard approach, predicts a way to revise quark charge calculations providing charge parity with positron and electron pairs, a way to explore e new theoretical atomic framework, which includes positions. It also provides a model to identify electromagnetism in orbital layers of atoms through rearranging Einstein's mass energy equivalence equation from E=mc2 to c2 = E/M providing a relationship between E and M at right angles to one another and the photons generated in the Z dimension.

The discovery of the quantum landscape in terms of atomic selection pressure showed that the universe is selected to contain a set of functional fields that generate a set of atomic species that are placed under the selective pressure of the quantum field. This pressure of the early universe created ideal conditions for the formation of dark energy, dark matter that arose from helium Bose Einstein condensate 100%. After 13,8 billion years the cause of the change of the cosmological composition is predicted to be an alpha particle emission from the He-BEC isotropic singularity. The SUSY inversion model provides a new atomic framework which includes positrons in atomic orbital layers so that sorbitals have also two positrons whose inclusion gives a negatively charged neutron. This new geometry allows exploration of more fundamental aspects of atoms including the formation of mass based on proximity to the singularity in a linear relationship to the decay system operating in atoms that generates three generations of particles. The generation of unstable atoms (isotopes in the aromatic ring of neurotransmitters and phenolic ring systems provides the identification of a quantum biological process associated with neurotransmitter function. The unstable atom physics model based on SUSY inversion provides the basis for the application of single atom physics to human biology and a framework for the inclusion of quantum gravity into GR at the Planck scale through an inverse square law framework.

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

Note:

Note:

INDEX

LOPS 2024

WILL BE

ANNOUNCED SOON