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LOPS2022™

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LOPS Annual Conferences™

Odd Higher Harmonic Generation and Ultra -Supercontinuum explained from instantaneous electronic cloud and slower molecular nonlinear Kerr index of refraction of materials for intense Femtosecond laser pulses

A fundamental theoretical model is presented for odd Higher Harmonic Generation (HHG) and Ultra –Supercontinuum (USC) light generation based on changes to the instantaneous temporal response of index of refraction n(t) from ultrafast Kerr electronic clouds distortion temporal response and from slower molecular motion from average index of refraction < n(t)> index of refraction from nonlinear Kerr index n2 and n4 at extreme intensities > 10 14 W/cm2 for 50 fs pulses, respectively.

Ultra-Supercontinuum broadening for n2 and n4 at extreme intensity can extend from zero DC frequency to X rays . At modest intensity the SC spectra at green pump laser will broadened to yield white light generation on Red Stokes side to Blue Anti-Stokes side covering the entire visible and NIR spectra . Since the SPM process is symmetrical, the spectra for a Gaussian 50 fs pump laser pulse at frequency ωo can extents to Anti-Stokes side up to 2 ωo and on the Stokes side can extent to DC (zero frequency). The theory HHG and USC is presented and compared with available experimental data.

This work was done in collaboration with Shah Faisal Mazhar (CCNY) and Lingyan Shi (UCSD).

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.

Robert R Alfano
Discoverer, White-light supercontinuum laser
Initiator, Optical Biopsy, SPIE Gold Prize Awardee, 2019
Founding Director, The City College of New York, USA
Plenary Speaker, Chief Planning Committee member | LOPS™ Annual Conferences

Areas of Expertise/Research:

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

Michael S. Feld Biophotonics Award

Charles Hard Townes Medal

PLENARY SPEAKER

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

PLENARY SPEAKER

Deep Tissue Optical Tomography: From Clinical Systems to Wearable Technology.

Biography

Professor Hielscher leads the recently established Department of Biomedical Engineering and directs research in his Clinical Biophotonics Laboratory (CBL). The mission of the CBL is to establish optical tomography as a viable biomedical imaging modality and transfer this technology into clinical practice. The goal is to develop a

patient-centered approach that addresses all aspect of modern precision medicine in state-of-the art healthcare. To this end Prof. Hielscher's team is developing cutting- edge imaging hardware and software that provide 3-dimensional distributions of physiologically relevant parameters such as oxygen saturation or total hemoglobin concentrations and more. This includes the design of wearable devices that allow continuous patient monitoring. The CBL is currently applying this emerging technology in various clinical and preclinical studies that focus on the diagnosis and monitoring breast cancer, arthritis, peripheral artery disease (PAD), and diabetic foot syndrome (DFS). Furthermore, techniques are being developed for real-time monitoring of brain activities.

Research Interests: Biomedical Imaging, Medical Instrumentation, Biophotonics, Biomedical Optics, Near-Infrared Imaging, Tomography, Image Reconstruction, Medical Imaging Analysis, Wearable Devices, Imaging of: Breast Cancer, Skin Cancer, Prostate Cancer, Rheumatoid Arthritis, Lupus, Peripheral Artery Diseases (PAD), Diabetic foot Syndrome (DFS), Brain, Modeling of Light Transport in Tissue, Equation of Radiative Transfer (ERT).

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LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Ultrafast laser science and technology using semiconductor diode lasers.

Peter J. Delfyett
Pegasus Professor, Optics & Photonics,
ECE & Physics,
Director, Townes Laser Institute,
University of Central Florida, USA
LOPS 2021, lops2022™

PLENARY SPEAKER

This presentation will review the underlying physics of ultrafast, high power pulse generation in diode lasers and show how one can 'engineer' around the limitations imposed by physics to achieve new levels of performance. Building on these ideas, stabilized optical frequency combs generation is achieved and lay the foundational groundwork for developing chip scale systems for communication signal processing, lidar and imaging.

Biography

Peter J. Delfyett received the B.E.(E.E.) degree from The City College of New York in 1981, the M.S. degree in EE from The University of Rochester in 1983, the M. Phil and Ph.D. degrees from The Graduate School & University Center of the City University of New York in 1987 and 1988, respectively. His Ph.D. thesis was focused on developing a real time ultrafast spectroscopic probe to study molecular and phonon dynamics in condensed matter using optical phase conjugation techniques. After obtaining the Ph.D. degree, he joined Bell Communication Research as a Member of the Technical Staff, where he concentrated his efforts towards generating ultrafast high power optical pulses from semiconductor diode lasers, for applications in applied photonic networks. Some of his technical accomplishments were the development of the world's fastest, most powerful modelocked semiconductor laser diode, the demonstration of an optically distributed clocking network for high speed digital switches and supercomputer applications, and the first observation of the optical nonlinearity induced by the cooling of highly excited electron-hole pairs in semiconductor optical amplifiers. While at Bellcore, Dr. Delfyett received numerous awards for his technical achievements in these areas, including the Bellcore Synergy Award and the Bellcore Award of Appreciation. Dr. Delfyett joined the faculty at the College of Optics & Photonics and the Center for Research and Education in Optics and Lasers (CREOL) at the University of Central Florida in 1993, and currently holds the positions of University of Central Florida Trustee Chair Professor of Optics, ECE & Physics. Dr. Delfyett served as the Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics (2001-2006), and served on the Board of Directors of the Optical Society of America. He served as an Associate Editor of IEEE Photonics Technology Letters, was Executive Editor of IEEE LEOS Newsletter (1995-2000) and sits on the Presidential Science Advisory Council of thqQe Orlando Science Center. He is a Fellow of the Optical Society of America, Fellow of IEEE/LEOS, was a member of the Board of Governors of IEEE-LEOS (2000-2002), and is also a member of Tau Beta Pi, Eta Kappa Nu, and Sigma Xi, and SPIE. Dr. Delfyett has been awarded the 1992 YMCA New Jersey Black Achievement Award, the 1993 National Black Engineer of the Year Award – Most Promising Engineer, the University Distinguished Research Award '99, and highlighted in Design News' "Engineering Achievement Awards". In addition, Dr. Delfyett has been awarded the National Science Foundation's Presidential Faculty Fellow Early Career Award for Scientists and Engineers, which is awarded to the Nation's top 20 young scientists. Dr. Delfyett has published over 500 articles in refereed journals and conference proceedings, has been awarded 30 United States Patents, and has been highlighted on 'C-SPAN', "mainstreekweek.com" and in "Career Encounters", a PBS Special on technical careers in the optics and photonics field. Dr. Delfyett was awarded the 1999 University Distinguished Researcher of the Year Award, the 2000 Black Engineer of the Year Award – Outstanding Alumnus Achievement, and the 2000 Excellence in Graduate Teaching Award. He was awarded the University of Central Florida's 2001 Pegasus Professor Award which is the highest honor awarded by the University. He is also a Founding Member in NSF's Scientists and Engineers in the School Program, which is a program to teach 8th graders about the benefits of science, engineering and technology in society. In 2003, Dr. Delfyett received the Technology Innovation Award from the Orlando Economic Development Commission. He was selected as one of the "50 Most Important Blacks in Research Science in 2004" and as a "Science Trailblazer in 2005 and 2006" by Career Communications Group and Science Spectrum Magazine. Dr. Delfyett has also endeavored to transfer technology to the private sector, and helped to found "Raydiance, Inc." which is a spin-off company developing high power, ultrafast laser systems, based on Dr. Delfyett's research, for applications in medicine, defense, material processing, biotech and other key technological markets. Dr. Delfyett was also elected to serve 2 terms as President of the National Society of Black Physicists (2008-2012). Most recently, he was awarded the APS Edward Bouchet Award for his significant scientific contributions in the area of ultrafast optical device physics and semiconductor diode based ultrafast lasers, and for his exemplary and continuing efforts in the career development of underrepresented minorities in science and engineering. Awards & Honors International Society for Optics and Photonics (SPIE) Fellow American Physical Society (APS) Fellow IEEE Photonics Society Fellow Optical Society of America (OSA) Fellow 2019 Excellence in Graduate Teaching College Award 2014 Florida Academy of Science's 2014 Medalist 2013 National Academy of Inventors Fellow 2013 Letter of Appreciation – SPIE 2013 Faculty Excellence for Mentoring Doctoral Students 2013 College Research Incentive Award (RIA) 2012 Faculty Excellence in Mentoring Doctoral Students 2012 College Excellence in Graduate Teaching Award 2012 Excellence in Graduate Teaching Award 2011 Excellence in Graduate Teaching Award 2011 APS Edward Bouchet Award 2010 American Physical Society Edward Bouchet Award 2010 IEEE Photonic Society Graduate Student Fellowship 2010 SPIE Educational Scholarship in Optical Science and Engineering 2010 Incubic/Milton Chang Travel Award to attend CLEO 2006 Science Spectrum Trailblazer 2005 District Advocate for the American Physical Society 2005 Science Spectrum Outstanding Black Professional in Science 2003 Technology Innovation Award 2003 UCF Millionaire's Club 2002 Pegasus Professor Award 2002 UCF Distinguished Research Professor Award 2002 UCF Millionaire's Club 2001 UCF Nguzo Saba Award 2000 Research Incentive Award (RIA) Research Group

Conducting research on ultrafast high power optical pulses from semiconductor diode lasers, for applications in applied photonic networks and laser induced materials modification.

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Structured Light and Dark by Metaoptics

Metasurfaces also offer fresh opportunities for structuring light as well as dark. I will discuss spin to total orbital angular momentum (OAM) converters and high OAM lasing, as well as flat devices that enable light's spin and OAM to evolve, simultaneously, from one state to another along the propagation direction . Finally, the demonstration of 2D phase and polarization singularities and the unique applications that they will open will be discussed.

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.

Federico Capasso
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PLENARY SPEAKER

Femtosecond Laser Ablation for Chemical Sensors and Other Devices

Peter J. Hesketh, D. Struk, Seung Joon Paik
School of Mechanical Engineering, Georgia Institute of Technology
V. Patel, D. Peaslee, M. Findlay, J. R. Stetter*
*KWJ Engineering, Newark, CA 94560

Femtosecond laser ablation is a highly flexible and versatile approach for microfabrication and patterning of different materials useful in chemical and biosensors. Ultrashort laser pulses generate surface energy absorption with reduced sub-surface damage due to the short thermal penetration depth with ultra short pulse duration. A wide range of materials can be processed with ultrashort laser processing including metals, ceramics, semiconductors and superconductors. Hydrogen sulfide, nitrogen dioxide, and sulfur dioxide are highly toxic gases with health effects at ppb and ppm levels in air. These compounds occur in industrial operations as well as in environmental atmospheric polluted air. Amperometic gas sensors were fabricated on a porous hydrophobic substrate made of layers of a Teflon woven mesh, on to which a 400 nm gold film was sputtered with a tungsten adhesion layer. A total of 60 sensors was patterned in a 6 by 10 grid per substrate with each sensor having a footprint of 15 mm x 15 mm. Traditionally, microfabricated electrochemical gas sensors use photolithography processes for patterning of the electrodes and defining the electrode geometry for high surface area to increase the sensor gas sensitivity. We present herein a series of gas sensor designs fabricated via laser ablation of sputtered Au films. For these sensors, the laser ablation step itself takes less than two hours to pattern up to 60 sensors. The sensor electrodes were assembled by lamination between several plastic layers and then an electrolyte was added. The assembled sensors were diced from the assembled 10x6 sensor wafer and individual sensors were connected to a potentiostat and tested via exposure to the various pollutant gases. The current response of these amperometric sensors was measured and found to be linear with respect to concentration in the low ppm range. This work illustrates an alternative to photolithography for the preparation of thin film gas porous electrodes for use in amperometric gas sensors.

Biography

Peter Hesketh received a B.Sc. in Electrical and Electronic Engineering from the University of Leeds (1979) and was a Thouron Fellow at the University of Pennsylvania, obtaining an M.S. (1983) Ph.D. (1987) in Electrical Engineering. He worked in the Microsensor Group at the Physical Electronics Laboratory of Stanford Research Institute and then Teknekron Sensor Development Corporation before joining the faculty at the University of Illinois in 1990 in the Department of Electrical Engineering and Computer Science. He is a Professor of Mechanical Engineering at Georgia Institute of Technology, Member of the Parker H. Petit Institute for Bioengineering and Biosciences, and Member of the Institute for Electronics and Nanotechnology, in the School of Mechanical Engineering. He is a past chair of the Sensor Division, and past chair of the Honors and Awards Committee of the ECS. His research interests include micro/nanofabrication techniques, MEMS based chemical gas sensors and gas chromatography systems, micro-magnetic actuators and microfluidics for sample preconcentration of microbial contamination. He has published over 100 journal papers and edited sixteen books on microsystems. He is a Fellow of the AAAS, ASME, ECS, a member of Sigma Xi and IEEE. His is married to Ann Marie with two children Gabriel and Lillian Hesketh.

KEYNOTE SPEAKER

Vibrational Spectroscopic Imaging of Biopolymers: From Micrometer to Nanometer Scale

This presentation focuses on structural investigations of phase-separated biopolymer blends by vibrational spectroscopic imaging techniques and will illustrate the improvement of lateral resolution from the micro- down to the nanometer scale over the last two decades. Generally, bio-degradable polymers which are produced from raw materials of the agricultural production chain or by the action of microorganisms are rapidly gaining economic importance. This is due to the increasing demand for reducing the exploitation of fossil raw materials and recycling short-lived products such as food packaging and has gained dramatic importance in view of the environmental problem of micro-plastics. Notwithstanding their ecological advantages, such biopolymers must fulfill the same end-user requirements in terms of their thermal and mechanical properties as the standard plastics, which presently dominate the world market. However, individual biopolymers do not fulfill these specifications and are blended with other biopolymers for the optimization of their properties. Dependent on the blend concentrations, such biopolymer mixtures can undergo phase-separation, which is the target structural parameter of the reported investigations.

In this context, polymer blends of bio-degradable poly(3-hydroxybutyrate) (PHB) and poly(L-lactic acid) (PLA)1 were analyzed by FT-IR, Raman and photothermal Atomic Force Microscopy (AFM)-IR imaging spectroscopy. Generally, vibrational spectroscopic imaging enables a detailed lateral and chemical visualization of the investigated samples. However, while the FT-IR and Raman spectroscopic imaging techniques2 are diffraction-limited and have lateral resolutions of – at best – a few micrometers and a half micrometer, respectively, the advent of the AFM-IR3 technique, that exploits the photothermal effect, launched spectroscopic imaging to the 10 nm lateral resolution level with the additional benefit of topographical information. The imaging results obtained from the above biopolymer blends will demonstrate the significant improvement of structural details revealed by the application of these techniques ranging from lower to higher lateral resolution (viz. FT-IR, Raman and photothermal AFM-IR spectroscopic imaging).

Keywords: FT-IR, Raman, AFM-IR, Imaging Spectroscopy, Biopolymer Blends, Phase-Separation, Lateral Resolution, Micrometer to Nanometer.

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Miriam Unger[1] and Heinz W. Siesler[2]

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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.

KEYNOTE SPEAKER

Robert Fisher
President and Senior Laser Physicist, RA Fisher Associates, LLC, Santa Fe, New Mexico, USA

KEYNOTE SPEAKER

The Early Days of Self-Phase Modulation, Pulse Compression and Supercontinuum.

This presentation attempts to show others the excitement and intellectual growth that occurred during the first ten years since the invention of the trivalent Nd-doped mode-locked glass laser. The time period started with total uncertainty as to the nature of the excessive bandwidth of the 5 picosecond pulses, and with my personal frustration for the usefulness of such pulses. Great progress was made when E. Brian Treacy invented the grating pair whose anomalous dispersion could compress pulses if they were predominantly positively chirped. This led a lot of us at the time to become more serious about the possibility that these pulses have an excessive bandwidth associated with an instantaneous frequency which could vary with time during the 5 picosecond pulse. In musical terms, although the pulses could be monophonic, homophonic, or polyphonic, the Treacy experiments emphasized the monophonic possibility. This thinking led me, with Kelley and Gustafson to invent, publish, and patent a pulse compression scheme where Kerr-like effects can put a chirp onto a transform-limited ultrashort (in those days ~ 5 picosecond duration) pulse for subsequent compression by a properly adjusted Treacy grating pair. A 50 femtosecond compressed pulse was theoretically demonstrated. At about the same time, I pointed out to Treacy that I thought he had a typographical error in his publication, and he indicated in a correction to his manuscript that it was really a more fundamental error. I rather quickly found a whole class of pulses which, although not predominantly positively chirped, theoretically produced an excellent fit to Treacy's auto- and cross- correlation data. By this counterexample, Fleck and I published that Treacy, in today's language, mistook the "coherent artifact" for the pulse duration. This presentation continues with a discussion of the split-step technique, and our theoretical finding of extra linear chirping and of shock formation. It took about a quarter of a century for the technology to advance where our predicted shock formation could be experimentally demonstrated. Finally, attention is drawn to Alfano's pioneering Supercontinuum activities.

Biography

Dr. Robert A. Fisher is President and Senior Laser Physicist with R A Fisher Associates. Dr. Fisher received his Ph.D., M.A., and B.S. degrees from the University of California, Berkeley. Starting in 1971, he worked in the Laser Fusion Group at Lawrence Livermore National Laboratory and he taught graduate courses in nonlinear optics and solid state physics at the University of California, Davis. Joining Los Alamos National Laboratory in 1974, he was affiliated with the laser fusion and laser isotope separation programs. He was a member of seven Red-Blue government panels, and he teaches numerous professional advancement courses. His expertise includes: nonlinear optics, laser technology, carbon dioxide lasers, molecular spectroscopy, x-ray lasers, optical phase conjugation, and modern optics. He has authored over 60 publications. He is the Editor of the book "Optical Phase Conjugation," and he chaired six SPIE Conferences on Nonlinear Optics. He was Associate Editor for the journal "Applied Optics," and for the journal "Optics Letters." He served on the committees of four international Conferences. For the Journal of the Optical Society of America he was guest Editor of a special issue on Optical Phase Conjugation, and he was a member of the Special Advisory Committee to the Provost, University of New Mexico. He served for three years as a member of the Board of Directors of SPIE, and for three years as Topical Editor of Optics Letters. He serves the legal community as an Expert Witness. He served on the 2003, 2004 and 2005 Nonlinear Optics Subcommittee for the CLEO Conference, and presently serves as the Chairman of that Subcommittee. He served on the OSA's Excellence in engineering award Committee for 2002 and 2003, and as Chair of that Committee in 2004. He served 2002-2004 on SPIE's Scholarship Committee, and now serves on SPIE's Education Committee. Dr. Fisher is a Fellow of the Optical Society of America, a Senior Member of the IEEE, and a fellow of SPIE. For those needing further information, his biography appears in Who's Who in America.

Exploring the sub-diffuse scatter of photons by superficial tissue layers using polarized light.

The superficial layers of a tissue include the epithelial/connective tissue interface where cancer often arises and other disease states occur. In skin, the epidermis/papillary dermis interface is modulated by ageing, actinic damage, edema, and cosmetic rejuvenation treatments. While most (>90%) of observable optical reflectance from a tissue is due to photons that have migrated deeply and returned to the surface for escape, a small amount (<10%) is due to "sub-diffuse" photons that have scattered only a few times before escaping. Consequently, sub-diffuse photons offer information about the light-scattering structures in a superficial tissue layer. Polarized light imaging (PLI) based on the difference image, Q = co-polarized - cross-polarized, also involves only a few scattering events. The use of PLI to characterize the scattering structures of a superficial tissue is presented.

Biography

Steven L. Jacques, Ph.D., received a B.S. degree in Biology at M.I.T., and an M.S. degree in Electrical Engineering and Computer Science and a Ph.D. degree in Biophysics and Medical Physics from the University of California-Berkeley (1984), where he used dielectric microwave measurements to explore the in vivo distribution of water in the stratum corneum of human skin. His postdoctoral work was at the Wellman Center for Photo Medicine at Massachusetts General Hospital, rising to the position of Lecturer in Dermatology/BioEngineering, Harvard Medical School. His team developed the use of Monte Carlo computer simulations to study optical transport in biological tissues, which is now widely used in the field of BioPhotonics. In 1988, he joined the University of Texas M. D. Anderson Cancer as an Assistant Professor of Urology/Biophysics and established a laboratory developing novel laser and optical methods for medicine, later achieving a tenured position as Associate Professor. He developed a hand-held spectrometer and the analysis software to noninvasively measure hyperbilirubinemia in newborns. This device was patented, licensed, and FDA approved to replace heel stick tests, and is now in practice in neonatal care. As of 2018, over 280 million newborns have been tested with the device. In 1996, he joined the Oregon Health and Science University in Portland where he served 21 years as Professor of Dermatology and Biomedical Engineering. He is currently an Affiliate Professor of Bioengineering at the University of Washington in Seattle.

Jacques, Steven L
SPIE Membership: 14.2 years
SPIE Awards: Fellow status | 2019 SPIE Community Champion
SPIE Involvement: Conference Program Committee | Track Chair | Author | Instructor
Area of Expertise: Tissue optics, Laser-tissue interactions

PLENARY SPEAKER

Wolfgang Osten
Institute for Applied Optics ITO
University Stuttgart, Germany

PLENARY SPEAKER

55 Years of Holographic Non-Destructive Testing: What are the challenges for the future?

Methods of holographic non-destructive testing, shape measurement, and experimental stress analysis have shown to be versatile tools for the solution of many inspection problems. Their main advantages are the non-contact nature, the non-destructive and areal working principle, the fast response, high sensitivity, resolution and precision. In contrast to conventional optical techniques such as classical interferometry, the holographic principle of wavefront storage and reconstruction makes it possible to investigate objects with rough surfaces by temporal wavefront division. Consequently, the response of various classes of products on operational or artificial load can be examined very elegantly. The paper looks back to the history of holographic metrology, honors the inventors of the main principles, discusses criteria for the selection of a proper inspection method for, and shows exemplary applications such as the inspection of aircraft and automotive parts, the investigation of micro-components, the measurement of residual stresses in spray-coated specimen, the erosion monitoring in harsh environments and the inspection of paintings with respect to internal faults. Following the experiences gathered in these applications, we discuss the challenges for an extension of the application range of holographic technologies for non-destructive testing.

Biography

Wolfgang Osten's research work is focused on new concepts for industrial inspection and metrology by combining modern principles of optical metrology, sensor technology and image processing. Special attention is directed to the development of resolution enhanced technologies for the investigation of micro and nano structures. Ongoing activities are directed to the profound investigation of the institute's strategic research topics such as multi-scale sensor fusion, computational microscopy, resolution enhancement, model-based reconstruction of measurement data, asphere and freeform metrology, optical systems design, hybrid optics, digital holography, and inverse scattering.

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Tailoring Quantum Oscillations of Excitonic Schrodinger's Cats as Qubits

Shouvik Datta[1] Amit Bhunia[1], Mohit Kumar Singh[1], Maryam Al Huwayz[2,3] and Mohamed Henini[2]

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[2]School of Physics and Astronomy, University of Nottingham, Nottingham, UK

[3]Physics Department, Faculty of science, Princess Nourah Bint Abdulrahman University, Saudi Arabia

We report [https://arxiv.org/abs/2107.13518] opto-electrical detection and control of Schrodinger's Cat like macroscopically large, quantum coherent state of a two-component Bose-Einstein condensate of spatially indirect electron-hole pairs or excitons using a resonant tunneling diode of III-V Semiconductors. This provide access to millions of excitons as qubits to allow efficient, fault-tolerant quantum computation. In this work, we measure phase coherent periodic oscillations in photo generated capacitance as a function of applied voltage bias and light intensity over a macroscopically large area. Periodic presence and absence of splitting of excitonic peaks in the optical spectra measured by photocapacitance point towards tunneling induced variations in capacitive coupling between the quantum well and quantum dots. Observation of negative 'quantum capacitance' due to screening of charge carriers by the quantum well indicate Coulomb correlations of interacting excitons in the plane of the sample. We also establish that coherent resonant tunneling in this well-dot heterostructure restricts the available momentum space of the charge carriers within this quantum well. Consequently, the electric polarization vector of the associated indirect excitons collective orients along the direction of applied bias and these excitons undergo Bose-Einstein condensation below ~100 K. Generation of interference beats in photocapacitance oscillation even with incoherent white light further confirm the presence of stable, long range spatial correlation among these indirect excitons. We finally demonstrate collective Rabi oscillations of these macroscopically large, 'multipartite', coupled and uncoupled quantum states of two-component excitonic condensate as qubits. Therefore, our study not only brings the physics and technology of Bose-Einstein condensation within the reaches of optoelectronics chips, but also opens up experimental investigations of the fundamentals of quantum physics using similar techniques.

Biography

Shouvik Data obtained his PhD from Tata Institute of Fundamental Research (University of Mumbai) in 2001. He was a postdoctoral fellow in University of Nebraska-Lincoln, USA (2001-2004) and in University of Oregon, USA (2004-2008) before joining IISER-Pune in July 2008.Bonding of Tissues with Light Biomedical Optics and Detection of Cancer with Light Spectroscopy Expertise in Properties of Light and Photonics Ultrafast Spectroscopy and Lasers Physics and Electrical Engineering Science and Engineering

SESSION SPEAKER

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Laser Based Solid State Lighting, Illumination Engineering and Communication

Mehta D. S
IIT Delhi, India

SESSION SPEAKER

Biography

Dr. D. S. Mehta is currently a Professor at the Department of Physics, Indian Institute of Technology Delhi. Previously, he worked as Associate Professor and Assistant Professor (June 2002 - Dec. 2012) at the Instrument Design Development Centre, Indian Institute of Technology Delhi. Before Joining the Institute he was JSPS Post Doctoral Fellow (July 2000 - June 2002) at the University of Electro-communications, Tokyo, Japan, Post Doctoral Fellow National Dong Hwa University, Taiwan (Nov. 1999 — May 2000) Research Associate, NPL, New Delhi, STA Post Doctoral Fellow (June 1997 – May 1998), NIRE, Tsukuba, Japan and UNESCO Research Fellow (Jan. 1996 – Sept.1996), Tokyo Institute of Technology Tokyo, Japan. He has been actively working in the areas of Bio-photonics (Optical Coherence Tomography and Optical Tweezers), Green Photonics (LEDs and OLEDs) and Optical Metrology. He has contributed more than 140 research papers in International Refereed Journals, and more than 160 in International and National Conferences. He has delivered more than 50 Invited Talks/Lectures in various International and National Conferences and Universities. He has supervised 15 Ph. D. students and currently supervising 10 Ph. D. students. He has also supervised more than 50 M. Tech./B. Tech. students major projects. He received Teaching Excellence Awards in 2017 and in 2013 from the Indian Institute of Technology Delhi, India. Many of his Ph. D. students and master students has received Best Paper Awards, Best Poster Presentation Awards, and Alumni Association Award in International and National conferences. He has filed 9 patents and one technology transferred to Industry.

Control Field Induced Suppression of Modulation Instability in Multiple Quantum Wells

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This article presents a theoretical investigation of the dynamics of the modulation instability (MI) in an asymmetric multiple quantum well (MQW) under an electromagnetically induced transparency (EIT) scheme. To study the MI of a weak probe pulse, a strong control beam in the MQW has employed using a Ladder type of excitation scheme. Employing density matrix approximation, the third-order susceptibility (leading to Kerr-nonlinearity) and the group velocity dispersion (GVD) of the probe field have been evaluated. It has found that the magnitude of Kerr-nonlinearity and the GVD of the probe field can be shifted to any desired frequency by selecting a suitable probe frequency under the EIT window. MI is not only depends on Kerr-nonlinearity and GVD but also on input power. The control beam parameter has a great control over the gain and spectral width of the MI. At constant input power, the gain and width of MI spectra varies with control field Rabi frequency. It is also identified that the MQW system is stable against MI for small control field intensities whereas the growth gradually reduces for higher intensities of the control field.

Keywords: Multiple Quantum Well; Density Matrix Approximation; Electromagnetically Induced Transparency; Rabi Frequency; Susceptibility; Modulation instability.

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Biography

Dr. Nitu Borgohain is an assistant professor in the Department of Physics at University of Science and Technology Meghalaya, India. He received his M.Sc. degree in Physics from Indian School of Mines, Dhanbad, India, in 2012 and Ph.D. degree in Science from the Department of physics, Birla Institute of Technology, Mesra, Ranchi, India in 2019. His research interest includes nonlinear and quantum optics, optoelectronics and photonic crystal fibers. He has published several research articles in reputed international journals, and also receives recognition as a potential reviewer from many reputed journals. He is a life member of many societies such as Indian Science Congress Association, Optical Society of India etc.

Published 11 research papers in peer reviewed international journals,

Published 18 research articles in conference proceedings,

Google Scholar Citations: 138

Google Scholar h-index: 6

Supervised 20 post graduate student projects,

Supervising 03 PhD Scholars

Established an Astronomical Observatory in USTM

Google Scholar Link: https://scholar.google.co.in/citations?user=kNhBTmsAAAAJ&hl=en

SESSION SPEAKER

From Quantum Simulation to Quantum Sensing for Ultracold Matter Waves

Utpal Roy
Department of Physics,
Indian Institute of Technology Patna,
Bihta-801106, India

SESSION SPEAKER

A spatially localized ultracold matter wave is a long lived, coherent wave packet of high tunability, paving huge scope for emerging areas like quantum simulation and quantum sensing. Applications of ultracold atoms as quantum simulator mostly rely on the external trap which can efficiently be engineered to a desired shape due to the unprecedented progress in the experimental front. However, investigating the dynamics of such system through exact theoretical approach becomes quite nontrivial due to its nonlinear nature and the presence of varying external trap upon engineering. A quantum simulator to simulate an extremely nontrivial task of another system is an essential requirement for quantum enhanced implementation of various novel phenomena [1]. Optical lattices are found to be the most favorable candidate for quantum simulation, envisaged from the high tunability of the system and the potential. Bose-Einstein condensate (BEC) under disordered optical lattices has become one of the most paramount fields and the underlying dynamics can exhibit various novel and complex quantum phenomena like Anderson-like localization, negative absolute temperature etc. [2-6]. In this talk, I will present analytical approaches for a quasi-periodic optical lattice which can hold and mould matter waves in self similar form like soliton. BEC under a bi-chromatic optical lattice and engineered superlattices will be addressed [4, 7]. Various interesting matter-wave dynamics will be explicated which also include Anderson-like localization and models for negative absolute temperature [2,3,5]. Favorable models for quantum sensing will also be demonstrated [8].

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Biography

Utpal Roy did his Ph.D from Physical Research Laboratory, India. After few years of his post doctoral experience in Italy & Durban, SA, he has joined as a faculty in the Department of Physics, Indian Institute of Technology Patna, India since 2010. Currently, he is Associate Professor in Physics since 2015 and heading the 'quantum dynamics' theoretical research group at IIT Patna, which is involved towards emerging research areas in Bose-Einstein condensate & nonlinear excitations, quantum simulation, quantum optics, quantum information, quantum sensing and quantum machine learning. Recently, he was awarded with the Outstanding Teacher Award in Physics, "Science and Technology Academic, Innovations and Research Awards 2021" and Bharat Vikas Award, Physics, ISR-India, 2018. His group has made significant breakthrough by providing the first exact model for quantum simulator of bichromatic optical lattice, first exact model for negative absolute temperature, inventing the phenomena of fractional revivals for ultracold atoms, quantum simulators for a four-color optical lattice and a coupled optical lattice. Models for quantum sensors, quantum logic gates of matter waves and quantum machine learning algorithm are under exploration.

A novel wavefront modulation based free space optical communication system.

In this talk I will discuss a novel free space optical communication system that sends user information from point to point by modulating the wave front. The scheme has number of advantages such as inherent capability to tolerate turbulence to a certain extent, security against eaves dropping and so on. Along with the proposed experimental setup I will present some results of a recent implementation of the scheme.

Biography

Bosanta Ranjan Boruah obtained his PhD from the Photonics group of Imperial College London in the year 2007. Presently he is serving as a professor in the department of Physics of IIT Guwahati, Assam, India. His current research interests are confocal and super-resolution microscopy, wavefront sensing, optical trapping and free space optical communications. His research group in collaboration with Imperial College London recently built a super-resolving fluorescence microscope at IIT Guwahati. Dr. Boruah has been recognized as the senior member of OSA and SPIE in the year 2018. He also served as the managing guest editor of Dynamic Light shaping special issue of Optics Communications and the reviewer of several reputed journals of OSA, AIP and IOP. So far seven students have completed their PhD work under the supervision of Dr Boruah.

Bosanta Ranjan Boruah
Indian Institute of Technology
Guwahati, India

SESSION SPEAKER

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Whispering gallery modes of microcavities and photonic nanojets for sensing applications

Prem B. Bisht* and Tulika Agrawal
Indian Institute of Technology Madras, Chennai-600036, India University of Nottingham, UK

SESSION SPEAKER

When the light rays fall on the microcavity at nearly glancing angle, the rays can fold back on themselves due to total internal reflection. This results in whispering gallery modes (WGMs) in nearly transparent- symmetric shaped cavities. WGMs have high quality factors and low volume with applications in a wide variety of fields. One of the applications is sensing of other particles as the modes are quite sensitive to the parameters such as size, shape and relative refractive index of the cavity. Another complementary phenomenon is the photonic nanojet (PNJ) from microcavities. PNJ is a narrow and intense beam emerging from the shadow side of the cavity. Its characteristic parameters such as the length, width, focal point and field strength are functions of cavity parameters. Hence, PNJ is also used in sensing applications. In this talk, we will first bring out the principle of sensing using WGMs and PNJ and then take some examples, respectively where such sensors have been implemented.

Acknowledgements: We thank Science & Engineering Research Board (SERB) for financial assistance under grant no. CRG/2021/000136.

Biography

Prem Bisht is a professor (HAG) in the Physics department of Indian Institute of Technology Madras (IITM) at Chennai. He is heading a centre of excellence in Biosensing at IITM. He has been associated with IIT Madras since 1997 after completing a JSPS fellowship program at Kyoto. Prof. Bisht has taught several courses in photonics as well as undergraduate level courses in physics at IIT Madras during last 24 years. Prem has been a visiting scientist at Herriot-Watt University under Erasmus Mundus visiting fellowship, LMU Munich under Indo-German joint project, ORC Southampton and DCU Dublin under FP7, and has held a visiting professorship at TUT Toyohashi. Prem is a member of Indian Laser and Physics Teachers Associations, Indian Science Congress, SPIE and OPTICA. In 2014, he was awarded the "Platinum Jubilee Lecture award for Physical Sciences at 101st Indian Science Congress. In 2021, Prem Bisht became senior member of OPTICA. He has over 90 peer- reviewed Journal publications, and over 150 conference publications with over 1432 citations (H-index 20). He has delivered over 90 talks at national and international universities. Prem has trained 15 Ph.D. students, several post-doctoral fellows and over 35 undergraduate students. Currently, 5 students are working under his guidance. Areas of Expertise/Research His research interests are mainly in ultrafast laser fluorescence spectroscopy of low dimensional materials with a particular interest in working with non-collinear optical parametric amplifiers and, whispering gallery modes (WGMs) of nano-micro-cavities as well as photonic nano jet. Find more information at https://physics.iitm.ac.in/~prem/

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Depth-resolved measurements of cerebral hemodynamics with non-invasive diffuse optical methods.

Sergio Fantini
Tufts University, USA
LOPS2021, LOPS2022™

Honors & Awards:

Fellow, American Institute for Medical & Biological Engineering (AIMBE)
Fellow, The International Society for Optical Engineering (SPIE)
2004: Graduate Student Council's Award for Outstanding Faculty Contribution to Graduate Studies, Tufts University
2001: Outstanding Faculty Award,

KEYNOTE SPEAKER

Diffuse optics in the wavelength range 600-950 nm (the first near-infrared optical tissue window) allows for non-invasive measurements of the cerebral hemodynamics of the human brain. Because light is delivered and detected on the scalp, i.e. at the tissue surface, extracerebral hemodynamics or optical changes in scalp and skull tissue, as well as in dural, epidural, and subarachnoid space can contribute to the measured optical signals. Therefore, these extracerebral contributions to the optical signals may confound the targeted measurements of cerebral hemodynamics. Several approaches to address this issue have been proposed in the field of optical cerebral oximetry and functional near-infrared spectroscopy. Here, we present measurements with frequency-domain near-infrared spectroscopy (FD-NIRS) performed at multiple source-detector distances on the scalp of human subjects in a variety of protocols. We report results of intensity and phase measurements of photon-density waves collected either at a single source-detector distance (as a function of distance) or at multiple source-detector distances (to measure slopes of intensity or phase versus distance). In particular, slope measurements were performed using either a single detector and multiple sources (single slope) or a special combination of two sources and two detectors (dual slope). Our results indicate that a better selective sensitivity to deeper tissue (i.e. to the brain) is achieved with phase versus intensity measurements (for both single-distance and multi-distance data collection) and with slope versus single-distance measurements (for both intensity and phase measurements). The main conclusion of this work is that slope measurements (especially when conducted using dual-slope approaches) of the phase of photon-density waves with FD-NIRS provide a more selective sensitivity to brain tissue with respect to single-distance intensity measurements with continuous-wave NIRS (CW-NIRS)

Biography

Sergio Fantini received his doctoral degree in physics from the University of Florence, Italy, in 1992. His dissertation was based on a Raman scattering study of ceramic superconductors. From 1993 to 1999, Fantini held postdoctoral and faculty appointments at the University of Illinois at Urbana-Champaign, in the Department of Physics. In 1999, he joined Tufts University as an assistant professor and has been one of the inaugural faculty members of the Department of Biomedical Engineering, which was created at Tufts in 2002.

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Widely Tunable High Energy Tm:Yap Laser for Biomedical Applications

Salman Noach#, Uziel Sheintop, Eytan Perez , Rotem Nahear
Department of Applied Physics,
Electro-optics Engineering Faculty,
Jerusalem College of Technology,
Havaad Haleumi 21, Jerusalem, Israel

We demonstrated a tunable, mJ level, narrow bandwidth, end-pumped Tm:Yap laser. Spectral continues tunability of 35nm between 1926-1961nm with a spectral linewidth of 0.15nm FWHM was achieved. The tuning and spectral band narrowing were obtained using a pair of YAG Etalons. The laser was actively Q-switched using an acousto-optic modulator and mJ level pulse energy was measured along the whole tuning range at a repetition rate of 1 KHz. Up to 2.3 mJ energy per pulse was achieved at a pulse duration of 29.5 ns at a wavelength of 1935 nm, corresponding to a peak-power of 80 kW and at a slope efficiency of 31 %.The combination of both high energy pulsed lasing and spectral tunability while maintaining narrow bandwidth across the whole tunability range enhances the laser abilities, which could enable new applications in the sensing, bio-medical and material processing fields. Laser performance will present, as well results of laser interaction with tissue showed successful ablation and preliminary results of medical plastic welding.

Biography

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

SESSION SPEAKER

Metal-organic Frameworks (MOFs) for Sustainable Energy Using Computational Simulations

Jaewon Lee
Woodberry Forest School, USA

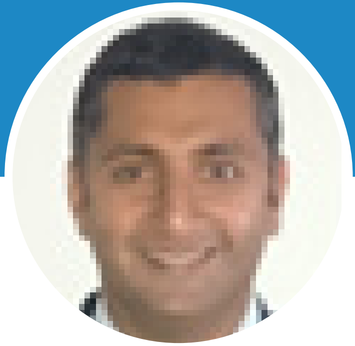
Renewable energy is an important field of research amidst the 21st-century energy crisis. Researchers are looking for new energy sources, but not as much as the efficient storage of energy produced from these eco-friendly sources. Using computational simulations, this research considers how to increase the capacitance through inserting Metal-Organic Frameworks (MOFs) as dielectrics to use such dielectrics as a substantial tool for sustainable development. MOFs, composed of inorganic metal joints and organic carbon linkers, are porous and have large spaces within them that can store charges for alternative energy sources or capture gases such as carbon dioxide. Research shows the high potential of increasing capacitance in batteries by using MOFs.

The research focuses on increasing the capacity of batteries using MOF particles as dielectrics, differing the structure of capacitors, and various combinations of inorganic metal joints and organic carbon links in order to increase the maximum capacity of batteries that can store more energy with better efficiency. Computational chemistry such as Avogadro and ChemCraft has been employed to figure out the stability and capacity of the MOF particles.

Biography

Jaewon is interested in sustainable energy using computational simulations. Renewable energy is an important field of research amidst the 21st-century energy crisis. He is looking for new energy sources produced from these eco-friendly sources. Using computational simulations, his study shows a way to increase the capacitance through inserting MetalOrganic Frameworks (MOFs) as dielectrics to use such dielectrics as a substantial tool for sustainable development.

STUDENT POSTER



Study of Plasmonic Nano Sensors for Hydrogen Leak Detection

Nicolas Javahiraly
University of Strasbourg, France
Scientific Committee & Session Chair at LOPS Annual Conferences™

KEYNOTE SPEAKER

Hydrogen is currently positioned as one of the very serious alternatives to current energies. A sustainable energy vector of the future, it can be used to produce, store...and be one of the current points of interest in many industries (transport, electricity production, photoconversion...). But this gas cannot be used as a standard gas because of its dangerousness if it is not used correctly in the specific safety standards. It is indeed 4% explosive in air, for example. Hence the need for significant research into detection and nano-detection systems that meet European and / or international safety standards and standards.

The study presented here focuses on the study and development of an optical plasmonic nano sensor for detecting hydrogen leaks, which uses the change in permittivity of different types of nanoparticles thus exploiting the effects of local exaltation of the electromagnetic field when these nano-antennas are under hydrogenation. The optical response of these nano systems therefore informs us about the characteristics of these nano sensors thus achieved.

Keywords: Hydrogen, nano sensors, plasmonic, nanoantenna, nanoparticles.

Biography

Nicolas Javahiraly is an associate professor in physics at the University of Strasbourg, France. He did his PhD in Photonics at the same university on fiber optic sensors. After a post-doc at Harvard University on the interaction between ultra-short laser pulses and matter, he worked as a project manager and expert in the Sagem Defense group in Paris. He joined the University of Strasbourg in 2007 and is currently working on nano-optical sensors and plasmonics for various applications such as gas detection, pollutants detection and photoconversion systems for example.

Nanomaterial based Wearable biosensing technology for healthcare applications

The skyrocketing demand for personalized medicine based on predictive analytics has given impetus to the rise of wearable biosensors. In recent times, nanomaterial-based wearable biosensors are receiving significant attention due to their lightweight, physiochemical stability, biocompatibility, and ecofriendly characteristics. Wearable biosensors are also gathering substantial interest due to their potential to provide continuous, real-time physiological information via dynamic, noninvasive measurements of biochemical markers in biofluids, such as sweat, tears, saliva, and interstitial fluid. The involvement of nanoparticles has greatly influenced the operation of wearable biosensors in terms of reduction in time and cost. The electrical, mechanical, and thermal advantages of nanoparticles have imparted the wearable sensors to be deployed for the detection of multiple physiological parameters associated with human beings. Additionally, over the centuries, natural living organisms are also acting as a source of motivation to design smart nanomaterials with incredible features to design high sensitive sensing devices. Therefore, the urgency of time demands to focus on the impact of nature inspired sensing technology.

Ashis Tripathy
Center for Microelectro Mechanics Systems (CMEMS), University of Minho, Campus de Azurém, Guimarães
Portugal

SESSION SPEAKER

Biography

Dr. Ashis Tripathy is currently working as a scientific investigator at the Center for MicroElectroMechanical Systems (CMEMS), University of Minho, Portugal. He has received his Ph.D. degree in Biomedical Engineering from University of Malaya (QS Ranking-65), Kuala Lumpur, Malaysia. He was honored with Award of Excellence for outstanding research contribution in his doctoral research program. He has obtained his M.Tech. degree from Jadavpur University, Kolkata, India and B.Tech. from Biju Patnaik University of Technology, Odisha, India. He has received several national and international fellowships, such as MHRD, India, High Impact Research (HIR) Grant, from Ministry of Higher Education (MOHE), Malaysia and Postdoctoral International Exchange Fellowship, from Ministry of Human Resources and Social Security, China and Postdoctoral fellowship from Foundation for Science and Technology (FCT), from ministry of higher education Portugal, co-financed by the European Regional Development Fund (ERDF), under Portugal vision 2020. He has worked in various academic institutions like Thapar University, Patiala, JK Lakshmipat University (JKLU), Jaipur and Siksha 'O' Anusandhan University (SOA), Odisha, India. He has supervised several Master and PhD students. He has received several awards and recognitions including BEST PAPER award in ISMDMA 2017 Conference, held in DUBAI, UAE and ICETMM–2018, IEEE conference held at Poornima University, Jaipur, India. He also received Bronze medal for the poster presentation in the Infrastructure University, Kuala Lumpur, Malaysia. Dr. Tripathy has been invited and delivered as keynote speaker at several conferences, academic institutions, faculty development programs (FDP) in India and abroad. He is an active and life member of several professional bodies, like IEEE, IE, ISTE etc. He has published several high impact Q1 research articles in reputed international journals with cumulative impact factor of 94.15. His research interests are focused on materials for electronics applications, MEMS, sensor fabrication, wearable electronics, nanomaterial synthesis, biomedical engineering.

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Image Processing Using Numerical Analysis and Computational Simulations

Jewan (Richard) Youn,
Saint Johnsbury Academy, Korea

In order to produce a biomedical image domain from MRI, there is a complex computational process that requires an intensive analysis. Each MRI is equipped with four to ten coils that pick up information about the image. Each coil produces one k-space, which then creates one image domain. In producing a high-resolution image, creating the k-space and choosing the right low pass filter (LPF) is most critical. LPF is a function used to extract the data that is needed, and typically determines the resolution of the image. The k-space, a frequency domain, is transferred to the image domain using Inverse Fourier Transform.

In this study, we examine how we are able to increase the resolution of biomedical images, and in turn, reduce the Gibbs ringing artifact.

Biography

Richard(JeWan) attends Saint Johnsbury Academy in Korea. He has been interested in computer science and its applications. He would like to study more about Artificial Intelligence or possibly data science in the future. One of his biggest hobbies is 3d printing, and he has been leading a printing club. He would like to be actively involved in the school community.

POSTER PRESENTATION

Elisabetta Primiceri
Omnics Lab, Italy

Core-shell 3D chiral metamaterial for femtomolar detection of biomolecules

Liquid biopsy consists in the molecular analysis of body fluids (blood, serum/plasma, urine, CSF, saliva, etc…) without the needs of tissue biopsy and painful procedures.

This approach provides a non-invasive access to molecular information about the physiological conditions of body and diseases. Advanced sensing tools, detecting extremely low concentrations of circulating biomarkers, can open unexplored routes toward early diagnostics and diseases progression monitoring. In this regard, we optimized biosensing devices based on Localized Surface Plasmon Resonance realized by Nanosphere lithography (nanoholes, nanodisks and nanoprisms) achiving a limit of detection of 5ng/ml. to furtherly improve sensitivity of the sensing platform we exploited the chirooptic response of chiral metamaterials with helicoidal shape. In particular we demonstrate the sensing capabilities of a chip-based metamaterial, combining 3D chiral geometry with a functional core−shell nanoarchitecture. The chiral metamaterial provides a circular polarization-dependent optical response, allowing analysis in a complex environment without significant background interferences. The functional nanoarchitecture, based on the conformal coating with a polymer shell, modifies the chiral metamaterial near- and far-field optical response. The system sensitivity slope is 27 nm/pM, in the detection of TAR DNA-binding protein 43, clinically relevant for neurodegenerative diseases. Measurements were performed in spiked solution and in human serum with concentrations from 1 pM down to 10 fM, which is a range not accessible with common immunological assays, opening new perspectives for next-generation biomedical systems.

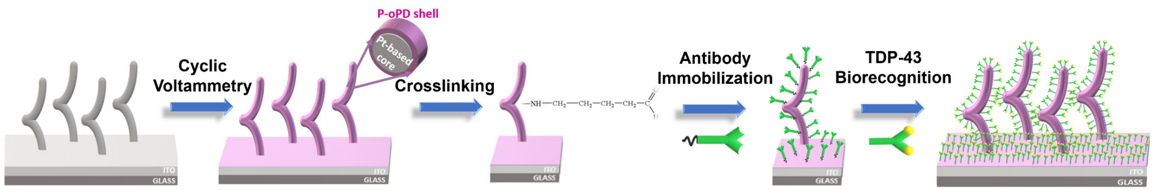


Fig. 1: Schematical description of steps involving the sensor realization. The core consists of an array of Pt nanohelices on an ITO-on glass substrate. The core−shell architecture arises from covering the fabricated helix array with the P-oPD insulating polymer through cyclic voltammetry. Then, through a cross-linking by gluthereldeyde, the antibody is immobilized onto the shell, and then, the target analyte TDP-43 covalently binds to its specific antibody. The final scheme displays the functionalized core−shell sensor, wherein the TDP-43, deposited on the sample surface, is recognized by the specific antibody sites.

Biography

Elisabetta Primiceri (1982) received her master degree (magna cum laude) in Industrual and Molecular Biotechnology in 2006 at University of Bologna and in 2011 she finished her PhD in "Interdisciplinary Science and Technology" at University of Salento, Lecce – Italy, with thesis entitle "Cell-Chip: new tools for cell biology". Since 2011 she worked as a post-doc researcher at Consiglio Nazionale delle Ricerche (CNR) in Lecce and from January 2019 she is permanent researcher at CNR Institute of Nanotechnology (CNR-Nanotec). Her activities are focused on the development of biosensors (expecially electrochemical and plasmonic detection) and new materials for sensing applications. She is also focused on the development of sensing platforms for cell biology. Her skills include microfabrication techniques (photolithography and soft lithography), electrochemical measurements, electrosinthesys of polymers. She gained also experience in cell culture and cell biology. EP is co-author of many scientific publications including a book chapter and 2 patents with H-index of 17.

YRF/POSTER PRESENTATION

Mara Lucia Goncalves Diogo
UNINOVE, Nove de Julho University, Brazil

KEYNOTE SPEAKER

Effect of Blue Light on Acne Vulgaris: A Systematic Review

Acne is a dermatosis that affects almost 90% of the adolescent population worldwide and its treatment is performed with retinoids, antimicrobials, acids, and topical or systemic antibiotics. Side effects such as skin irritation in addition to microbial resistance to antibiotics are the main side effects found. Phototherapy with blue light is being used as an alternative treatment. Our objective was to analyze the use of blue light to treat inflammatory acne. We conducted a systematic literature review, following the recommendation PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses), including in the sample randomized clinical trial studies that compared blue light with another intervention as control. The research was carried out in the PUBMED and WEB of SCIENCE databases and the methodological quality of the studies evaluated were made by the Cochrane Collaboration Bias Risk Scale. After the exclusion of duplicates, the titles and abstracts of 81 articles were evaluated, and 50 articles were selected for full reading, including in the review at the end 8 articles. Studies have shown significant improvements in the overall picture of acne. It is concluded that despite the great potential in its use in the treatment of acne, there is a need for more detailed trials on the effect of blue light on the treatment of inflammatory acne.

Keywords: acne; photobiomodulation; LLLT (Low Level Light Therapy); phototherapy; LED (Light Emitting Diode); blue light.

Biography

Mara Lúcia Gonçalves Diogo

She is Nurse, graduated in 1986 from the Wenceslau Braz College, Itajubá - MG – Brazil, Occupational Nurse at the Catholic University of Santos in 1989- Santos- São Paulo – Brazil, Nurse Specialist in Dermatology in 2007 by the Brazilian Association of Dermatology Nursing - SOBENDE - São Paulo – Brazil, Master in Biophotonics Applied to Health Sciences - Universidade Nove de Julho - São Paulo – Brazil, Doctoral student in Biophotonics applied to health sciences - Universidade Nove de Julho - São Paulo - Brazil.

Area of research: acne light treatments

Experience:

Independent Dermatology Nurse.

Professor of graduate courses in dermatology for nurses.

Coordinator of postgraduate courses in aesthetics and dermatology for nurses.

Heidi Yu
Manhasset HS, USA

Biochemical Analysis of Porphyrin Molecules with Genes Used in the Photodynamic Therapy(PDT) of Neurodegenerative Diseases

The structural modification of the prototypical porphyrin generates a large family of porphyrins that shows diverse properties. In this paper, the molecular and physical properties of metalloporphyrins as photoreceptor molecules were studied since metal homeostasis is currently emerging as a key factor in maintaining brain health and preventing neurodegenerative diseases.

In several common neurodegenerative diseases such as Alzheimer's Disease (AD), Parkinson's Disease (PD), and macular degeneration, dyshomeostasis of redox-active metals and subsequent detection of elevated levels of redox-active metals such as iron and copper in the brain suggests that such metals play a significant role in the pathogenesis of such disease.

For the analysis of the molecules which are a part of DNA complexes, molecular gene-editing programs were used. Density Functional Theory (DFT) was employed to find the compounds' biophysical properties such as optimized energy and electrical properties in assessing the thermodynamic stability of the compounds.

Biography

Tsai He (Heidi) Yu is interested in Psychology and Biochemistry (Neuroscience, genetic mutations, molecular biology, structural compounds, chemical properties, and DNA). Her future goal is to become someone who has the ability to help people with mental disorders or genetic mutations. Her research focused on the analysis and characteristics of porphyrin molecules with genes used in Photodynamic Treatment by computational and theoretical methodology. The research indicated the different properties of porphyrin molecules and their isotopes and also explained the application of porphyrin under different situations.

STUDENT PRESENTATION

2nd Annual International Scientific Conference & Hybrid Expo on

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

LOPS Annual Conferences™

Resonance Raman in Cancers

Currently the gold-standard diagnostic method for cancer diagnosis is biopsy, which is invasive, time consuming, and subjective due to judgment of the pathologist. Optical biopsy is an alternative optical molecular diagnostic technique that has attracted great attention in the past decades following the pioneering work by Dr. Robert Alfano's group in 1980s. Optical biopsy includes a collection of early detection and diagnostic techniques using optical measurements, such as label-free intrinsic fluorescence and Raman spectroscopy and various types of optical imaging techniques.

Raman spectroscopy is a technique used to observe molecular vibrational, rotational, and other low-frequency modes in a substance. Raman spectroscopy is commonly used to provide spectral fingerprints by which molecules can be identified. When used for optical biopsy, Raman spectroscopy uses intrinsic biomarkers and can operate in situ and in real time, which leads to a rapid progress for researches and clinical applications in cancer diagnosis. But most reports in the literature which demonstrated spectral differences between normal and cancerous breast tissues used near-infrared (NIR) laser excitation. Since Raman scattering is very weak, some researchers used high power (e.g. 300mW) and long signal collection time (e.g. minutes). Such approaches have limitations for practical applications.

We have been developing a visible resonance Raman (VRR) spectroscopy technique using a 532nm laser beam for excitation which can address the limitations of NIR Raman spectroscopy techniques. The vibrational resonance effect occurs in RR spectroscopy when the energy of the excitation approaches an optical transition energy level in the substance. The resonance effect can lead to greatly enhanced intensity of the Raman scattering, which facilitates the study of compounds present at low concentrations. In our preliminary studies, the RR spectra with 532nm excitation collected from chromophores, and many other large conjugated molecules, exhibited enhanced peaks. Biological cells and tissues contain many large biomolecules such as flavins, nicotinamide adenine dinucleotide (NAD), reduced nicotinamide adenine dinucleotide (NADH), collagens, elastin, carotenoid, tryptophan and the heme proteins, many of which may be used as biomarkers for cancer diagnosis. The resonance-enhanced signals from these biomolecules suggest that 532nm excitation wavelength is at resonance or near resonance with these compounds in the cells and tissues. Therefore, VRR may be used to detect the spectral fingerprints of the biomarkers for cancer diagnosis.

Here we present some promising results of preliminary studies for cancer diagnosis based on enhanced Raman spectra collected using visible resonance Raman spectroscopy. The spectral data were analyzed using machine learning methods.

Binlin Wu
Physics Department and CSCU Center for Nanotechnology, Southern Connecticut State University, 501 Crescent Street, New Haven, CT 06515, USA.

SESSION SPEAKER

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.

Space-Based Microwave and Laser Defense Mechanisms for Hypersonic ICBMs

Anthony Peters
CEO & Founder, Iron Strike Engineering, LLC, USA

The rapid expansion in Chinese offensive military capabilities and technology is a cause of great concern to United States national defense, especially due to the hypersonic advances with intercontinental ballistic missiles (ICBMs). A critical mission of the United States Navy is strategic deterrence, which would place immense emphasis on the development of robust and innovative defense mechanisms to intercontinental threats. As foreign offensive weapons technology continues to evolve, it is paramount that new defense technologies adapt to meet current needs for protection of homeland security. In this conference, a comprehensive analytical framework is presented regarding the political, economical and scientific needs for space-based defense technology utilizing lasers and microwave emitters.

This presentation seeks to address the methods by which proper target acquisition can be applied and integrated into the example notional kill chain for existing counter ballistic missile systems. Specifically, how to identify, track and subsequently utilize an effective intercept for existing ballistic missile defense (BMD) systems. As the interceptor is discussed to be the main system limitation for the hypersonic ICBM threat (ICBM-H), it is essential to seek space-based defense methods involving microwave emissions or laser technology. Discussed technical obstacles for space-based directed energy defense assets includes energy absorption and scattering due to atmospheric particle distributions, desired emission wavelength ranges, desired received power density to target based on frequency, system duty cycle, and observations for power electronics in the electrochemical conversion processes (i.e., photovoltaics and electrochemical storage systems).

Biography

Anthony (Tony) Peters is the CEO and Founder of Iron Strike Engineering, LLC, and has extensive experience in energy and aerospace engineering research. He is an internationally published energy researcher, a Navy Pilot, and Aerospace Engineering Duty Officer. He most recently served as Assistant Professor of Physics at Jacksonville University and is currently conducting research in Gallium Nitride semiconductors and photovoltaics integration and testing at Columbia University.

SESSION SPEAKER

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Lingyan Shi, Yajuan Li, Anthony A. Fung, Hongje Jang
Department of Bioengineering, UCSD, USA

KEYNOTE SPEAKER

Super Resolution DO-SRS Multiplex Imaging for Metabolism in Aging and Diseases

Understanding the dynamics of metabolism in a multicellular organism is essential to unraveling the mechanistic basis of many biological processes in healthy and diseased conditions. There has been an urgent need of high spatial resolution, non-invasive imaging techniques for imaging metabolism of various biomolecules in cells and tissues. Deuterium oxide probed Stimulated Raman scattering (DO-SRS) can generate chemical specific metabolic imaging with high resolution, deep penetration of depth, multiplex, chemical selectivity, 3D volumetric and quantitative capability. In the present work, we developed a new approach that combines super resolution A-SUPPOSe enhanced DO-SRS imaging and custom designed clustering methods to visualize mutiplex metabolic activities and subcellular distribution of newly synthesized macromolecules in living organisms. Within the broad vibrational spectra, we can image more than 30 different molecules including lipids subtypes-, protein-, and DNA-specific Raman profiles and develop hyperspectral detection methods to obtain multiplex imaging of various biomolecules. This technology platform is non-invasive, universal applicable, and it can be adapted into a broad range of biological studies such as neurodegeneration, aging, homeostasis, tumor progression, etc. We applied this method to study the diet regulated metabolic dynamics in animals during aging processes, the quantitative lipid and protein turnover rate, the intra-cellular metabolic heterogeneity.

We developed a new super resolution multiplex optical metabolic imaging platform with A-SUPPOSe enhanced DO-SRS microscopy to detect metabolic dynamics in cells and tissue for studying aging and diseases.

Biography

https://jacobsschool.ucsd.edu/faculty/profile?id=487

Dr. Lingyan Shi is currently an Assistant Professor in the Department of Bioengineering at UCSD. Her research focuses on developing high resolution optical spectroscopy and imaging platforms, and applications to studying cellular metabolic dynamics during aging and diseases in living organisms. She developed an innovative technology that combines deuterium oxide (heavy water) probing and stimulated Raman scattering (DO-SRS) microscopy to visualize metabolic activities in situ. Her group further developed new deconvolution and clustering algorithm to transform DO-SRS into a super resolution multiplex imaging platform, for metabolic imaging in living animals such as Drosophila and mice, especially for detecting lipid subtypes changes in diseased conditions and during aging processes. Dr. Shi has six awarded patents. She won Blavatnik Regional Award for Young Scientist in Physical Sciences & Engineering in 2018. Recently she won Hellman Fellowship Award 2021 for her research on nutrition regulated metabolic imaging during aging processes. She received "2021 Rising Star Award" by Nature Light, "Rising Star Award 2021" by Lasers Focus World, and selected as a "Advancing Bioimaging Scialog Fellow" by RCSA and the Chan Zuckerberg Initiative 2022.

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LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Fiber Bragg Grating Sensors – Some Recent Novel Applications

S. Asokan
Department of Instrumentation and Applied Physics,
Indian Institute of Science, Bangalore, India

Fiber optic sensors, in particular Fiber Bragg Grating (FBG) Sensors, have found extensive applications in a variety of fields due to many advantages such as high sensitivity, small footprint, multiplexing capability, electrical passiveness, chemical inertness, immunity to electromagnetic interference, etc. Conventionally, FBG sensors have been deployed in physical sensing applications, to sense strain, temperature, vibration, acceleration, etc. However, in the recent times, with suitable transduction methodologies, FBG sensors and etched & functionalized FBG (eFBG) sensors have been adopted for several newer applications in the fields of biomechanics, biochemical & chemical sensing.

This talk will highlight some of the recent novel applications of FBG sensors and etched & functionalized FBG (eFBG) sensors in biomechanical, biochemical, and chemical sensing. The applications illustrated will include sensing biological markers & toxic chemicals, water quality monitoring, Radial Arterial Waveform measurement, tracking eyeball movement, human gait analysis, etc.

Biography

Sundararajan Asokan obtained his M.Sc in Materials Science from Anna University, Madras and Ph.D in Physics from Indian Institute of Science Bangalore. He has been a visiting Scientist at Gifu University in Japan, Imperial College of Science, Technology and Medicine, London and Harvard University, Cambridge, MA, USA. He currently serves as a Professor and Chairman of the Department of Instrumentation and Applied Physics.

SESSION SPEAKER

Enactment Valuation of DF Cooperative Time Hysteresis Switchingbased Hybrid FSO-RF System

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Time hysteresis switching based cooperative DF relaying for hybrid FSO-RF system achieves SER of 10-7at lower SNR. The design utilises better spatial diversity MIMO as well as Majority Logic combining (MLC) algorithm for receiver reconstruction that provides effective detection of signals. Index terms: Free space optics (FSO), Symbol error rate (SER), Gamma-gamma (G-G), Malaga (M) Distribution, Decode and Forward (DF), Cooperative MIMO, Majority logic combining (MLC) algorithm.

I.INTRODUCTION: Nowadays with rapid growth in volume of handheld smart devices, high speed and cost effective communication protocols are prerequisite. Currently use of radio frequency (RF) techniques addresses the problem with spectrum congestion at global level [1-2]. To overcome this issue Free Space Optics (FSO) is one of the better way to go with. Free-space optical and millimeter wave (MMW) RF transmissions support a high data rate for shortrange transmission up to a few kilometers [3]. But FSO link degrades in presence of fog, smoke and turbulence [4]. We designed a hybrid FSO-RF communication system with low complexity and high efficient performance using Time Hysteresis based Switching. To ensure our design that provides better spatial diversity, we considered MIMO transmitter and receiver. For improving the long haul communication efficiency, we include the cooperative communication using Decode-Forward (DF) relaying [5]. For receiver reconstruction, Majority Logic Combining (MLC) algorithm is used as very low complexity and effective detection of signals at the receiver end. Simulations are performed to evaluate the proposed design in different scenarios with Gamma-Gamma and Malaga distributions for turbulence model. Also Strong and Weak turbulence models are validated for proposed hybrid FSO-RF system. Key performance parameter is average symbol error rate (SER). The simulations show that the proposed switching scheme for a cooperative hybrid FSO-RF system drastically improves the performance compared to that of a single-hop (SH) switching-assisted hybrid FSO-RF and cooperative FSO systems. To further show our design outperformance, we compare the hybrid FSO/RF with only RF and only FSO system without any switching mechanism. Gamma-gamma and Malaga distributions are considered for different turbulence regimes along with different pointing error effects. At low SNR region, proposed system achieves 1x10-7of SER which is 2 time higher than the results reported in earlier works. The main contribution of the proposed study is as follows:

• To design Cooperative MIMO DF relaying Hybrid FSO/RF system.

Modelling Gamma-Gamma and Malaga Distributions for strong and weak turbulencedesign of FSO fading.

• Algorithm of MLC for MIMO combining technique in cooperative hybrid FSO/RF receiver described to reduce the receiver reconstruction complexity.

Phase dependent large Kerr-nonlinearity in three level semiconductor quantum wells

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[2]Department of Physics, Birla Institute of Technology Mesra, Ranchi, Jharkhand, India-835215

The Kerr-nonlinearity and its related phenomena arising due to the interaction of intense incident radiation in semiconductor quantum well have been extensively studied. Their applications in optical devices and communication are widely known. In this study the third-order susceptibility (leading to Kerr nonlinearity) has been investigated in a three-level semiconductor quantum well with ladder type excitation scheme under the regime of Electromagnetically Induced Transparency (EIT). The existence of large third-order susceptibility of the order of / has been identified in this system. The magnitude as well as the profile of the Kerr susceptibility is found to vary when phases in the optical fields are varied. These results predict the tenability of not only the Kerr-nonlinearity but also other higher-order susceptibilities which may have potential applicability in nonlinear optics.

Keywords: Kerr nonlinearity, Electromagnetically Induced Transparency

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Biography

Monika Nath is a PhD student in Physics Department at University of Science and Technology Meghalaya, Meghalaya, India. She received her BSc degree in Physics from Birjhora Mahavidyalaya(Bongaigaon)and MSc degree in Physics(Nano Technology, Molecular and laser spectroscopy, General theory of relativity and cosmology, statistical and numerical methodology) from Guwahati University. Her research focuses on investigation of nonlinear phenomena in Semiconductor Quantum Well using EIT(Electromagnetically Induced Transparency).technological markets. Dr. Delfyett was also elected to serve 2 terms as President of the National Society of Black Physicists (2008-2012). Most recently, he was awarded the APS Edward Bouchet Award for his significant scientific contributions in the area of ultrafast optical device physics and semiconductor diode based ultrafast lasers, and for his exemplary and continuing efforts in the career development of underrepresented minorities in science and engineering. Awards & Honors International Society for Optics and Photonics (SPIE) Fellow American Physical Society (APS) Fellow IEEE Photonics Society Fellow Optical Society of America (OSA) Fellow 2019 Excellence in Graduate Teaching College Award 2014 Florida Academy of Science's 2014 Medalist 2013 National Academy of Inventors Fellow 2013 Letter of Appreciation – SPIE 2013 Faculty Excellence for Mentoring Doctoral Students 2013 College Research Incentive Award (RIA) 2012 Faculty Excellence in Mentoring Doctoral Students 2012 College Excellence in Graduate Teaching Award 2012 Excellence in Graduate Teaching Award 2011 Excellence in Graduate Teaching Award 2011 APS Edward Bouchet Award 2010 American Physical Society Edward Bouchet Award 2010 IEEE Photonic Society Graduate Student Fellowship 2010 SPIE Educational Scholarship in Optical Science and Engineering 2010 Incubic/Milton Chang Travel Award to attend CLEO 2006 Science Spectrum Trailblazer 2005 District Advocate for the American Physical Society 2005 Science Spectrum Outstanding Black Professional in Science 2003 Technology Innovation Award 2003 UCF Millionaire's Club 2002 Pegasus Professor Award 2002 UCF Distinguished Research Professor Award 2002 UCF Millionaire's Club 2001 UCF Nguzo Saba Award 2000 Research Incentive Award (RIA) Research Group Conducting research on ultrafast high power optical pulses from semiconductor diode lasers, for applications in applied photonic networks and laser induced materials modification.

Fiber Bragg grating-based intelligent surgical device

Fiber Bragg grating (FBG) sensing is a promising method in the field of surgical devices due to its inherent characteristics, such as biocompatibility, small size, low mass and insensitivity to electromagnetic interference. This presentation mainly introduces recent progress of the development of a serial of FBG-based sensors for intelligent surgical devices at Wuhan University of Technology of China. A high-sensitivity tri-axial catheter distal force sensor for cardiac ablation has been developed. Its resolution is 2.13 and 2.52 mN for both transverse directions within -1~1 N, and 23.12 mN for the axial direction within 0~2 N which facilitates improved control of cardiac ablation procedures and is beneficial to reduce tissue damages. For higher precision, an optimized tri-axial force sensor has been presented. The sensor characterization results indicate a high-resolution of 0.52 mN and 0.64 mN for both lateral forces within -0.8~0.8 N and 0.63 mN for axial direction force within 0~0.8 N. Experiments show that the sensor can provide a measurement with an RMS error of less than 3.00 %, temperature-induced errors for force detection are less than 6.5 %. To solve the coupled effect among the measured components of 3-axis force sensors, the Rectified Linear Unit (ReLU)-based Back Propagation (BP) method has been adopted. Average relative errors of experiments are less than 2 % which validates the feasibility and effectiveness of the method. For the tissue palpation in minimally invasive surgery, FBG-based tactile sensors have been designed. A high-sensitivity optical tactile sensor array with a resolution of 0.93 mN can detect tumors with an embedded depth up to 8 mm. Aiming at the needs of robot-assisted diagnosis, a FBG-based 3-axis tactile sensor for surface reaction force mapping, identification and localization of tissue hard-inclusion has been proposed. Experiments indicate that this proposed 3-axis tactile sensor can effectively identify the presence and location of hard-inclusions with varied sizes and depths. Moreover, the sensor can reconstruct the surface profile of a non-planar tissue such as lengthy vessels.

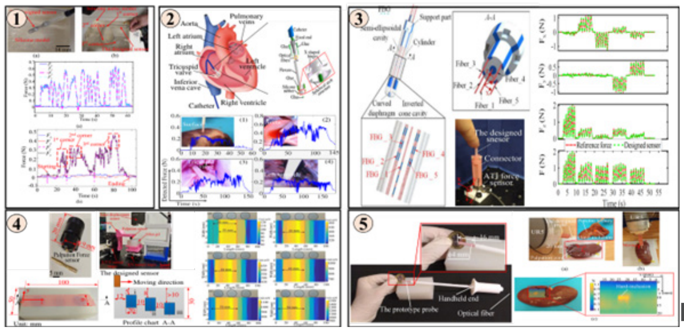

Fig. 1: Recent progress of a serial of FBG-based sensors for intelligent surgical device

Tianliang Li[1*]

[1]School of Mechatronics Engineering, Wuhan University of Technology, China;

SESSION SPEAKER

Biography

Tianliang Li is currently a Full Professor with Wuhan University of Technology (WHUT), China. Dr. Li received the M.S and Ph.D. degree from WHUT, in 2014 and 2016, respectively. After obtaining his Ph.D.,, he worked as a Research Fellow at Nanyang Technological University and the National University of Singapore. His research interests include advanced optical fiber sensing, mechanical equipment condition monitoring, medical robotics and its sensing technologies. He has authored more than 50 papers in international journals and conferences.

Diffusing Wave Spectroscopy with nonspherical particles: a framework for extracting visco-elastic spectrum from translational and rotational diffusion

Sriram chandran, saikat sarkar, ram mohan vasu*, debasish roy
Computational Mechanics Laboratory, Department of Civil Engineering, Indian institute of Science, Bangalore-560012, Karnataka, India

SESSION SPEAKER

We have studied experimentally dynamics of Brownian particles with shape-anisotropy trapped in the biharmonic potential of an acoustic focal region. Since dimension of acoustic trap is kept smaller than transport-mean-free-path, both the translational as well as rotational information are captured through a light-scattering probe. The geometric anisotropy of the trapped particles allows scattered light from them to carry rotational information of the particle, as well as translational. An expression is derived for the mean square fluctuation of phase of light reaching the detector through these particles. Since this quantity has contributions from translation and rotation of particles (which are not averaged out), the mean-square displacement (MSD) obtained from this appears to be scaled with respect to that from spherical particles. This scaling is seen even in the recovered complex modulus of elasticity ( ), an average for the region marked by the acoustic force, designated region of interest, the ROI. Application of periodic forcing in the ROI by the ultrasound transducers causes a periodic modulation to ride over the amplitude autocorrelation of transmitted light. The decay in the modulation depth is owing to Brownian motion of scattering centres within the ROI. The dynamics of the Brownian particles within the ROI is represented by that of a system particle obeying the generalized Langevin equation (GLE) with a multiplicative noise term in the restoration term, and a history-dependent viscous drag force. It is shown that the amplitude of this noise dictates the fluctuations seen on the plateau of the MSD curve and is directly related to the shape anisotropy of the Brownian particles. The memory kernel is expanded using Prony series, and the sum of a set of coefficients is seen to be proportional to the average radius of the scattering particles. The experimentally measured | | is verified by rheometer measurements, which agree with that obtained using spherical particles. With non-spherical particles, contribution from phase fluctuations from rotational diffusion as well makes | | scaled by a factor of 1.5, though perfectly matching the shape of the spectrum from spherical particles. When the Stoke-Einstein equation is modified to include phase from rotation as well, the computed matched exactly the rheometer measurement for the isotropic material used in the experiments.

Biography

~~Josef Vojtech received with honours MSc in Computer Science and PhD degree in the field of all-optical networking from the Czech Technical University, Prague, in 2001 and 2009, respectively. He leads research department of Optical networks CESNET a.l.e., e-infrastructure provider in the Czech Republic since 2015. He holds 13 patents (including 5 US) and multiple utility models. His record shows 140+ scientific publications. He participated in international projects: CLONETS-DS, TiFOON, CLONETS, COMPLETE, FI-PPP XIFI, GN4, GN3+, GN3, GN2, Porta Optica Study, SEEFIRE. He led contractual research for delivery of ultrastable coherent optical frequency for sensing of nuclear power plant containment stability and interconnection of quantum sources of ultra-stable optical frequency. He co-organizes Customer Empowered Fibre networks workshop since 2004 and special section on Photonic networks and their services within conference on Telecommunications and signal processing since 2016. He is a senior member of IEEE, OSA, SPIE and member of ION. In 2007 he received the research prize of the Czech minister of education. In 2007 he with Miroslav Karásek and Jan Radil received the research prize of the Czech minister of education.~~

Characterization techniques for fabricated step- and graded-index integrated-optic waveguides.

Detail characterization of optical waveguides is essential to obtain desired functionality of integrated photonic chip. These waveguides may be of different types: graded or step index, wire or rib, single or multimode, and ridge or buried. In this presentation briefly fabrication techniques, as was done by the author, of titanium indiffused, annealed proton exchanged, and direct UV-written waveguides in congruent lithium niobate, will be discussed. All these waveguides are graded-index and buried in nature. Among the step-index waveguides, fabrication processes followed in author's laboratory, for SU-8 polymer and silicon on oxidized silicon, silicon-on-insulator or glass substrate will be outlined. These are ridge or rib or wire waveguides. The characterization of a waveguide begins with measurement of propagation loss and fiber-to-waveguide coupling loss of the waveguide. Among different reported techniques most popular is cut-back method. This can be applied to multimode or single mode waveguides and of any nature, although its accuracy depends on preparation of same end-facets of the waveguide before and after cutting. However, by measuring total insertion loss of waveguides of different lengths, processed similarly, one may experimentally obtain more accurate average loss components (modified cut-back). Since this technique is destructive, researchers use Fabry-Pérot cavity measurement between the two ends of the single-mode waveguide to determine losses. But this method requires costly, stabilized, narrow linewidth laser source or high-resolution optical spectrum analyzer. In our centre we developed a new, low cost technique of loss measurement taking into account the resonator between fiber output and waveguide input ends. The method requires a low-cost, medium bandwidth (~20 nm) light source and a low resolution (~1nm) monochromator. Most of the waveguides used in integrated photonic chip are single mode in nature. So determination of wavelength range for which the fabricated waveguide guides only fundamental mode is extremely important. In our centre we developed a spectral analysis technique to determine multimode, single mode, and cut-off point of fabricated waveguides. In this characterization method a white-light source is coupled into the waveguide, and transmitted light through the waveguide is analyzed by a monochromator. The spectral data is used to determine various regimes of waveguide operation from multimode to cut-off. The mode index and refractive index profiles of fabricated waveguides are important parameters which determine optimized device performance. The conventional non-destructive method to determine these parameters for single mode waveguides is based on inversion of scalar wave equation and measurement of near-field intensity profiles of waveguides at desired wavelength. However, this technique is very sensitive to spatial frequency noise which is further amplified by involved Laplacian operator. Moreover as the refractive index change is a small quantity, the mode index required for computation is approximated by substrate index value, which induces an underestimation of index variation. In a recently developed method at our centre, simultaneously mode index and refractive index change profiles (lateral and depth-wise) were estimated accurately by solving the above two difficulties. During the presentation these three characterization techniques will be discussed in details along with measured experimental data for different waveguides.

Pranabendu Ganguly
Senior Scientific Officer
Advanced Technology Development Centre Indian Institute of Technology, Kharagpur, India

Biography

Pranabendu Gangopadhyay (Ganguly) was born in Kolkata, India, in 25th October, 1968. He graduated from Scottish Church College, Calcutta University with Physics (Honors) in 1990 and received M.Sc. (Technology) in Optics and Optoelectronics from Dept. of Applied Physics, Calcutta University in 1993. After that he worked on Fourier Optics in same Department as a research fellow for couple of months and in June 1994, he joined the Indian Institute of Technology, Kharagpur, as a mission engineer and initiated research on Integrated Optics. He got his Ph.D. in 2000 from Department of Electronics and Electrical Communication Engineering, IIT Kharagpur. Currently he is working as Senior Scientific Officer in Advanced Technology Development Centre of the institute where he is leading the Microphotonics research group. Apart from integrated optics his current research interest includes fiber optics, optical metrology, MEMS / MOEMS, and micro/nano-photonics. Dr. Ganguly has published 98 research papers in journals and conferences, has two copyrighted software in the field of Guided Wave Optics, and coauthored one book on "Photonic waveguide components on silicon substrate: modeling and experiments". He is a life-fellow of the Optical Society of India and was a Royal Society Visiting Scientist in Optoelectronics Research Centre, University of Southampton, UK, in 2008-09.

SESSION SPEAKER

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Optical Techniques for Information Security

Naveen K. Nishchal
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Bihta, Patna-801 106, India

SESSION SPEAKER

Developing technology for securing information has become very significant in this digital era and has started attracting attention of researchers from around the world. Due to technological advancement large amount of data is being generated, stored, and disseminated, which requires an efficient cryptosystem. Such system should offer strong security, enough storage capability, and extremely fast in processing information. For these reasons, researchers are trying their best to develop alternatives to existing digital techniques of data security. Optical technologies are being considered as a potential candidate for information security since optics offers various degrees of freedom such as amplitude, phase, spatial frequency, wavelength, state of polarization, orbital angular momentum to encode data securely. Also, high speed and parallel processing are the inherent features of optics. The pioneering work on optical encryption technique referred to as double random phase encoding was reported in 1995. The technique was proved vulnerable due to involved linearity. To overcome the weakness, optical asymmetric schemes and many other variants have been reported. This paper presents a review of the literature on the topic with special emphasis on the research work carried out at IIT Patna.

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Biography

Dr. Naveen Nishchal is an associate professor in the department of physics at the Indian Institute of Technology (IIT) Patna. Dr. Nishchal received his Ph.D. degree in physics from IIT Delhi in 2005. He has served Instruments Research and Development Establishment (DRDO), Dehradun as a Scientist 'C' during 2004-2007. He also served IIT Guwahati as an assistant professor in the physics department during 2007-2008. He has been a Researcher to the Oulu Southern Institute, University of Oulu, Finland. His research interests include optical information processing and security, digital holography, correlation-based optical pattern recognition, fractional Fourier transform-based signal processing, interferometry, and orbital angular momentum of light. He is a senior member of OSA and SPIE since 2015. He is a life member of Optical Society of India, Indian Science Congress Association, and Lasers and Spectroscopy Society of India. He has authored a monograph Optical Cryptosystems published from IOP Publs., Bristol, UK in 2019. He has authored/co-authored 72 peer-reviewed international journal papers, three book chapters, and 170 papers in various conferences/seminars/symposia. He has supervised six PhD theses and currently two research scholars are pursuing their PhD program under his guidance. Currently, he is an Associate Editor of Optical Engineering (SPIE, USA) and Asian Journal of Physics (India) and Review Editor to the Editorial Board of Optical Information Processing and Holography, Specialty section of Frontiers in Photonics. He served as an Academic Editor to the scientific world journal: signal processing during 2013-2016. He is an active reviewer to the journals published from OSA, SPIE, Elsevier, Springer, IEEE, IEE, IOP, CSIR, Hindawi Publs, and MDPI-online. Dr. Nishchal was selected as outstanding reviewer for the year 2016 for the journal of optics from IOP, UK. Dr. Nishchal received the India Top Cited Author Award-2019 as an author of one of the top 1% most-cited papers in physics published over the period of 2016-2018 by IOP Publs., UK. Recently, his name appeared in world's top 2% scientists list in optics published by Stanford University, USA (PLOS Biology, Oct. 2020). As per Google Scholar, Dr. Nishchal has more than 2665 citations to his credit. His h-index is 30 and i-10 index is 52.

Designing fiber-tip optical resonators for strong field enhancement

Peter Horak and Denis V. Karpov
Optoelectronics Research Centre,
University of Southampton, U.K

For many applications in quantum technology or optical sensing strong coupling between light and micro- or nano-particles is highly desirable. Fabry-Perot optical resonators formed between mirror-coated tips of two optical fibers lead to field enhancement and can be exploited for strong coupling of light to a particle, but the enhancement factor is still limited by geometrical restrictions.

In our work we investigate new designs of such fiber-tip resonators where the shape of the mirrors is optimized to create interference patterns inside the resonator that lead to high peak intensities at the position of the particle. We use a range of approaches, such as analytical theory, evolutionary algorithms, and machine learning, to find the best designs. Our results suggest that significant field enhancement is possible with mirror shapes that deviate only moderately from spherical shapes. These can be fabricated by laser ablation, focused ion beam milling, or micromachining of fiber ends and could give rise to more precise optical sensors and faster quantum information processors.

Biography

Dr Peter Horak is Associate Professor at the Optoelectronics Research Centre (ORC) at the University of Southampton, UK, where he leads the Computational Nonlinear Optics group. He received his PhD degree in Theoretical Quantum Optics from the University of Innsbruck, Austria, and held positions at the Ecole Normale Superieure in Paris, France, and at the University of Strathclyde in Glasgow, UK, before joining the ORC in 2001. His research focuses on theory and numerical simulation of nonlinear optics, optical fibers, integrated photonics, and quantum technology.

SESSION SPEAKER

Mr. Benedykt Michal Josef Campbell-Biezanek
Shropshire, UK

KEYNOTE SPEAKER

Quantum Relativity

The subject of Quantum-Relativity is about as simple as any subject can be, in fact, it is so simple that it almost fails to even exist on account of the subject containing only self-evident logic and some very simple mathematics that have been well-known about for almost all of the most recent 2000-years. In order to understand Quantum-Relativity, we must absorb only two new rather trivial insights into the physical nature of space and time. Quantum-Relativity is fully compatible with Einstein's Special Theory of Relativity and with his General Theory of Relativity. In fact, without the insights provided by a simple statement of Quantum-Relativity, it becomes rather hard to understand what was going on inside the minds of people who only thought that they understood relativity at all. That is about as polite as I can be, because in fact, Quantum-Relativity is indeed a trivial subject.

Insight # 1:

(For Quantum-Relativity we need to return to our arithmetical kindergarten.)

The physical nature of the universe can only be understood in terms of many physical quantities each containing the property of magnitude and phase. Cartesian space, that must consider an origin with both positive and negative magnitudes, must become abandoned as must the nature of any numerical origin. In Quantum-Relativity there is no such number (or rather, magnitude) as zero and there are no negative numbers. The number minus-one becomes replaced by the Gaussian concept of inverse-one. Inverse-one is simply direct-one rotated in phase by pi radians. In Quantum-Relativity there definitely is a square-root of inverse-one and there is nothing whatsoever "imaginary" about it at all. The square-root of inverse-one is simply direct-one rotated forwards by pi/2 radians (or inverse-one rotated backwards by pi/2 radians).

In Quantum-Relativity we must stop calling the operator "i" the "imaginary-operator" and call "i" the rotational-operator, we retain use of the symbol "i", even though it stands for nothing in particular and just means the rotational-operator.

Insight #2:

The present stands still upon the event-horizon of time-now, while historic events move in relative time-position backwards from the event-horizon of time-now

into imaginary-historic-space. The concept of time-travel is utter nonsense, the past is gone, it no longer even exists, if one wants to travel into that one needs a necromancer and not a "Tardis".

A well-known fact:

In about 1980, the CIPM finally adopted a proper definition for the units of spatial separation as being 1/c seconds. That is the only relativistically-robust and gravitational field indifferent definition of spatial displacement, or if you like, space "is" the "light-time-of-flight". As the units of space are definitely seconds of real-time, then what on earth is this stuff that that we call time itself? Time itself fails to even happen, what actually happens is the retreat of history into imaginary-historic-space.

1972 and all that:

In 1972, Clauser and Freedman first demonstrated quantum entanglement and the associated instant action at a distance. That result was so obvious and expected by myself, that the only thing that puzzled me about it was just what anybody thought was strange them about demonstrating the expected result. The entangled quanta pair still "exist" at the shared point of entanglement at the historic emitter, therefore it is only to be expected that when a determination is forced upon one quanta, it is also forced up the entangled partner. The energy state jumps through space-time from the historic emitter into the current detector, instantly. The very nature of space gives rise to the illusion of waves, but no waves actually exist, except by forced detection in the receiving aerial body. In other words; "space is an illusion created by history".

Forget all about the "Speed-of-Light".

The so-called "speed-of-light" is a nonsensical concept that is useful only in classical mechanics. In quantum-physics we may only talk about an "apparent-wave-velocity". The apparent-wave-illusion occurs because of entanglement with physical rotational effects that were taking place, only within the historic emission aerial body. In Quantum-Relativity the apparent-wave-velocity is 1/-1i, but this can be regarded as if it were +1i for most practical purposes.

Footnote:

For persons wishing to study further into the arcane subject of Quantum-Relativity, I have put up my website at the following location. This website contains about 120-pages and took me 14-years of full-time work to create. Hopefully, it should take an able and willing mind rather less than 14-years to absorb the tutorial study essays that I have published.

https://www.gnqr.co.uk/

Biography

The author is 71 years old; he is happily married (but also happily separated) with four sons and ten grandchildren. The author discovered the key solution that led to what he only now calls The Gauss-Newton Quantum-Relativity at nine years of age. It was too great a burden for a nine-year-old to deal with and the author decided to leave the issue until later in his life. The author became an electrical engineer with his own company designing and manufacturing highly specialised electronic instruments for the energy industry. In 2007, the author sold his company and at the age of 57, he took up the full-time theoretical work that led, as a mere byproduct of that overall work, to the development of what he now names as The Gauss-Newton Quantum-Relativity.

Advanced Radio Frequency Timing Apparatus-Techniques and Applications

Amur Margaryan
A.I. Alikhanyan National Science Laboratory
(Yerevan Physics Institute) Foundation, Armenia

Precise measurements of time intervals between two or more physical events or between a physical event and a clock are needed in many applications in science and industry. In a typical timing technique, the time interval is measured between the leading edges of two electronic pulses applied to the start and stop inputs of a time-interval meter. A typical circuit might measure the difference in arrival time of two photons. The detectors, e.g. vacuum or Si photomultipliers, produce ~ns rise time pulses, with constant-fraction discriminators (CFD) providing sub-ns, time-pick-off precision for the logic pulses fed to time-to-digital converters (TDC). This paper describes a new radio frequency timer of keV energy electrons. It is based on a helical deflector, which performs circular or elliptical sweeps of keV electrons, by means of 500 MHz radio frequency field. By converting a time distribution of incident electrons to a hit position distribution on a circle or ellipse, this device achieves extremely precise timing. Streak Cameras, based on similar principles, routinely operate in the ps and sub-ps time domain, but have substantial dead time associated with the readout system. Here, we report an advanced RF timing apparatus, where the position sensor, consisting of microchannel plates and a delay-line anode, produces ~ns duration pulses with small dead time. Measurements made with sub-ps duration laser pulses, synchronized to the radio frequency power, produced a timing resolution of ~10 ps. The time stability of the technique over a period of ~1 hour is within the range of the statistical uncertainty which is about 0.5 ps, FWHM. This ultra-high precision and ultra-stable timing technique has potential applications in a large variety of scientific devices, and in all cases, electrons are timed and detected simultaneously in the same device. Possible applications in single photon detectors are discussed.

Biography

Amur Margaryan has completed his PhD at the age of 33 years from Yerevan Physics Institute and continued studies in the field of experimental nuclear physics at Yerevan Physics Institute; Serpukhov proton accelerator, Serpukhov, Moscow region; JLab, Newport News, VA, USA; MAX-lab, Lund, Sweden; GRAAL experiment at European Synchrotron Radiation Facility in Grenoble, France. He is the Leading Scientific Researcher at A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute). He has published more than 150 papers in reputed journals. He holds one Soviet Union and one US patents. His current research interest is in ultrafast photon detectors and optoelectronic devices.

POSTER PRESENTATION

How to perform in vivo tissue macro- and micro- Raman spectroscopy reliably and implement clinical applications?

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

Raman spectroscopy is a powerful non-invasive optical technique for biochemical composition analysis. The inherent weak signal of Raman scattering makes it a great challenge for in vivo tissue analysis. We have developed a platform technology that meets the challenge and implemented in vivo diagnostic applications. One aspect of our technology measures Raman spectra from a macro-size (mm3) tissue volume using a fiber optic probe for excitation laser delivery and Raman signal collection and a proprietary technology to correct spectrograph image distortion, realized a >16 S/N improvement. The macro-Raman system is capable of acquiring a spectrum from tissue in vivo in about 1 second, facilitating practical clinical applications. Two application examples will be presented. One is for skin cancer detection, we have collected Raman spectra from over 1,000 skin lesions including skin cancers: melanoma, squamous and basal cell carcinomas. Diagnostic algorithms based on PCA-GDA/PLS-DA were developed that could calculate the posterior probability of a lesion being skin cancer within 0.5-seconds. Thus fast automatic diagnosis is completed within 2-seconds. The system has been commercialized and received regulatory approval from Canada and Europe. The application for endoscopy lung cancer detection will also be described.

The other aspect of our technology measures Raman spectra from micro-size (um3) tissue volume utilizing a confocal microscopy optical configuration. Different from other group's approaches, we provide confocal imaging guidance and monitoring during the whole micro-Raman data acquisition period (as long as 20 seconds) to make sure that the valid Raman data are always from the interested micro-target. Application example for in vivo non-invasive glucose measurement will be presented.

The presentation will also discuss a few practical issues for clinical translation, such as system calibration, laser safety consideration, and conditioning of ambient lighting so that patient measurements could be conducted in an illuminated environment instead of in the dark.

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.

Young Rok Choi
Saint Paul Preparatory Seoul, Korea

Stereochemical Analysis of Nanoscaled CNTs and C60 Compounds for the PDT of Immunodeficiency Disorders

Photodynamic Therapy(PDT) is considered a non-invasive treatment, involving the interaction between the light of a determined frequency, a photo-sensitizer, and oxygen. This interaction produces the formation of a highly reactive oxygen species (ROS), usually singlet oxygen, superoxide anion, and free hydroxyl radical. These radical species and oxidative stress damage the cell affected by the virus, possibly inducing apoptosis or even necrosis. In this study, computationally constructed CNT(carbon nanotube) and fullerene derivatives composites were studied to evaluate their efficiencies in the PDT of Immunodeficiency Disorders.

To examine the efficiencies of the compounds, qualitative and quantitative assessments for various CNTs and fullerene analogs were performed using computer simulations. The stereo-chemical and thermo-dynamical properties were also found and analyzed for the nano-scaled materials.

Biography

Ryan(Young Rok) is interested in Immunodeficiency analysis, such as Disorders Photodynamic Therapy(PDT) which is considered a non-invasive treatment. Also, he is interested in the analysis of other various molecules with genes used in Photodynamic Treatment by computational and theoretical methodology. He has been studying Immunodeficiency Disorders Photodynamic Therapy(PDT) and the interaction between the light of a determined frequency, a photo-sensitizer, and oxygen. His potential study area is Chemical engineering or Biochemistry. He is also interested in law, politics, and literature. His hobbies include fiction writing.

Remi Leandre
University of Franche Comte, France

Toward A Wong-Zakai Approximation For Big Order Generators

We give an approach to the Wong-Zakai approximation of diffusion to big order generators. This gives a relationship between ordinary differential equations and parabolic equations generated by big order generators. In "Symmetry in ordinary and partial differential equations and applications" C. Vetro editor. Symmetry (2020) (Open access).

Biography

Rémi Léandre is directeur de recherches in C.N.R.S.at the University of Bourgogne-Franche-Comté (Besançon). He has written about 170 papers in various journals and various proceedings about the applications of the Malliavin Calculus, White Noise Analysis and stochastic differential geometry to analysis, geometry and mathematical physics. He received Bronze Medal of C.N.R.S. in 1988 and Rollo Davidson Prize in 1989 for various works on hypoelliptic diffusions. He has organized several conferences in France and published with X. Dai, X. Ma ans W. Zhang two books in honour of Jean-Michel Bismut in Astérisque (French Mathematical Society)

SESSION SPEAKER

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Niloy Dutta
Department of Physics, University of Connecticut, USA

Optical Correlator Using Silica Waveguides

Correlators are important for pattern recognition in a digital data stream. A typical data stream used in transmission has a set of header bits for data routing and other processing needs. Future all-optical networks may require optical header recognition to enable fast routing and switching of optical packets. A compact reconfigurable 8-bit and 32-bit optical pattern matching circuit operating at 40 Gb/s is demonstrated. The planar lightguide circuit is fabricated using silica-on-silicon waveguides. The splitters/combiners along with variable optical attenuators and phase shifters in the circuit allow tuning and dynamic reconfiguration of the circuit.

Biography

Niloy Dutta is a professor of physics at the University of Connecticut, Storrs, CT. 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 Connecticut Academy of Science and Engineering. He received the Photonics Society Distinguished Lecturer Award in 1995 and Bell Laboratories President's Award in 1997.

SESSION SPEAKER

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LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Real time and sampling less quality control of T-cell culture

Bruno Wacogne[1,2,*], Naïs Vaccari[1], Marine Belinger-Podevin[1], Claudia Koubevi1, Alain Rouleau[1] and Annie Frelet-Barrand[1]
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[2]INSERM CIC 1431, Besançon University Hospital, 2 place St Jacques, 25030 Besançon cedex, France

SPEAKER

Advanced Therapy Medicinal Products (ATMPs) are promising therapeutic solutions based on modification of biological substances either directly from the patient to be treated or from healthy donors. CAR T-cells represent current and best known ATMPs used to treat cancers. However, these products suffer from their prohibitive price; around a few hundred thousand dollars per dose. The production of these new drugs can last over more than one week and requires multiple quality controls throughout the process. One of the most feared problem is the occurrence of a contamination which implies stopping the production and reducing the patient's survival chance. Although the whole process takes place in sterile facilities, the fight against contamination requires specifically trained staff and costly facilities maintenance. One critical stage of quality controls is the moment when the content of the bioreactor is sampled which constitutes a supplementary contamination risk. Also, the quality control is not performed in real time which delays the quality diagnostic and subsequently the final price of the product. In this conference, we present simple and real time white light spectroscopy means to simultaneously monitor T-cell growth, detect contaminations and estimate the production quality. The methods are based on the mathematical description of T-cell absorption spectra shapes. Describing the shape not only allows measuring the cell concentration (a Beer-Lambert derived method), but also detecting any contamination and assessing the production quality. Because white light spectroscopy is contactless, sampling the bioreactor's content is no longer required and on-line as well as real time operation becomes possible. The figure below shows examples of healthy and contaminated absorption spectra as well as a T-cells, bacteria and contaminated culture representation in a Principal Component Analysis.

Biography

Dr Bruno Wacogne is a CNRS Research Director at the FEMTO-ST Institute (one of the biggest Science and Technologies laboratory in France) where he was the head of the "Photonics for medical instrumentation" team before to join the BioMicroDevices group. He created and is now leading the Biom'@x transversal axis "Science et technology for personalized medicine" within this Institute. In 2010, at the request of Besançon University Hospital, he applied and has been awarded a Translational Research Fellow position from the National AVIESAN Alliance. This is a supplementary position that allows him to be at the interface between the health activities at the FEMTO-ST Institute and the Clinical Investigation Center in Technological Innovation at Besançon University Hospital. At the hospital, he is now the technological supervisor of the institution and the head of "Microsystems and biological qualification" unit. His research interests concern translational research, science and technology for health and more precisely immuno-combined medical devices, biological qualification devices and biomedical optics. He author or co-author of over 230 communications among which about 30 invited conferences and keynote lectures. He is regularly chairman in international conferences. He has been awarded several times: Gold Micron at the International MICRONORA Workshop in 2006, Best Poster Award at the 2nd International Conference on Bio-sensing Technology in 2011, and Best Paper Award at the 13th International Conference on Biomedical Electronics and Devices in 2020.

Dr. A.R. Ganesan
Department of Physics
Indian Institute of Technology Madras
Chennai – 600 036, INDIA

SESSION SPEAKER

Optical Wavefront Estimation and Control for Adaptive Optics and Vision Science

Adaptive Optics in a branch of Optics wherein the optics modifies itself to changing environmental conditions to provide high resolution imagery, somewhat similar to the human eye. In Adaptive Optics, the phase profile and the aberrations of an optical wavefront are measured with a wavefront sensor and corrected with tilting / deformable mirrors in a real-time closed loop fashion. The applications of Adaptive Optics range from Astronomical imaging to laser beam steering in free space satellite optical communication, high resolution imaging of the retina of the human eye, etc.

Wavefront sensing is the method of measurement of the phase of the propagating light beam. It also provides a single pass end-to-end diagnosis of an optical imaging system. The wavefront correction mechanisms mainly used in Adaptive Optics are the tip-tilt mirror and deformable mirror. The tip-tilt mirror, also called beam-steering mirror, compensates the global tilt of an incoming beam and keeps the beam tracked. The deformable mirror changes its shape conjugate to the wavefront fluctuations, compensating the wavefront aberrations.

In vision science, the use of slit-lamp apparatus by an ophthalmologist provides only the defocus and astigmatism components of the eye lens-corneal system. However, the imaging system of the eye could have higher order aberrations like spherical aberration, coma etc. The Wavefront Sensor can also be used to measure the geometric higher order aberrations of the human eye.

The talk shall discuss the design and development of an indigenous Shack-Hartmann Wavefront Sensor and its features. The experimental results of aberration measurement and compensation will be presented. New methods developed for geometric aberration measurement of intervening media and the results of the measurement of higher order aberration in human eye will also be presented.

Biography

Dr. A.R. Ganesan obtained his Ph.D. degree from the IIT, Madras in 1989. His areas of research and specialization are Holography, Laser Speckle Metrology, Optical metrology, Adaptive Optics, Fiber Optics & Laser Instrumentation and related fields. He has been the principal investigator for a number of projects sponsored by various organizations in Indian and abroad.

Dr. Ganesan has published more than 110 research papers in reputed international journals and Conferences. He has co-authored a book on "OPTICS" with Eugene Hecht. He is a member of many professional societies and a Fellow of the Optical Society of India. He is a reviewer for several international journals.

Current Status and Future Trends of NIR Spectroscopic Analysis of Natural Products

Christian W. Huck
University of Innsbruck, Austria

The ability of straightforward on-site usage, non-destructive analysis of samples featuring wide variety in chemical composition and physical form, while remaining sensitive to the chemical fingerprint is the hallmark of NIR spectroscopy (Bec and Huck, 2020). High performance, sensitivity, reproducibility with low methodological development costs, accompanied by the capacity to perform through-package analysis, makes NIR technique particularly valued in food quality control. In the near future, the problem of natural product quality control will be one of the most important and focused topics in the public debate, where the risk is seen two-fold, intentional or accidental; to address both, new, powerful and efficient analytical methods need to be established (Charlebois et al., 2016). NIR spectroscopy appears as one of the most promising analytical frameworks for fulfilling this urgent demand.

In general, the design principles of the NIR instrumentation (spectrometers, optics, cells, sample handling) guarantee a wide area of expansion in the currently rapidly diversifying food production and supply chain. The possibility of high sample volume and fiber probe instrumentation enables a fundamental reduction of the necessity of sample preparation. One of the most up-to-date breakthroughs is the sensor miniaturization. Low-cost, portable NIR spectrometers have become reality, and in the next few years, with ultra-miniaturized spectrometers directly integrated smartphone devices being developed nowadays (Bec, Grabska and Huck, 2021). Currently, there are two major trends in advancing NIR spectroscopy in natural product analysis which are followed in our working group. The first is the development and employment of miniaturized NIR sensors for approaches in the discussed fields. The second trend is the implementation of innovative frameworks for spectra interpretation and calibration, where quantum chemistry provides deeper understanding about the performance of individual spectrometers and chemometric models, respectively.

Keywords: sensor fusion, chemical interpretation of calibration models, in silico NIR spectroscopy

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Biography

Christian Huck obtained his doctorate in chemistry in 1998 from the University in Innsbruck, Austria, where he continued to work as an assistant professor until the habilitation in 2006. In 2013 he received a call as a full professor to the University of Stuttgart, Germany, in 2015 a call for a full professor to the University of Innsbruck, where he is currently vice-head of the Institute of Analytical Chemistry and Radiochemistry and head of the spectroscopy unit. From 2014 until 2017 Christian Huck worked as a visiting scientist with Professor Yukihiro Ozaki at Kwansei-Gakuin University (Sanda, Hyogo, Japan). Christian currently is editor-in-chief for Spectrochimica Acta A (Elsevier) and NIR news (Sage), associate editor for Journal of Near Infrared Spectroscopy (JNIRS, Sage) and several others known journals in the broader field of analytical chemistry. In 2023 he will be chair to host ICNIRS 2023 international conference and is the current vice-president of the Austrian Chemical Society. During the last 15 years Christian received about 15 international awards including Tomas Hirschfeld. Christian has published more than 300 peer-reviewed manuscripts resulting in an h-index of 57 based on more than 12900 citations.

SESSION SPEAKER

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

IR Spectroscopy of PAH variants: Astrophysical significance

Amit Pathak
Department of Physics
Institute of Science, Banaras Hindu University (BHU),
Varanasi - 221 005, India

Polycyclic Aromatic Hydrocarbon (PAH) molecules are fused Benzene rings. The delocalized electrons make them very stable structures. These molecules are commonly found in terrestrial environments and are supposed to be air and water pollutants. Our group focuses on the infrared (IR) spectroscopy of these molecules with an aim to investigate their presence in different interstellar environments.

PAH molecules dominate the IR spectra of astrophysical regions with strong emission features at 3.3, 6.2, 7.7, 8.6 and 11.2 μm. These features have been observed not only in the Milky Way but also in external galaxies1. Confirmation of the presence of fullerene cation in the interstellar medium (ISM)2 strongly supports the presence of PAHs. In the harsh interstellar conditions, PAHs experience physical and chemical processing that brings changes in the molecular structure and molecular charges. Ionization, dehydrogenation, etc. produce significant spectral signatures that are being diagnosed spectroscopically.

We have been studying variants of PAHs, viz., deuterated3, dehydrogenated4 and also with addition of aliphatic side groups5. Density functional theory (DFT) has been used to calculate the theoretical vibrational spectra of PAHs. The spectra obtained matches well with available experimental spectra and provides important clues to the form of PAHs present in the ISM.

We explore the probable formation mechanisms and spectral signatures of PAH variants that may be related to the existence of deuterated PAHs, PAH anions and PAHs with aliphatic side groups. Unique spectral characteristics of these PAHs are discussed. Our results have enormous implications in establishing the existence of these large aromatics in space.

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Biography

My main research interest lies in understanding the properties of interstellar dust and interstellar Polycyclic Aromatic Hydrocarbon (PAH) molecules. I am interested in theoretical, observational and experimental spectroscopy of dust & PAHs using a multi-wavelength approach. I also have interest in astrobiological implications of these studies. On a wider perspective, I have interest in observational and theoretical modeling of interstellar dust, and theoretical and experimental spectroscopy of astrophysical molecules. I am also working in exploring UV properties of the interstellar and intergalactic medium.

KEYNOTE SPEAKER

Moo Young Lee
CRG-NJ, Cresskill, USA

Study on the Neurotransmitters Affecting Psychological Chemical Imbalance

Over the last few years, computational biomedical simulation technology has been perceived as being a possible solution for the study of chemical imbalances such as depression and anxiety. This research studies the main causes of chemical imbalance such as depression and stress are known to be faulty mood regulation, genetic susceptibility, stressful events, and medical issues. In better understanding, the diagnosis of depression, technological advancements, such as brain imaging technology, have played a significant role. In this paper, with the help of computational and data analysis, quantifiable measurements of neurotransmitters such as Serotonin, GABA, Acetylcholine, Dopamine, and Glutamate were studied for the observation of psychological disorders.

Computational tools that are capable of building a virtual molecule with optimized geometry using UFF (Universal Force Field) were used for the analysis.

Sukhdev Roy
Dayalbagh Educational Institute, India

SESSION SPEAKER

Low-power, High-frequency, and High-fidelity Optogenetic Switching of Neurons

Lasers are one of the effective tools to improve material processing. The laser beam cuts thick metals more finely than any cutter machine. The laser beam drills thick steels more accurately than any drill. Without lasers, welding technology was imperfect. Furthermore, printing, forming, and holograming are other roles of lasers in material processing. The present century began with the rapid development of nanotechnology, which opened new fields for laser applications in material science.

Biography

Professor Sukhdev Roy received the B.Sc. (Hons.) Physics degree from Delhi Univ. in 1986, M.Sc. Physics from DEI, in 1988, and PhD. from IIT Delhi in 1993. He joined the Dayalbagh Educational Institute in 1993, where he is at present the Head of the Department of Physics and Computer Science. He has been a Visiting Professor at many universities that include, Harvard, Waterloo, Würzburg, Regensburg, Osaka, City University and Queen Mary University of London, TIFR, Mumbai and IISc. Bangalore. He has also been an Associate of the International Centre for Theoretical Physics, Trieste, Italy and is a Member of the Global Panel of MIT Technology Review.

Prof. Roy has made significant contributions in Photonics that encompass nano-bio-photonics, silicon and neuro photonics, fiber optics, and optical computing. His experimental and theoretical research on nano-bio-photonic systems that includes low-power and high frequency optogenetic control of neural spiking, defines a new paradigm of technological convergence and innovation and opens up fascinating prospects for energy-efficient, ultrafast and low-cost all-optical information processing, sensing, energy conversion and healthcare.

He has won a number of awards and fellowships that include, the, AICTE Career Award for Young Teachers in 2001, JSPS Invitation Fellowship, Japan in 2004, H.C. Shah Research Endowment Prize by Sardar Patel University in 2006, 1st IETE B.B. Sen Memorial Award in 2007, IETE-Conference on Emerging Optoelectronic Technologies Award in 2012, IETE-M. Rathore Memorial Award in 2016, the Systems Society of India's National Systems Gold Medal in 2016, and the Distinguished Alumni Award by the Dayalbagh Educational Institute in 2021. He also has been awarded seven best paper awards in international and national conferences. He has published 175 research papers in reputed journals and conference proceedings and 11 book chapters.

He chaired the 8th World Conference and Expo on Nanoscience and Nanotechnology, Philadelphia, USA in 2020. He has delivered more than 100 invited talks in India and abroad that include Keynote Addresses and Plenary Talks at International Conferences that include the prestigious International Year of Light commemorative Keynote Address, at the 38th Convocation of the International Council of Academies of Engineering and Technological Sciences (CAETS), in 2015 and at the Annual Meeting of American Physical Society in 2008.

He was the Guest Editor of the March 2011 Special Issue of IET Circuits, Devices and Systems Journal (UK) on Optical Computing. He is an Associate Editor of IEEE Access and is a member of the Editorial Board of Optics and Photonics Journal. He is also a Senior Member of IEEE and SPIE, and a Fellow of the Indian National Academy of Engineering, the National Academy of Sciences, India, IETE (India), and the Optical Society of India. He is listed in the recent Stanford researchers' study of Top 2% in World Ranking of Scientists-2020, in Optoelectronics and Photonics.

Guided wave photonics at the mid-IR

Babita Bakshi (nee Kumari)[1], Ajanta Barh[2], Somnath Ghosh[3], Ravendra K Varshney[1], and Bishnu P Pal[4]

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[3]Department of Physics, Indian Institute of Technology, Jodhpur-342 037 Rajasthan, India
[4]Mahindra University École Centrale School of Engineering, Hyderabad-500043, India

Guided wave photonics is a versatile platform for mid-infrared (mid-IR) wavelength band and offers option for realizing light sources, sensors and components in the technologically important wavelength window of 2-25 μm in view of their potential applications in areas as wide as astronomy, climatology, civil, medical surgery, military, biological spectroscopy, optical frequency metrology, optical tomography, and sensing. Mid-IR waveband also represents several atmospheric chemical molecules' characteristic absorption bands often referred to as molecular fingerprint bands for pollution atmospheric detection. This band is also attractive for defense, homeland security, sensing of noxious gases, astronomy, spectroscopy, LIDAR, optical tomography, etc. In this presentation, we will present a review of our own research in recent years in the context of highlighting role of guided wave photonics for realizing light sources, sensors, and polarization components suitable for use at mid-IR (2-10 μm) spectral domain. It is conjectured that since mid-wave infrared (MWIR) of 3-5 μm offers a clear atmospheric window for high power transmission, compact semiconductor and all-fiber light sources should attract applications in defense. The band 3-5 μm is also touted as a potential communication window with huge bandwidth, and can potentially serve as a possible solution to the problem of "capacity crunch" being faced now in the near-IR wavelength regime around 1.55 μm.

Biography

Bishnu P Pal is senior faculty and Professor, Department of Physics at Mahindra University's École Centrale School of Engineering. Before joining MU in July 2018 as Professor of Physics in School of Natural Sciences, he was a Consulting Professor for 1 year during 2017-18 at Bennett University in Greater Noida. He is also currently the Dean Academics at MU. Prior to these he had done a brief stint at Mahindra École Centrale (2014) and was a Professor of Physics for over 24 years since 1990 at the Indian Institute of Technology Delhi, during which he served as the Chairperson of the Physics Department (September 2008-December 2011) and Head of the Computer Services Centre (September 2003-August 2006). Bishnu Pal has been deeply involved in Guided Wave Optics and Photonics education since its nascent days in early 1980s. He played a key role in establishing the highly successful interdisciplinary MTech and research program on optoelectronics and a FO Laboratory @ IIT Delhi. A spin-off from this has resulted in commercialization of a FO Educational kit. Its alumni hold leadership positions in academia and industries like Facebook, Cisco, IBM, JDSU, OFS, NASA, Tejas Networks, Infinera, Cienna, Delhi Metrorail, fiber manufacturer Sterlite Tech, AlcaLuc-Nokia. OSA The Optical Society (USA), and IEEE Photonics Society (USA), respectively honoured him with the global awards namely, Esther Hoffman Beller medal during the centennial year of OSA in 2016 and Distinguished Lectureship (DL) for 2005-07. EHB medal citation reads 'You are being recognized for over thirty-five years of guided wave photonics education, including the development of graduate students and continuing education teaching programs and laboratories in optoelectronics and optical communications at IIT-Delhi, inspiring a generation of academic and industrial scientists'. IEEE DL award is given for 'delivering lectures at various IEEE Photonics Society (IPS) chapters around the world and is designed to honour excellent speakers who have made technical contributions of high quality and to enhance the technical programs of the IPS chapters'. Grand old Royal Norwegian Academy of Sciences and Arts (DKNVS, Norway founded in 1760) recognised Professor Pal with Honorary Distinguished Foreign membership under its Technology Division within the class of Natural Sciences for significant contributions to optical fiber communications. At the invitation of International Commission of Optics (ICO) he delivered a course of lectures on silicon photonics at the Winter College on Optics in 1998 at the International Centre for Theoretical Physics (ICTP), Trieste (Italy).

Prof Pal has edited several books published by Elsevier/Academic Press, John Wiley, Intech, New Age, and Viva publishers. Select chapters from his books (including ones authored by him) and also a research paper have been reprinted in standard reference books on optical communication. His e-book Frontiers in Guided Wave Optics and Optoelectronics (2010) published by IntechOpen has seen heavy downloads according to the publisher (over 228,130 to date and his own authored chapter over 12,480). He has also contributed over 15 chapters - all by invitation in several books. He has extensively contributed to sponsored research and industrial consultancy, especially several international collaborative research projects that involved France, UK, USA, and Russia.

His current areas of research is Guided Wave Photonics and Optical Communication that broadly encompasses application-specific specialty optical fibers e.g. for dispersion management, large mode area fibers and fibers for DWDM transmission; All-fiber components and devices as branching components for optical communication networks; designs of new generation microstructured optical fibers for supercontinuum light, metro optical networks, and mid-infrared photonics; optical fiber sensors; guided wave components based on silicon photonics; all-fiber THz generation and transmission, and Anderson type localization of light in disordered optical waveguide lattices.

Professor Pal has worked as a guest scientist at ELAB at the Norwegian University of Science and Technology (NTNU) at Trondheim in Norway as Royal Norwegian CSIR (NTNF) Fellow in mid-1970s and later as NTNF Visiting Professor in late 1980s, CNRS laboratory LPMC at University of Nice in France as Senior Foreign Scientist of CNRS (France) for various periods, National Institute of Standards and Technology (NIST) Boulder Colorado in USA as a Fulbright Scholar, Heriot Watt University Edinburgh in UK as an Erasmus Mundus Scholar in Photonics, City U Hong Kong and University of Malay at Kuala Lumpur in Malaysia as Visiting Professor, and at Institute fur Physikalische Messtechnik (IPM) at Freiburg in Germany as an Alexander von Humboldt Fellow. He has been a founding member of Int. J. Optoelectron. (Taylor & Francis) and is currently a Member of the Editorial Advisory Boards of the journals: J. Opt. Comm. (Germany), J. Elect. Engg. & Tech. (Korea), Optoelectron. Letts. (China), J. Korean Opt. Soc. (Korea), Photonic Sensors (Springer), J of Electromagnetic Waves and Applications (Taylor &Francis), and Kiran of the Indian Laser Society.

He has published and reported over 200 research papers and research reviews in peer reviewed international journals and conferences, delivered over 50 plenary/invited talks at international conferences in India and abroad, and has co-authored one each Indian and US patent. Prof. Pal is a Fellow of OSA The Optical Society (USA), SPIE The International Society for Optics and Photonics (USA), Optical Society of India (OSI) and IETE (India), and Senior Member of IEEE (USA). He has been a recipient of the Homi Bhabha Award of UGC (India) for excellence in Applied Sciences for 2006, OSI (India) Life Time Achievement award (2010), Prof Y. T Thathachari Prestigious Research Award in Physical Science of Bhramara Trust Mysore for 2010, CEOT 2010 award of IETE (India) for contributions to Optoelectronic Devices in the broadest sense, Om Prakash Bhasin National award for Electronics and Information Technology 2013, Khosla National Research award of IIT Roorkee for Lifetime achievements, and was a co-recipient of the First Fiber Optic Person of the Year award in 1997 instituted by Lucent Technology and Voice & Data Magazine in India.

Prof. Pal was a Member of the Board of Directors (2009-2011) of OSA The Optical Society (USA), its International Council (2007-2009), and Long Term Planning Group for publications (2011-2014).

He was President of the Optical Society of India (2012–2015), Associate Vice President of IEEE Photonics Society's Membership Council (2011-2015), and member of the International Jury for the Galileo Galilei Prize of the International Commission of Optics (2010-2014).

Boris Gramatikov, Ph.D.,
Associate Professor
Wilmer Eye Institute, Johns Hopkins University School of Medicine, USA

KEYNOTE SPEAKER

Optimizing the performance of polarization sensitive free-space optical systems

Polarized light is used in various optical and optoelectronic systems for medical diagnostics, communication, material identification, object detection and tracking, weather systems, etc. Some application measure the changes in polarization (birefringence) caused by a specific material or tissue, others use polarization for encoding signals, avoid interference from external light sources, etc. It is important to understand how optical elements change polarization upon transition or reflection, and how these changes can be measured, utilized, or compensated for.

Our optimization methods are based widely on the measurement of the Mueller matrices of the separate optical components comprising the system, as well as of the system as a whole. Once the Mueller matrix is available, it is analyzed with the goal of establishing how much of retardation, depolarization, or diattenuation it causes. Then, each one of these factors is considered for compensation. Further, all Mueller matrices are included in a numerical model, whose output can be optimized by means of numerical optimization. Use of more than one compensator can help achieve better results. Dynamic compensators, such as liquid crystal electrically controllable retarders is also discussed.

The above methods will be illustrated on diagnostic systems for retinal birefringence scanning, where the signal-to-noise ratio is very low, and therefore all instrumental noise must be minimized.

Although many of the considerations may be applied to fiber optics as well, this presentation will focus specifically on free-space optics.

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.

Ebenezar Jeyasingh,
Jamal Mohamed College, Tamilnadu, India

Monitoring Redox States using Stokes Shift Spectroscopy in-vivo for Early Detection of Epithelial Precancer

PThe aim of this study is to use Stokes Shift Spectroscopy to characterise the metabolic coenzymes NADH and FAD, which can be monitored by redox ratio in a dimethylbenz(a)anthracene (DMBA) induced mouse skin tumour model. SS spectra were measured under in vivo conditions from 33 DMBA treated animals and 6 control animals in the wavelength region 250 – 600 nm at $\Delta\lambda$ = 20 nm. SS spectra show highly resolved bands and substantial variations between normal and different transformation lesions. During onset of neoplastic transformation, the epithelial tissues undergo biochemical, morphological and metabolic activity which in turn results in increased fluorescence intensity and spectral shift for tryptophan and NADH, and decreased fluorescence intensity for collagen, elastin, and FAD. The redox ratio was calculated to quantify the observed spectral differences between normal and different transformation lesions. The sensitivity and specificity for different lesion pairs were calculated using the discrimination value in the scatter plot and confirmed with histopathology. Redox ratio was used to discriminate normal from hyperplasia, hyperplasia from dysplasia, dysplasia from well differentiated squamous cell carcinoma (WDSCC) with specificities of 100%, 80%, and 100% and sensitivities of 100%, 80%, and 100% respectively. The redox ratio can also be used as a non-invasive complementary analytical method to discriminate normal and different tissues transformation.

Biography

My primary area of interest is in physics principles with basic and translational research. Specifically, I am interested in applying my area of expertise in optical biopsy (OB) of cancer and tumor therapy to better characterize and understand physiological and pathological processes toward the development of diagnostic and therapeutic solutions. To realize these efforts it is my aim to lead and participate in multidisciplinary areas such as Biomedical imaging & diagnostics, Ultrafast Laser Physics, Raman & Fluorescence spectroscopy, and Nano and biomaterials. The primary focus of my research emphasizes the design, prototyping, and clinical testing of optical biopsy system to detect, diagnose, treat and monitor the molecular signatures of cancers of oral, breast, cervix and skin cancers. This includes: new OB and imaging instrumentation and molecularspecific optical contrast agents; experimental studies into the biophysical origins of measured optical signals; The fundamental basis of our work lies in the fact that optical signals arising from tissue are altered during disease progression, as the source of these signals originates in tissue microstructure and biochemical makeup. Currently, I am working on developing biocompatible nano-particles for combined diagnosis and therapy of cancers or other diseases.

SESSION SPEAKER

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Physics-AI Symbiosis

Deep neural networks have achieved dazzling performance in image and speech recognition and synthesis. However, these come at the expense of an exponential rise in computation and memory utilization. Featuring millions or even billions of adjustable parameters, these data-driven models require large labeled datasets for training which are not available in many domains where the acquisition and labeling of data are costly and laborious, such as medical diagnostics and the modeling of complex dynamic systems. Furthermore, the latency of deep neural networks precludes their use in real-time control loops where a fast response time is required. To address the above-mentioned problems, physics priors can be used to regularize the training of deep neural networks, therefore reducing the model complexity and the need for labeled data. On the other hand, by blending physics laws into the design and training of neural networks, AI models can act as a computationally-efficient proxy for conventional physics-based numerical calculations in forward and inverse complex problems. This is a powerful tool when the network is guided to yield physically inconsistent results and generalize outside the scenarios encountered in the training datasets. This talk will review how the emerging symbiosis of physics and AI can confront these challenges, extend the reach of artificial intelligence, and create opportunities for the advancement of science. For example, Physical phenomena such as diffusion and diffraction are being exploited to enhance computational imaging. Physics-guided neural networks perform the inverse design of physical systems, solve differential equations, and outperform traditional algorithms for signal reconstruction in the presence of noise and distortions.

Bahram Jalali
Fang Lu Chair in Engineering,
Department of Electrical and Computer Engineering, UCLA, USA
Yiming Zhou, Achuta Kadambi, and Vwani Roychowdhury
Department of Electrical and Computer Engineering, UCLA, USA

Biography

Bahram Jalali is the Fang Lu Endowed Chair in Engineering and Professor of Electrical and Computer Engineering at UCLA with joint appointments in Biomedical Engineering, and the California NanoSystems Institute (CNSI). He received his Ph.D. in Applied Physics from Columbia University in 1989 and was with the Physics Research Division of Bell Laboratories in Murray Hill, New Jersey from 1988 to 1992 before joining UCLA. He is a member of the National Academy of Inventors (NAI), Fellow of IEEE, OSA, APS, AIMBE, and SPIE. He is the recipient of the R.W. Wood Prize from the Optical Society of America for creating the first silicon laser, the Aaron Kressel Award from IEEE, and the Achievement Medal from IET (U.K), and the Pioneer in Technology Award from the Society of Brain Mapping & Therapeutics. He is the inventor of the time stretch and the radiofrequency imaging and sensing modalities that have been commercialized for applications to blood screening. He is a member of the UCLA Parker Institute for Cancer Immunotherapy (PICI). He has been elected into the Scientific American Top 50 and MIT Technology Review Magazine Top 10 and has served on the board of directors of the California Science Center, the Brentwood School, and was a member of the Institute of Defense Analysis' Microsystem Exploratory Council. He currently serves on the Board of Visitors of Columbia University School of Engineering.

STUDENTS

Magneto-immunoassay of cancer biomarkers: Recent progress and challenges in biomedical analysis

Ultrasensitive biomarker sensing has been used to develop novel strategies in detecting early-stage cancer. Due to their unique characteristics, ie, ease of synthesis, conductivity, and bio-compatibility, iron magnetic nanoparticles (MNPs) are exceptional nanomaterials in theragnostic. The current review focuses on the critical role of iron MNPs in the development of several immunoassay technologies including electrochemical, electrochemiluminescent, photoelectrochemical, optical, and microfluidic biosensors. The type and composition of magnetic particles, detection methods, relative specificity, and sensitivity are discussed. The advantages and limitations of various strategies for label-free immunogens of cancer biomarkers are explored.

Keywords: Cancer Nanobiomedicine Biomedical analysis Biotechnology Magnetic nanomaterials Electrochemistry Optical biosensors

Biography

Mahdieh Alipour is a academic researcher at Tabriz University of Medical Sciences who has co-authored 18 publication(s) receiving 109 citation(s). The author has an hindex of 5. The author has done significant research in the topic(s): Biocompatibility & Self-healing hydrogels.

Mahdieh Alipour
Tabriz University of Medical Sciences, Iran

SESSION SPEAKER

Fiber photonics for biomedical applications

Viacheslav Artyushenko
art photonics GmbH, Berlins

SESSION SPEAKER

The latest innovative fiber solutions to be reviewed for the advanced biomedical applications in 0.3-16µm range, including multispectral diagnostics to detect tumor margins and osteoarthritis in cartilage, tumor detection with IR-fiber endoscopy and flexible cables for smart Mid IR-lasers.

The latest design of fiber probes for all key spectroscopy methods: ATR-absorption in Mid IR, Raman, Diffuse Reflection and fluorescence, - enables to compare them and select the best one for tumor margin detection ex-vivo & in-vivo or to combine them to achieve much higher accuracy, specificity and sensitivity. Examples of probes for multispectral analysis will be described – using special Silica fibers with metal coating for Raman, Fluorescence and DRS-probes in 0.3-2,2µm range, Polycrystalline PIR-fibers for Silver Halides for 3-16µm range, Hollow Waveguides for Mid IR and IR-glass fibers (Chalcogenide & Fluoride) for 1-6µm range.

The great synergy effect in fusion of spectral data from 2 (or more) spectral methods was found in cancer diagnostics for several organs - when spectra were collected from the same spots of tissue using the different probes: Near+Mid IR-absorption, Near IR-absorption + Fluorescence, and Mid ATR-absorption + Fluorescence. But the most advanced results were obtained with the most innovative combi-fiber probes – collecting spectra from the same tissue spot: Raman + Fluorescence, Fluorescence + Mid ATR-absorption, Raman + Mid IR-absorption. These results to be presented 1st time at BiOS´22, including the application demo for the smallest diameter <200µm Fluo/ Raman probe used to detect ex-vivo 3D shape of oral tumor margins very fast.

The most exciting part of presentation will highlight the new concept of dual wavelength spectral sensor for tissue - coupled with the innovative Combi-Fluo/ATR-absorption probe. This probe was used, at first, to fuse Fluorescence spectra with IR-absorption spectra obtained with FTIR-spectrometer to differentiate 3 organs of chicken (as for the model) – resulted in development of chemometric model with only 2 wavelengths selected (one for Fluorescence + one in Mid IR) to differentiate these 3 organs even better but saving substantially sensor cost & size. This result will open the new horizon in design of combi-spectral fiber sensors – to be used with spectral data treatment in iClouds and results return to end-user in real time, like for IoT sensors.

I addition the new generation of multiwavelength spectral QCL-sensors will be shown where the bundle of thin Mid IR-fibers combines radiation from the set of selected QCL into the innovative arthroscopy probe with side ATR-tip – enabling to detect osteoarthritis in cartilage in-vivo.

The newest results of very efficient coupling of the longest PIR-fiber ATR-probe with Dual Comb QCL-spectrometer from IRsweep, Zurich, - will show that remote Mid IR-spectroscopy can be used at the distance >10m (3-4 times more compared to standard Mid IR ATR-probes).

Comparison of all 4 different types of flexible IR-cables (based on PIR-, CIR-, Fluoride fibers or Hollow Waveguides) will be also done in review to assist end-users to select the best one for their Mid IR-lasers applications in 3-16μm range. Unique advantage of Mid-IR-fibers to transmit IR-emittance from the tissues will open the chance to design medical "smart" lasers with tissue temperature control in irradiation spot – to be programmed in dependence on the application on tissue: ablation, coagulation or welding.

Preliminary results on IR-imaging of tissue made with PIR-fiber coherent bundles open the way to Mid IR-endoscopy – which will enable to detect cancer in hollow organs using its IR-emission.

Biography

Dr. Viacheslav Artyushenko was born on 02.01.1954 in Stalingrad, Russia, and got his PhD in physics in 1981 at General Physics Institute in Moscow – focused on his pioneering development of polycrystalline fibres for Mid IR-range (3-18μm). He has published multiple papers & patents on fibre technologies & applications in laser medicine, spectroscopy, optical sensing & diagnostics. Since 1987 he joined & organized many SPIE conferences on Infrared Fiber Optics and Laser Medicine. In 1998 he has founded art photonics GmbH in Berlin (www.artphotonics.com) – to develop and produce specialty fiber products for various applications. Now art photonics is one of worldwide leaders in unique fiber optic solutions for a broad spectral range: 0.3-16μm (especially, for Mid IR) and participant of many EU & German projects successfully realized with R&D & industrial partners. V.Artyushenko is a member of SPIE, OSA, SAS, EPIC, Optec-BB, CPACT, Spectaris, CLIRSPEC, etc.

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Structures of Optical Vortices from Sparse Arrays of Light Sources

Andrei Afanasev
The George Washington University, United States

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

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

Biography

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

Gudrun Kalmbach H.E.
MINT, PF 1533, D-886818 Bad Woerishofen, Germany

KEYNOTE SPEAKER

Energy Spaces

It is an opeen question how physical systems arise after a Higgs or big bang HB. The author proposes an evolution, adding this to the biology and chemistry evolutions. A first setting is that color charges of quarks CC are present in dark matter as 1-dimensional lemniscate retracts of quarks. The usual Lie groups or algebras approach is not used for them as an independent force, but the Noether theorem. The geometry for CC is a complex real 2-dimensional Riemannian sphere S2 with the symmetry of Moebius transformations MT. Their six invariant cross ratios arise by permuting among the four members z (as complex variable), 0, 1, ∞; present them as z (CC red r), 1/z (turquoise c(r) the conjugate of r), (1 – z) (yellow c(b)), 1/(1-z) (blue b), (z – 1)/z (magenta c(g)) and z/(z-1) (green g). After HB a Feigenbaum evolution sets in octonian coordinates 0,1,2,…,7 physical energies. The cross ratios factor from 24 possibilities to the symmetry D3 of order 6. The factor classes of four members associate with a CC an energy, a coordinate and a D3 symmetry. The classes are:

r, electromagnetism EM as charge, coordinate 1 or x, symmetry the first Pauli matrix σ1;

c(r), mass and gravity GR, coordinate 5, symmetry identity id as MT for scalings of mass;

c(b), magnetism, coordinate 4 or time, symmetry a (nucleons quark) triangle reflection a2σ1;

b, frequency f in the equation E = hf (E energy, h Planck constant), also momentum, coordinate 6, symmetry a of order 3 (rotation by 120 degrees);

c(g), rotional energy, angular momentum, coordinate 3, symmetry a2;

g, heat, coordinate 2, symmetry aσ1 of order 2.

The energy evolution is fromthe CC as input coordinate 0 to 1, 5, from 1 to 2, 4, from 5 to 3, 6, adding later on in the development (of the universe for instance) as output 7 for the electromagnetic interaction EMI, light when neutrinos and photons can escape from atoms.

The conjugate CC couplings are 15, 46, 23 as Heisenberg uncertainties. There are for the evolving couplings three 4-dimensional spaces, 1234 space time, 1456 an EM space and 2356 a SI strong interaction rotor. Both spaces 1456, 2356 are projected into 1234. The SI rotor is for integrating energies from forces to speeds or potentials. Similar to the Hopf fiber bundle for EM 1456 it has a SI geometry fiber bundle with space a 5-dimensional sphere S5, fiber S1 (a circle) and base CP2 (complex projective 2-dimensional space with boundary S2. EM 1456 has a WI rotor for differentiating functions and the Lie group SU(2) with Pauli 2x2-matrix (spin) generators and geometry S3 while SI has the SU(3) toroidal geometry S3xS5. It is postulated that the nucleons neutral color charge rgb is presented by the first three GellMann SU(3) 3x3-matrices and a neutral GR rgb-graviton whirl projects them onto the three SU(2) Pauli matrices. As a geometrical configuration, a nucleon is presented by a tetrahedron having as one vertex its conic rgb-graviton whirl tip and as base three quark vertices of CC r, g, b.

New measures are attributed to the energies as Gleason operators T which transform vectorial coordinate x metrics in <Tx,x>. They are presented as orthogonal base triples of S2, - energy as length (meter or EM charge e0 as 1, 123 as space xyz-coordinates), time (second or magnetic force µ0 Tesla 4, 145), heat (k Kelvin 2, 246), rotational energy (J Joule 3, 347), mass (kg 5, 257), frequency (Hz 6, 356). They use a D3 symmetry eigenvector as unit and are the seven octonians spin-like energy bases with 167 added for EMI (cd 7).

Biography

Gudrun Kalmbach is a Mathematics Professor, inventor of the educational program MINT (Mathematik, Informatik, Naturwissenschaften, Technik), organized for MINT 1985-2002 the Tag der Mathematik Baden-Wuerttemberg and university courses for highschool students (with 11000 highschool sudents participating), and publishes articles and scientific books in mathematics, MINT and quantum structures. She publishes the book series MINT (Mathematik, Informatik, Naturwissenschaftler, Technik) and acts as chief editor. She has three more lifetime works: setting up the theory of orthomodular lattices in her 1983 book, organizing for European Women in Mathematics from 1982 to today programs, founded for this the International Emmy Noether Association. Her activities are presented in an Emmy Noether Memorial Room, and a research project with a Tool bag existing in this MINT-Wigris E-Tools museum. She is honored with a public plaque, Engelgasse 4, Ulm, Germany, title H.E., World Laureate of Germany 2000, four medals, Albert Schweizer Medal and two books dedicated to her 60th birthday.

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

KEYNOTE SPEAKER

Frontier in Optical Coherence Tomography: Doppler OCT, OCTA, and Optical Coherence Elastography

Doppler OCT, a technology that we developed almost 25 years ago, is one of the fastest growing areas of biomedical optics with many potential clinical applications. I will describe the latest advances in Doppler OCT and OCT angiography. In addition, I will report the development of an acoustic radiation force optical coherence elastography (ARF-OCE) technology to characterize tissues biomechanical properties based on Doppler OCT. Knowledge of tissue mechanical properties provides valuable medical information in disease diagnosis and prognosis. There is a close correlation between tissue elasticity and pathology. We recently demonstrated, to the best of our knowledge, the first in vivo OCE imaging of retina and lens in animal model. The ARF-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 translational this technology for clinical application in 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.

LASERS, OPTICS, PHOTONICS, SENSORS & ULTRAFAST NONLINEAR OPTICS

Scaling Laws of Voxels in 3D Laser Nanoprinting

Yahya Bougdid[1,*] and Zouheir Sekkat[1-3]

[1]Department of Chemistry, Faculty of Sciences, Mohammed V University in Rabat, Rabat, Morocco
[2]Optics and Photonics Center, Moroccan Foundation for Advanced Science, Innovation and Research, MAScIR, Rabat, Morocco
[3]Department of Applied Physics, Osaka University, 2-1 Yamadaoka, Suita, Osaka 565- 0871, Japan.

STUDENTS

In this study, we report what is believed the first detailed study of voxel size dependence on the z-position of the laser's focus in 3D nano-printing by two-photon polymerization (TPP). That is, we study the evolution and the low limit size (diameter, length and aspect ratio) of voxels fabricated in the vicinity of the glass/resin interface. We use two-photon absorption in a photopolymerizable resin, and we vary the position of the laser focus, with respect to the glass/resin interface, i.e., in the z-direction. We found that the minimum lateral and longitudinal sizes of complete voxels depend on the extent of penetration of the laser focus inside the resin. Truncated voxels, which are fabricated by the partial overlap of the resin and the laser focus, allow for the fabrication of nano-features that are not diffraction-limited, and we achieved near ≈100 nm feature sizes in our 3D printed micro-objects. Our work is of central interest to 3D laser nanoprinting technology, since it addresses the spatial resolution of this technology and might have potential impact for industry.

Keywords: 3D laser nanoprinting, Two-photon absorption, Nonlinear effect, Voxel, Resolution, Aspect ratio, 3D micro-nano-objects.

Fig. (a) Nanofiber of a 420 nm diameter; (inset) the overlapping of voxels with a x-y- scanning of ≈300 nm. (b) Top view of a 3D micro-gear. (c) A microsized map of Morocco. (d) A 3D pyramid printed with a resolution of ≈124 nm. Exposure parameters: Ith≈ 820 kW/cm2, 1ms exposure time and z-position≈120 nm [1]. [1]: Y. Bougdid, and Z. Sekkat , Sci. Rep., vol. 10, (2020).

Biography

Yahya Bougdid, Ph.D. in Optics & Photonics. He did his Ph.D. from Mohammed V University in Rabat, in collaboration with MAScIR foundation, Morocco. Yahya's Ph.D. project was focused on TPP-based 3D nanoprinting in photoresists combining nonlinear optics, materials science & optical technology. He contributed to building TPA-based 3D micro-nanofabrication technology in Morocco. Currently, he is working as postdoc at CREOL, The College of Optics and Photonics, University of Central Florida, USA.

Quantum-Classical Mechanics: Principles, Applications, and Prospects

Vladimir V. Egorov, PhD, Dr Phys&Math Sci; FSRC
"Crystallography and Photonics", Russian Academy of Sciences, Moscow, Russia.

In quantum mechanics, the theory of quantum transitions is grounded on the convergence of a series of time-dependent perturbation theory. In nuclear and atomic physics, this series converges because the dynamics of quantum transitions are absent by definition. In molecular and chemical physics, the dynamics of "quantum" transitions, being determined by the joint motion of a light electron (or electrons) and very heavy nuclei, are present by definition, and this series becomes singular. An exception is the dynamic problem for stationary states in the Born-Oppenheimer adiabatic approximation, when the electronic subsystem turns out to be "off" from the general dynamic process and therefore is not dynamically full-fledged: it only forms an electric potential in which the nuclei oscillate. Removing the aforementioned singularity can be accomplished in two ways. The first method was consisted of introducing an additional postulate in the form of the Franck-Condon principle into molecular quantum mechanics, in which the adiabatic approximation is used. The second method was proposed by the author and consisted of damping the singular dynamics of the joint motion of an electron and nuclei in the transient state of molecular "quantum" transitions by introducing chaos. This chaos arises only during molecular quantum transitions and is called dozy chaos. Dozy chaos leads to the continuity of the energy spectrum in the molecular transient state, which is a sign of classical mechanics. Meanwhile, the initial and final states of the molecule obey quantum mechanics in the adiabatic approximation. Molecular quantum mechanics, which takes into account the chaotic dynamics of the transient state of molecular "quantum" transitions, can be called quantum-classical mechanics (QCM). The efficacy of the damping for the aforementioned singularity is shown by different QCM applications, in particular, by applications of the so-called Egorov resonance to optical spectra in polymethine dyes and J-aggregates both for single-photon and two-photon processes, which, in particular, are rationalizing experimental studies in the field of bioimaging and photodynamic therapy. Prospects for further developments in QCM and their applications to problems of cancer and viral infections are discussed.

Recent Publications

1. V. V. Egorov and S. Thomas, "Quantum–classical mechanics: On the problem of a two-photon resonance band shape in polymethine dyes," Nano-Structures & Nano-Objects 25, 100650-1–100650-10 (2021).
2. V. V. Egorov, "Dynamic symmetry in dozy-chaos mechanics," Symmetry 12, 1856-1–1856-19 (2020).
3. V. V. Egorov, "Dozy-chaos mechanics for a broad audience," Challenges 11, 16-1–16-12 (2020).
4. V. V. Egorov, "Quantum-classical electron as an organizing principle in nature," Int. J. Sci. Tech. Soc. 8, 93–103 (2020).
5. V. V. Egorov, "Quantum-classical mechanics as an alternative to quantum mechanics in molecular and chemical physics," Heliyon Physics 5, e02579-1– e02579-27 (2019).
6. V. V. Egorov, "Quantum-classical mechanics: Luminescence spectra in polymethine dyes and J-aggregates. Nature of the small Stokes shift," Res. Phys. 13, 102252-1–102252-14 (2019).
7. A. Petrenko and M. Stein, "Toward a molecular reorganization energy-based analysis of third-order nonlinear optical properties of polymethine dyes and J-aggregates," J. Phys. Chem. A 123, 9321–9327 (2019).

SESSION SPEAKER

8. V. V. Egorov, "Nature of the optical band shapes in polymethine dyes and H-aggregates: Dozy chaos and excitons. Comparison with dimers, H*- and J-aggregates," Royal Soc. Open Sci. 4, 160550-1–160550-20 (2017).

Biography

Prof Dr Vladimir Valentinovich Egorov has his expertise in theoretical molecular and chemical physics. Education: National Research Nuclear University MEPhI, Faculty of Theoretical and Experimental Physics (1966 – 1972), Moscow, USSR. He has completed his PhD from Theoretical Department of Institute of Chemical Physics, USSR Academy of Sciences (1981), and he has completed his Dr Phys&Math Sci degree from Institute of Physical Chemistry, Russian Academy of Sciences (2004). He is leading researcher at FSRC "Crystallography and Photonics", Russian Academy of Sciences, Moscow, Russia. Prof Egorov is working on the development of a fundamentally new physical theory - quantum-classical mechanics and its applications in physics, chemistry, biology and biomedicine.

Study of MRI Image of the Brain with Neurodegenerative Disease Using Physical and Computational Simulations

Hoyeol Baek
Berkeley City College

The study of neurobiological abnormalities associated with cognitive impairment is possible with the help of advances in brain imaging. Magnetic resonance imaging (MRI) is one of the most widely used technologies to detect, diagnose, and study various diseases. This paper studies the transformation from the frequency domain to the image domain in MRI. This process requires numerical and physical operation via inverse Fourier transformation which takes every frequency point to determine the final output image. We studied Low Pass Filters(LPFs) to increase the quality of the MRI scans and also analyzed the scans of patients with varying degrees of severity of Alzheimer's disease to develop image-processing algorithms.

Biography

Hoyeol Baek is a student attending Berkeley City College. Hoyeol Baek is interested in cognitive science and human sensor using data science and virtual reality. His ultimate goal is to participate in creating a virtual space that is very similar to the real one where people can feel all the senses.

STUDENT POSTER

Resonant light scattering by sub wavelength particles: new aspects and prospects

Dr Tribelsky
Lomonosov Moscow State University
Russia

SESSION SPEAKER

Biography

Prof. Dr Tribelsky received his MS from Lomonosov Moscow State University in 1973, his PhD from Moscow Institute of Physics and Technology in 1976, and Dr. of Sci. (habilitation) from Landau Institute in 1985. He received numerous national and international awards: Leninsky Komsomol Prize (1979); COE Professorship, the University of Tokyo, (2006, 2008) and Kyushu University (2007), Japan; Honorary PhD, Yamaguchi University, Japan (2016), etc. Now he heads a laboratory at Lomonosov Moscow State University. His field is theoretical and mathematical physics. Presently, his interest lies in subwavelength optics. He is the author of several books, book chapters, review articles, and more than 100 research papers.

Power-dependent kinetics of the up-conversion process in NaYF4:Er3+/Yb3+ single nanocrystals

In this work, we investigate the kinetics of the up-conversion process in nanocrystals doped with Er3+ and Yb3+ ions. First, we discuss the experimental results of confocal photoluminescence (PL) microscopy of the single nanocrystals. We focused on the red emission of Er3+ (4F9/2 ® 4I15/2), which can be activated by a pulsed laser operating at 980 nm. Interestingly, we observed a strong dependence of the PL transient character on the power of the excitation laser. For low laser power (~ 100 µW), the transient featured pronounced and relatively slow rising part, preceding a proper luminescence decay tail. However, the transient intensity is peaking immediately for higher excitation power (> 10 mW), and no rising part is observable. To understand this phenomenon, we solved the set of time-dependent kinetic equations of the Er3+/Yb3+ system. We demonstrated that for low excitation power, the upconversion process is mainly driven by the nonradiative energy transfer from Yb3+ to Er3+ ions, populating excited states of the Er3+ relatively slow. When the laser power is high, Er3+ is excited mainly by direct, sequential absorption of photons in the excited state absorption process. Moreover, we identified an additional nonradiative decay channel, depopulating the red-emitting level. We attributed this channel to the presence of surfactants coupling excited states and the ground state of the Er3+. Eventually, we estimated the radiative decay rate of the red emission level regardless of the excitation laser power. We found this approach valuable for the kinetics of the up-conversion processes analysis.

Biography

I'm particularly interested in light-matter interactions in nanoscale, like plasmonics and photonics from the perspectives of both experimental and theoretical approaches. I'm dealing with spectroscopy and imaging of up-converting materials doped with rare-earth metals, as well as computations of rate equations describing the kinetics of up-conversion processes in single nanoparticles.

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SESSION SPEAKER

Kevin Choi
Jericho HS, USA

Study on the Surface Plasmon Polariton(SPP) in the Meta-materials to Improve Photon Absorption

Surface Plasmon Polariton(SPP) occurs when the polaritons propagate along the interface until their energy is lost either due to absorption in the metal or scattering into another medium. The presumption is that this research would find an example of a metamaterial that shows an optimal incident angle. In this paper, a study of photonics on nano-scaled metal and nonmetal units is performed. To maximize the optical strength in optical devices, optical and material properties are employed to find the optimal angle of incident light in the absorption layer. The relative permittivity of the unit and the wavelength of the incident light are used to find the effective index of refraction of the unit. Through numerical and computational calculations, this study is to find optimal metamaterials composed of metal and nonmetal units while the light resonantly excites surface plasmon polariton(SPP) in the SPP employed device.

Biography

Kevin's research interest is photonics and metamaterials: metallic behavior through one axis and dielectric behavior through another. When light strikes the surface of the metal, it is absorbed by electrons, exciting them (becoming surface plasmons) to resonate at a specific wavelength. He is interested in most photonic devices. His main hobby is building keyboards and personal computers, which he uses to help his friends and utilize his knowledge in physics. He is also a competitive golfer who has played in multiple tournaments and achieved awards such as coming in 3rd in the MGA PGA Junior Tour Eisenhower Fall Challenge.

POSTER PRESENTATION

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