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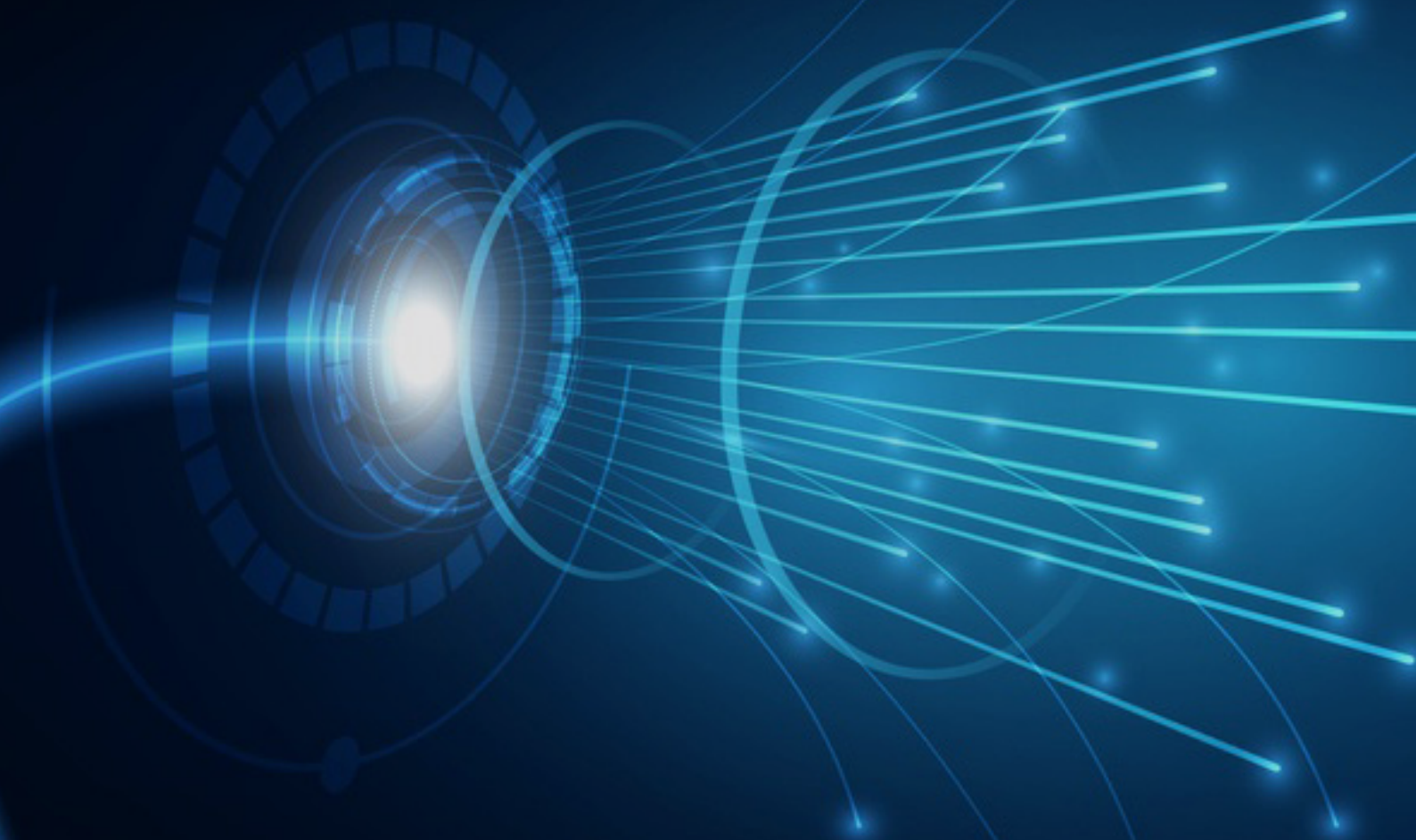
EUROPEAN LASERS, PHOTONICS AND OPTICS TECHNOLOGIES SUMMIT

September 22-23, 2021



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ELOS 2021

BOOK OF ABSTRACTS

EUROPEAN LASERS, PHOTONICS AND OPTICS TECHNOLOGIES SUMMIT

SEPTEMBER 22-23, 2021

Theme:

Multifaceted aspects of Lasers, Photonics and Optics technologies.

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About MAGNUS GROUP

Magnus Group (MG) is initiated to meet a need and to pursue collective goals of the scientific community specifically focusing in the field of Sciences, Engineering and technology to endorse exchanging of the ideas & knowledge which facilitate the collaboration between the scientists, academicians and researchers of same field or interdisciplinary research. Magnus group is proficient in organizing conferences, meetings, seminars and workshops with the ingenious and peerless speakers throughout the world providing you and your organization with broad range of networking opportunities to globalize your research and create your own identity. Our conference and workshops can be well titled as 'ocean of knowledge' where you can sail your boat and pick the pearls, leading the way for innovative research and strategies empowering the strength by overwhelming the complications associated with in the respective fields.

Participation from 90 different countries and 1090 different Universities have contributed to the success of our conferences. Our first International Conference was organized on Oncology and Radiology (ICOR) in Dubai, UAE. Our conferences usually run for 2-3 days completely covering Keynote & Oral sessions along with workshops and poster presentations. Our organization runs promptly with dedicated and proficient employees' managing different conferences throughout the world, without compromising service and quality.

About ELOS 2021

Magnus Group welcomes members from different parts of the world to join our Online Event - "European Lasers, Photonics and Optics Technologies Summit" scheduled during September 22-23, 2021. It includes prompt Keynote presentations, Oral presentations, Poster presentations, interactive and informal exchanges. This is going to be one of the most remarkable events of the year. Through the theme "Multifaceted aspects of Lasers, Photonics and Optics technologies" conference will explore the advances in the field. ELOS 2021 goal is to bring together bright minds to give talks that are ideas-focused, and on a wide range of scientific sessions, to faster learning inspiration. It will provide an international platform to share expertise, foster collaborations, discover new information, stay current with trends and networking.

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KEYNOTE FORUM

DAY 1

EUROPEAN LASERS, PHOTONICS AND OPTICS TECHNOLOGIES SUMMIT

SEP 22-23, 2021

ELOS 2021

MJ Prandolini[1,2*], T Golz[1], JH Buß[1], M Schulz[1], R Riedel[1]

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A review of high-power femtosecond MID-IR laser systems for attosecond science and spectroscopy

A review is presented of current high power, femtosecond (< 100fs), laser systems at mid-infrared (MIR-IR) wavelengths (3 – 12 nm), pumped by Yb-based solid-state lasers. The technology used to achieve a high-power laser source is optical parametric chirped-pulse amplification (OPCPA) together with white-light-generation (WLG). This combination makes it possible to provide carrier-envelope phase (CEP) stable femtosecond pulses, which are scalable to high power levels. In this review we cover basic design features of our OPCPAs, including the important optical nonlinear materials that can withstand high thermal loads and the various OPCPA-pump technologies. Finally, we demonstrate some applications of these lasers to attosecond science, biology and spectroscopy. An important feature of these new OPCPAs is their reliability and compact design, requiring no complex cooling systems.

Audience Take Away:

- What are the state-of-the-art laser parameters for high-power femtosecond MID-IR lasers
- The basic design features of these laser systems
- The critical nonlinear materials required for these high-power systems
- And the applications of high-power femtosecond MID-IR lasers

Biography:

Dr. Mark J. Prandolini studied physics at the University of New South Wales (Australia) and graduated with a PhD in 1994. He then had research postdoctoral positions at University of New South Wales (Australia), University Leuven (Belgium), Freie Universität Berlin (Germany), Goethe-Universität Frankfurt (Germany), and DESY (Germany). He is also cofounder of the laser firm Class 5 Photonics GmbH and is also the Technical Leader of an Ultrafast Laser Laboratory of the Universität Hamburg (Germany). He has over 70 publications and two review articles.

Vladimir Chigrinov

Nanjing Nanhui Intelligent Optical Sensing and Manipulation Research Institute Co., Ltd., China

Azodye nanolayers: Applications in E-paper and security films

Photo alignment and photopatterning has been proposed and studied for a long time [1]. Light is responsible for the delivery of energy as well as phase and polarization information to materials systems. It was shown that photo alignment azodye materials could provide high quality alignment of molecules in a liquid crystal (LC) cell by nanolayers from 1 to 20 nm. Over the past years, a lot of improvements and variations of the photo alignment and photopatterning technology has been made for display and photonics applications. In particular, the application of this technology to active optical elements in optical signal processing and communications is currently a hot topic in photonics research [2].

Photo aligned optically rewritable (ORW) liquid crystal based on azodye Nano layers is made to write, store and rewrite again the information generated by computer on a glass or flexible carrier. Optically rewritable technique is highly desirable, as e-paper displays suffer from the high level complexity of driving electronic due to the insufficient durability of flexible conductor and contact bonding [1,2]. The optical security film with high security features by using azodye photo-alignment technology were also implemented. Azodye photo-alignment, which is a new technology for aligning liquid crystal, is being used to produce a flexible and highly recognized security film.

[1] V.G. Chigrinov, V.M. Kozenkov and H.S. Kwok, Photoalignment of liquid crystalline materials, Wiley, 2008.

[2] V.G. Chigrinov, Liquid Crystal Photonics, Nova Science Publishers, 2015.

Biography:

Professor Vladimir G. Chigrinov is an Expert in Flat Panel Technology in Russia, recognized by the World Technology Evaluation Centre, 1994, and SID Fellow since 2008. He is an author of 6 books, 25 reviews and book chapters, 320 journal papers, more than 656 Conference presentations, and 35 US patents in the field of liquid crystals since 1974. He got Excellent Research Award of HKUST School of Engineering in 2012. He is a Member of EU Academy of Sciences (EUAS) since July 2017. He got A Slottow Owaki Prize of SID in 2018. He is 2019 Distinguished Fellow of International Engineering and Technology Institute.

Xiangping Li
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Nanoplasmonics enabled multi-dimensional optical multiplexing

The electromagnetic radiation in the vicinity of metallic nanoparticles or nanostructures can be concentrated and confined to a region with sizes far smaller than the wavelength. Consequently, the augmented electric fields can lead to a variety of amplified photophysical or photochemical processes, underpinning tremendous appealing optical applications. Moreover, the dispersion of nanoplasmonics can be tailored to manipulate nanoscale light matter interaction to introduce advanced functionalities. In particular, femtosecond laser beam can induce enormous photothermal effects and even permanent shape transitions. In this talk, we present the recent progresses towards ultra-high capacity multi-dimensional optical memories. This is achieved through multiplexing information in the physical domain of the writing beams through tailoring the interaction between a tightly focused pulsed laser beam and nanoplasmonic materials. Amplitude, polarization, wavelength, wavevector and orbital angular momentum represent the basic dimensions over which we describe and manipulate light's wavefronts, can be utilized to multiplex information in the volume of focal spots. By circumventing the diffraction limit, multi-dimensional optical storage paves the new way to next generation big data technologies.

Audience Take Away:

- A new multiplexing technology that can harness light's all parametric divisions will be introduced. Consequently, it can greatly increase the information capacity and security.
- The demonstration can open up new routes to tailoring light's engagement with nanoplasmonic materials, which might not only facilitate the study of fundamental science mediated by nanoplasmonics, but also underpin tremendous nanoplasmonics based applications for quantum entanglements, ultra-high capacity information storage and ultra-secure encryption.

Biography:

Dr. Xiangping Li completed his PhD at Swinburne University of Technology in 2009. His research is focused on nanophotonic techniques for high capacity optical information technologies including optical multiplexing, plasmonics and superresolution microscopy. Dr. Li has published over 60 internationally referred journal publications including Science, Nature Photonics, and Nature Communications. Dr. Li is a recipient of a number of prestigious awards including the Australian Postdoctoral Fellow funded by Australian Research Council in 2011, Swinburne's Vice Chancellor Award for early career researcher in 2012, Victoria Fellowship in 2013, Discovery Early Career Researcher Award by Australian Research Council in 2014, China's Young 1000 talents Award in 2015 and Distinguished Young Scholars from National Natural Science Foundation of China in 2015. He joined the Institute of Photonics Technology in Jinan University as a full professor and research leader in nanophotonic devices group in 2015.

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Coherent radiation from inverse compton scattering sources by means of particle confinement in an optical lattice

Inverse Compton scattering (ICS) sources also named as optical undulator radiation sources are one of the promising compact tools to generate short wavelength radiation from electron beams based on the relativistic Doppler effect. Nonetheless, these sources suffer from a few shortcomings such as incoherent radiation and low-efficiency in radiation generation. The theory of FEL using an optical undulator has been proposed in the 1980s for the first time. However, despite the extensive efforts in the past decades, there exists no operational FEL based on optical or EM undulators. Research efforts are already devoted to explore the main challenges in free-electron lasing of low-energy electrons using the available simulation tools. This contribution argues that the strong space-charge forces between electrons are the main impediment in achieving a coherent gain in the radiation. Afterwards, we aim at establishing a mechanism based on particle beam confinement for relativistic electrons to propose an unconventional approach for tackling the compact coherent x-ray source problem. It is known that charged particles inside a spatially varying field profile are influenced by gradient forces, driving them towards the area of weaker field strengths. This occurs inside an optical cavity or when two counter-propagating twin beams impinge on the electron bunch. It is hypothesized that when the electrons in a beam are transversely confined, many of the existing challenges emanating from transverse motions and repulsive forces are overcome, thereby achieving the coherent-gain regime is alleviated. The full-wave solution of first- principle equations based on finite-difference time-domain and particle in-cell (FDTD/PIC) is performed to simulate inverse-Compton scattering (ICS) off both free and confined electrons. It is shown that by confining the electron beam at the field nodes of an optical cavity, the space-charge effect is compensated, and additionally, the ultrahigh charge density enables high FEL-gain at confinement spots. The full-wave numerical simulations predict enhancement of about three orders of magnitude in the radiation efficiency when ICS is carried out with confined electrons compared to free electrons. These theoretical results show promising potential as a new scheme for implementing a compact coherent x-ray source.

Audience Take Away:

- Existing challenges in making compact coherent x-ray sources
- Presentation of a new scheme based on optical undulators and particle confinement to develop a compact coherent x-ray source
- Properties and challenges in making a compact coherent x-ray source based on the introduced concept

Biography:

Since 2019, Arya Fallahi holds a joint position as a senior research scientist at ETH Zurich and project leader in computational electromagnetics at IT'IS Foundation in Switzerland. He was a research scientist at DESY from 2012 to end of 2018 and a postdoctoral scientist at PSI from 2010-2012. He earned his PhD degree from ETH Zurich in 2010. His research interests focus on the general electromagnetics theory in the whole frequency spectrum from RF and microwave to optics, plasmonics, and x-ray science. He has been the inventor in four patents, authored more than 40 journal publications and numerous conference papers.

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SPEAKERS | DAY 1

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Masahiko Kondow*, Yifan Xiong, Hanqiao Ye, Masato Morifuji, Hirotake Kajii, Akihiro Maruta

Graduate School of Engineering, Osaka University, Japan

Circular Defect in Photonic Crystal (CirD) Laser for Intra-chip Optical Interconnects

By the analogy of inter-chip optical interconnects, the target density for intra-chip optical interconnects is estimated to be 10 Pbps/cm2. This value may not be possible anymore by so called Si-photonics that is the state-of-the-art technology, because its target density is as small as 10 Tbps/cm^2. The authors have proposed a breakthrough by using 2 dimensional photonic crystal (2D-PhC). The laser has a circular defect (CirD) cavity in the triangular PhC lattice. Compact optical modules with a wavelength division multiplexing (WDM) function can be constructed by integrating several CirD lasers with one PhC line-defect waveguide for light output without a conventional optical multiplexer that have huge footprint in comparison with CirD lasers. In the numerical analysis, uniform low threshold and a modulation speed of approximately 50 Gbps within a lasing wavelength range of 20 nm can be estimated for the CirD lasers, because quality factors (Q) of CirD lasers are expected to be several thousands. In addition, single-mode lasing operations of CirD lasers with a linewidth narrower than 0.07 nm and the side-mode suppression-ratio (SMSR) of approximately 30 dB have been experimentally confirmed by conducting optical pumping under room-temperature continuous-wave (RT-CW) conditions. The lasing wavelengths of CirD lasers can be modulated over 20 nm. Thus, the bandwidth capacity of 1 Tbps may be realized by 20 channels of WDM within footprint of approximately 100 mm squire that equals 1×10^{-4} cm^2. This meets the extremely high bandwidth density requirement of 10 Pbps/cm^2 for intra-chip optical interconnects.

Acknowledgments: This work was partially supported by JSPS KAKENHI Grant JP19H02198, the Nanotechnology Platform of MEXT, Grant Number JPMXP09F21OS0013, ULVAC, Inc., and Nippon Sheet Glass Foundation.

Audience Take Away:

- 2 dimensional photonic crystal (2D-PhC)
- Circular defect (CirD) cavity
- CirD laser
- Intra-chip optical interconnects

Biography

Dr. Masahiko Kondow received the B.E. and M.E. degrees in electrical engineering, from Osaka University in 1984 and 1986, respectively. Since 1986, he had been with Central Research Laboratory, Hitachi, Ltd. He received the Ph.D. degree in electrical engineering, from Osaka University in 1991. In 1998, he was with University of California, San Diego, as a visiting scholar. Since 2005, he has been with Osaka University as a professor in Graduate School of Engineering.

Junjie Wu

Institute for Quantum Information and State Key Laboratory of High Performance Computing, College of Computer Science and Technology, National University of Defense Technology, 410073 Changsha, China

Silicon photonic quantum walk processor

Applications of quantum walks can depend on the number, exchange symmetry and indistinguishability of the particles involved, and the underlying graph structures where they move. Here, we show that silicon photonics, by exploiting an entanglement-driven scheme, can realize quantum walks with full control over all these properties in one device. The device we realize implements entangled two-photon quantum walks on any five-vertex graph, with continuously tunable particle exchange symmetry and indistinguishability. We show how this simulates single-particle walks on larger graphs, with size and geometry controlled by tuning the properties of the composite quantum walkers. We apply the device to quantum walk algorithms for searching vertices in graphs and testing for graph isomorphisms. In doing so, we implement up to 100 sampled time steps of quantum walk evolution on each of 292 different graphs. This opens the way to large-scale, programmable quantum walk processors for classically intractable applications. This talk mainly includes our works published in [*Science Advances* 7, eabb8375 (2021)], [*National Science Review* 5, 715–720 (2018)] and [*New Journal of Physics* 22, 033022 (2020)].

Audience Take Away:

- Building quantum computing experiment
- Designing and using silicon photonic chips
- The concept of boson sampling, quantum walk and so on

Biography

Dr. Wu received the Ph.D. degree in computer science and technology from National University of Defense Technology, China, in 2009. Now, he is a professor and the director of the Institute for Quantum Information & State Key Laboratory of High Performance Computing, National University of Defense Technology, China. His research interests include quantum computing, integrated photonic chip and quantum algorithm. He has published more than 50 articles including those in Science Advances, Physical Review Letters, National Science Review.

Ligang Huang*, Tao Zhu
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External cavity self-adaptive lasers assisted by distributed feedbacks

With excellent properties of the high purity spectrum and long coherent length, narrow-linewidth lasers can be applied in many fields, such as optical quantum information, low-noise microwave generation, high-resolution spectroscopy, precise sensing, high-speed optical coherent communication and so on. Herein, commencing from the in-depth analysis for the effective suppression of spontaneous emission under the excitation of a cavity signal, we propose a compression scheme to extremely compress laser linewidth assisted by a distributed feedback. Subsequently, we develop a novel laser configuration that comprises the main laser cavity and an external cavity with a distributed feedback characteristic. To provide an excitation signal required for linewidth compression, we inject into the main cavity through the distributed feedback structure a cavity mode signal matched with the output wavelength. Moreover, we conduct an experimental investigation based on an on-chip laser system with a distributed feedback. Eventually, an ultra-narrow linewidth laser with a side mode suppression ratio (SMSR) greater than 80 dB, an output linewidth of 10 Hz, and a relative intensity noise (RIN) less than -150 dB/Hz is successfully obtained under normal conditions. The proposed concept is valid in any other gain-types lasers with various wavelengths, providing a new perspective for extreme modulation of other laser parameters. We further explore the linewidth compression in tunable lasers. With all-optical tunable narrow-band fiber Bragg gratings and RBS linewidth compression, we obtain tunable fiber lasers with a precise tuning step of less than 0.02 nm and linewidth of about 200 Hz. With all-fiber acousto-optical tunable filters, we obtain fast tunable narrow-linewidth fiber lasers with a tuning band of 20 nm and switching time of less than 1 ms. Finally, we propose parameter measurement methods of ultra-narrow-linewidth lasers. For frequency-stabilized lasers, we propose an ultra-narrow linewidth measurement method based on the short delayed fiber self-heterodyne interferometer (SDSHI). For wavelength-swept lasers, we propose the measurement method of transient frequency noise and linewidth.

Audience Take Away:

- The audience will know the method to fabricate sub-kHz narrow-linewidth lasers by external cavity self-adaptive feedbacks.
- This presentation provides a practical solution of fast and wide-band tunable narrow-linewidth lasers.
- This presentation provides the measurement method of laser parameters, including the transient frequency, linewidth, frequency noise, phase noise, intensity noise and state of polarization.

Biography

Ligang Huang is a Chinese Physicist. He received Ph.D. in Physics from Nankai University (China) in 2016. Since September 2020, he works as an associate professor at the College of Optoelectronic Engineering in Chongqing University, China. His research interests include narrow-linewidth lasers, laser parameter measurement, all-fiber acousto-optic tunable filters and whispering-gallery-mode tunable filters. He is author or co-author of more than 50 peer-reviewed journal papers in the field of narrow-linewidth lasers and tunable filters, which have been cited by more than 500 times.

Jin Li*, Yannan Wang, Fanli Meng

College of Information Science and Engineering, Northeastern University, Shenyang, Liaoning, China

Preparation and experimental studies on microfiber sensors

In this presentation, several kinds of microfiber sensors were proposed based on that the strong evanescent field of micron optical fiber is sensitive to the changes of the external environment. The related temperature, gas and load sensing performance has been experimentally demonstrated, studied and optimized. Here, the microfibers were fabricated by flame scanning-stretching method (based on traditional single-mode fiber) and sol-gel one-step stretching technique (based on polymer and organic solvent). Among them, silica microfiber taper can be used to prepare the S-type temperature sensor probe, whose sensitive area was extended by splicing a cut of dislocation optical fiber; or to fabricate the Fabry-Perot interferometer temperature probe by inserting and encapsulating it in the capillary; or it can be made into knot ring structure through micro-operation technology and PDMS package to improve its temperature sensing performance. Polymer microfiber can be obtained by one-step stretching method and used for sensing refractive index after being connected with single-mode microfiber taper using the low refractive index UV glue. By virtue of the easy doping property of polymer sol, metal micro/nano-materials and laser dye were doped to explore the functional microfibers, which were used for determining the refractive index, gas concentration and for developing micro-ring laser resonator. The temperature sensitivity of higher than 10 nm/ was experimentally demonstrated for both the S-shaped and knot microfiber temperature probes. The silver micro-particles have been doped in the silica capillary to prepare the composite microfiber with the diameter of 2.3 μm, resulting in a refractive index sensitivity of 19.2 nm/RIU; one cut of amorphous polymer microfiber with the length of 728μm and diameter of 28μm was obtained from the PMMA-chloroform gel, where the Pd nano-particles were successfully elaborated in and contributed to the high hydrogen sensitivity of 5.2×10-4 nm/ppm.

Audience Take Away:

- Explain how to fabricate one microfiber from the normal fibers or polymer materials
- How to design the microfiber resonator structure and study its sensing performance
- What kinds of optical fibers or silica capillary can be used to prepared the low cost fiber sensor with compact structures

Biography

Jin Li is Associated Professor in Northeastern University, China since Jan. 2016. He earned the bachelor, Master's and Doctor's degree in Harbin Institute of Technology. He worked in Laser Physics Centre of the Australia National University in 2017 as a visiting fellow. In the middle of 2018, he joined in the research group of Professor Fanli Meng in Northeastern University, and expanded his research interest to gas sensors based on nanomaterials. His other research interests include micro/nanofiber sensors and integrated optical devices. He has published more than 90 research articles in SCI(E) journals.

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Aberration-insensitive interferometric microscopy

Imaging techniques based on optical correlation measurements and using spatially incoherent illumination have been shown to be able to reduce the effect of optical aberrations. One of such techniques is classical ghost imaging based on spatial intensity correlations in two optical beams of which one is transmitted through the object. The image can be obtained from the correlation measurements even though the object beam is analyzed with a bucket detector. Another imaging technique using spatially incoherent illumination is full-field optical coherence tomography that is based on optical interference instead of intensity correlations for three-dimensional imaging of back-scattering objects. This technique, utilizing light with short coherence time, is insensitive to aberrations if the wavefront shifts are smaller than the longitudinal coherence length of the field.

In this presentation, a novel interferometric ghost-like imaging microscopy that is insensitive to severe optical aberrations will be discussed. The aberration insensitivity stems from a large longitudinal coherence length of the applied spatially incoherent illumination. The approach makes use of a Mach-Zehnder interferometer for transmissive objects or a Michelson interferometer for reflective and back-scattering objects. The technique yields sharp and non-deformed microscope images even if the objects are screened by an optical diffuser that destroys the intensity image completely. Furthermore, not only amplitude, but also phase objects can be imaged with high resolution in the presence of strong aberrations. The resolution is given by the size of the aberration-free diffraction-limited point-spread function no matter if the aberrations are deterministic or random. The approach may find applications in optical microscopy and interferometry.

Audience Take Away:

- The key features of optical interferometry with spatially incoherent light
- Reduction of the effect of aberrations on image quality by interferometric methods
- A novel imaging technique that allows one to see micro-objects behind or inside a highly aberrative and scattering medium
- The approach may find applications in biology and medicine
- The approach can be further developed towards specific applications, such as aberration-free three-dimensional imaging

Biography

Dr. Andriy Shevchenko is a Finnish physicist. He received his D.Sc. (Tech.) degree from Helsinki University of Technology in 2004. In 2007, he was appointed as Docent in optical physics, and since 2012, he holds the position of University Lecturer at Aalto University, Finland. He is the author of more than 100 scientific publications in international journals and conference proceedings. He acted as a member of academic committees for scientific conferences, as an evaluator of scientific proposals and activities, e.g., for ERC Advanced Grant, and as a referee for many scientific journals. He currently acts as a Topical Editor for Optics Letters.

Nabamita Goswami*, Bijaya Saha, Ardhendu Saha
Department of Electrical Engineering, National Institute of Technology Agartala, India

Highly sensitive early detection of breast cancer using surface plasmon resonance based fiber optic biosensor by shining gaussian beam: A wave theory based approach

With the experimental validation, a new approach towards the wave theory based fiber optic biosensor using Gaussian beam for early detection of breast cancer is explored, in a multilayered fiber structure. This structure comprises an unclad multimode fiber with a core diameter of 15 μm, followed by the layers of gold of 15 nm thin, a layer of APTES, Glutaraldehyde, HER2 antibody and HER2 antigen, respectively. Here, HER2 antigen is used as a sensing layer with varying concentrations from 2 ng/mL to 100 ng/mL. It is well known that, for a healthy person, the HER2 concentration is between 2 ng/mL and 15 ng/mL and after 15 ng/mL breast cancer patients will be detected. Here, the wave theory based technique is used to achieve more similarities between analytical and experimental solutions and for accurate analysis of different modes within the fiber. Thus, as compared to the ray theory, this strategy is more apparent and successful. Here, the proposed technique is shined by a Gaussian beam and the output beam is observed with the help of power-meter head. With the help of graphical representations, the amplitude distribution of the electric field and its propagation inside the MMF for the suggested fiber sensor has also been observed. It can be deduced from the graphical representation that the radial mode number 2 has the highest coupling efficiency among all the modes inside the MMF. The transmission loss within the MMF varies in response to the change in concentration of HER2 biomarker in Phosphate Buffered Saline (PBS). The proposed sensor has a sensitivity of 6734.93 dB/RIU and 0.26 nm/ng/mL and a resolution of 1.48×10^{-6}, which is 3 times better than the reported ray theory-based articles till date. Here, owing to the more spectral shifts from 2 ng/mL to 15 ng/mL, an enhanced sensitivity and resolution is observed at lower concentration, through which the proposed idea of early detection of breast cancer is materialized. The proposed biosensor intends to improve in the existing fiber optic based sensors in terms of sensitivity and resolution for early detection of breast cancer using HER2 biomarker. It is also observed that resonance wavelength of the proposed sensor shifts towards right with an increase in the concentration of the HER2 biomarker. The proposed idea will result in a better sensing platform for identifying breast cancer by optically assessing the earlier stage of the cancer.

Audience Take Away:

- It is a new approach of wave theory based fiber optic biosensor, using Gaussian beam as a source for early detection of breast cancer. Here, HER2 antigen is used as a sensing layer with varying concentrations from 2 ng/mL to 100 ng/mL. As it is well known that, for a healthy person, the HER2 concentration is between 2 ng/mL and 15 ng/mL and after reaching 15 ng/mL, breast cancer patients will be detected. Here, owing to the enhanced sensitivity and resolution from 2 ng/mL to 15 ng/mL, the idea of early detection of breast cancer is materialized which attracts the audience for better design with efficient output.
- To the best of our knowledge, the proposed idea using wave theory provides better sensitivity and resolution as compared to the other existing fiber-optic biosensors till date, which are based on ray theory. Accurate analysis of different modes within the fiber and better similarity between the analytical and experimental results can only be achieved using this

wave theory approach. Thus accurate solution with appropriate design can be achieved through this idea.

- To reduce the complexity in fabrication process instead of using tapered, bending, U-shaped fiber, D- shaped fiber, coiled structure, side-polished fiber, in the proposed structure, straight fiber has been considered which makes the idea promising and attractive for the detection of breast cancer.
- The proposed sensor has a sensitivity of 6734.93 dB/RIU and 0.26 nm/ng/mL and a resolution of 1.48×10^{-6}, which is 3 times better than the reported ray theory-based articles till date.

Biography

Dr. Nabamita Goswami is an Assistant professor at National Institute of Technology, Agartala, India (since 2014). She received her M.Tech and PhD degrees in 2010 and 2015 respectively from the Department of Electrical Engineering, National Institute of Technology, Agartala, India. She has published 13 SCI Journals and over 25 articles in International Conference proceedings, one article in National Conference, and delivered 2 invited talks in 2 International Conferences. She serves one of the potential reviewers of the international journals like "Optics Communication", "Applied Optics" and "IJAREEIE". She is also one of the members of OSA.

Sukhdev Roy
Department of Physics and Computer Science, Dayalbagh Educational Institute, Agra 282005, India

Low-power optogenetic control of high-frequency neural codes with single-spike resolution

One of the greatest scientific challenges is to understand the working of the brain, the most complex system in the universe. Optogenetics has revolutionized neuroscience research by enabling control of genetically modified neurons in culture, tissue and living animals with light. Natural light-sensitive proteins called 'opsins', are expressed transgenically in neurons to cause light-induced excitation or inhibition of neural activity. This provides opportunity to study the function of different neurons in the brain with unprecedented spatiotemporal resolution. Intense efforts are on to discover and engineer opsins to provide better control, larger photocurrent, improved kinetics, high-sensitivity, spectral tuning, and protein stability, along with light-delivery systems and opsin-expression strategies. Experimentally testing each combination of opsin and target cell type of interest is practically impossible, and thus needs a theoretical framework. Computational optogenetics has provided tremendous opportunity to understand complex experiments, under different photo-stimulation protocols, and explore applications. It requires simulation of the photocurrent in opsins and optically-induced spiking in opsin-expressing neurons. The talk would focus on our research on the formulation of accurate theoretical models for ultrafast optogenetic excitation using recently discovered ultrasensitive Chronos, red-shifted vf-Chrimson and ChRmine, optogenetic inhibition using newly discovered light-driven pumps namely eNpHR3.0 and Jaws, and bidirectional control with various experimentally studied and prospective opsin pairs for the first time. The study is useful in designing new optogenetic neural spiking experiments with desired spatiotemporal resolution, to provide insights into temporal spike coding, plasticity, and for curing neurodegenerative diseases, especially retinal prostheses.

Audience Take Away:

- Cutting-edge research in the challenging emerging are of Neurophotonics.
- It will help in understanding and designing new optogenetic experiments to control neural spiking with low-power laser light at desired spatiotemporal resolution.
- It opens up prospects for understanding neural coding and addressing important neurodegenerative diseases such as retinal prostheses.

Biography

Professor Sukhdev Roy received the B.Sc. (Hons.) Physics from Delhi University in 1986, M.Sc. Physics from DEI, in 1988, and PhD. from IIT Delhi in 1993. He is at present a Professor in the Department of Physics and Computer Science and has been a Visiting Professor at many universities that include, Harvard University. He has won a number of awards and fellowships and published 175 research papers. He is an Associate Editor of IEEE Access, Senior Member IEEE and SPIE, and Fellow of Indian National Academy of Engineering, National Academy of Sciences, India, IETE (India), and Optical Society of India.

Yuri B. Ovchinnikov[1], Folly Ayi-Yovo[1], Andrew Greer[2], Nikolaj Gadegaard[2], Anthon E. Kelly[2]

[1]Time and Frequency Department, National Physical Laboratory, Teddington, UK

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Towards all-optical atom chips based on optical waveguides

Coherent guiding of atoms in two-colour evanescent light fields of two main single modes of suspended optical rib waveguides is investigated theoretically. Special attention is paid to waveguides of widths larger than the wavelength of light, which provide better lateral stability of the surface traps and waveguides, and can be used in coherent Bragg beam splitters for matter waves, based on optical gratings formed by interference of evanescent light waves of two crossed optical waveguides. A single-mode regime for evanescent-wave waveguides for atoms is investigated. The general structure and key elements of all-optical atom chips are discussed. The current progress in manufacturing of the corresponding suspended optical rib waveguides is reported.

Audience Take Away:

- A new approach to all-optical chips for ultra-cold atoms is presented.
- Based on that approach new compact and ultrasensitive inertial sensors (accelerometers, gyros, gravimeters) and elements of quantum logic can be built, which can find various applications in industry and science.

Biography

Yuri Ovchinnikov has graduated the Moscow Institute of Physics and Technology in 1986 and after that has joined the Institute of Spectroscopy of RAS (Troitsk, Russia), where in 1993 he has acquired PhD degree for the investigation of induced light forces on atoms. From 1995 until 1997 he was a Humboldt Fellow at the Max-Planck-Institute für Kernphysik (Heidelberg, Germany) working on light forces and traps for neutral atoms. Between 1998 and 2000 he was working as a Guest Researcher at the National Institute of Standards and Technology (Gaithersburg, USA) on investigation of the interaction of the Bose-Einstein condensate (BEC) with light and its applications to atom optics and interferometry. From 2000 until 2003 he stayed at the University of Stuttgart (Germany), where he was leading the Rb BEC project and in parallel was working on a novel multimode optical interferometer. In 2002 he was awarded the Friedrich Wilhelm Bessel Research Award for his international input in development of atom optics and invention of a new type of light interferometer by the Alexander von Humboldt Foundation. Since 2003 he is working at NPL (UK) on atomic clocks and atom interferometry. Since 2011 he is an Honorary Professor of the University College London. The main scientific interests of Yuri are related to laser cooling and trapping of atoms, atom optics, Bose-Einstein-Condensation of diluted neutral atoms and light optics.

Victor Z Han*, Gerhard Magnus
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Cell-type specific responses of cerebellar GABAergic neurons to photo-stimulation

This experiment was designed to examine the responses of different cell types to photostimulation in the same functional system in an optogenetic model. A Cre-mediated genetic approach was utilized to generate mice in which channelrhodopsin-2 (ChR2), fused with a fluorescent reporter, is selectively expressed by GABAergic neurons. We focused on GABAergic cells in the mouse cerebellum, where such cells are abundant (Han et al., 2014). Slices (typically sagittal, 200 μm in thickness) were prepared from the cerebellum of ~1 month-old mice of either sex. (Several experiments were also carried out in mice at postnatal day 6.) Whole-cell patch recordings were performed under visual control. In some experiments, neurobiotin or biocytin was included in the internal solution to label the recorded cells for later morphological identification. TTL signals were used to trigger 473 nm blue laser light pulses, which were delivered to the tissue via a 200 μm optical fiber. The tip of the optical fiber was submerged in the recording chamber ACSF at a tip distance of about 1-1.5 mm from the recording site. The power level was ~1 mW/mm2 and the duration of the TTL signals, 1-500 ms, was adjusted based on the responses. The inward currents (pA) or depolarization (mV) elicited by the light pulses were measured in voltage- or current-clamp mode, respectively. Data acquisitions and analysis was carried out using the P Clamp 9. Labeled cells were visualized with the streptavidin-conjugated fluorescent dye for confocal image analysis and cell-type identification. As expected from it being the principal GABAergic cell-type in the cerebellum, Purkinje cells (PCs) had robust responses to photostimulation. Under current clamp, light pulse as brief as 1 ms consistently evoked > 10 mV of membrane depolarization and generated spikes with 13.15±3.1 mV amplitudes (n=47). Under voltage-clamp, a 1 ms light pulse evoked inward currents ranging 200-350 pA. When the duration of the light pulse was increased to 50-100 ms, the inward current became stable, reaching a maximum of 910±119 pA (n=47). Surprisingly, however, responses of all other GABAergic cell types in the cerebellar cortex were significantly smaller: basket cells 33±16.4 pA (n=8); stellate cells 27±11.4 pA; (n=); Golgi cells 110±34.8 pA (n=4). We also recorded from 18 smaller cells in the deep cerebellar nuclei region, likely local GABAergic interneurons, showing 72 ± 15.6 pA inward currents and 1.5 ± 0.55 mV depolarization in response to photostimulation. Among these cells, 3 responded with spikes in some of the tests. These results indicate that responses to optical stimulation by all non-principal GABAergic cell types in our Ai27 and Ai32 mouse model were much weaker than that those of PCs. The mechanisms for such differences deserve further investigation.

Audience Take Away:

- The use of optogenetic models is a powerful tool to answer many challenging questions in neuroscience that are otherwise difficult to tackle. Our data indicates that results can be cell-type specific in the same functional structure. Whether the different results for some cerebellar cells are a result of low expression of the optogenetic channels in non-PCs, or intrinsic cell properties "fighting back" against the currents induced by light remains to be determined.

Biography

Dr. Han studied Neurophysiology at the Shanxi Medical University, Taiyuan, China under Prof. JT Qiao and graduated as MS in 1982; and Neuroscience at The Fourth Military Medical University in Xi'an China, under Prof. G Ju and graduated as PhD in 1988. He Joined the research group of Dr. Curtis Bell at the Oregon Health & Science University in 1995. He is currently a Senior Research Scientist at the University of Washington. His research interests are in functional neuronal circuitry, particularly how it remains stable following plasticity changes such as LTD and LTP.

Nunzio Cennamo*, Luigi Zeni
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Plasmonic sensors based on polymer wave guides

Several developed low-cost, highly sensitive, and simple to realize and to use plasmonic sensor configurations are here presented. In particular, the presented sensor configurations are based on polymer waveguides, such as polymer optical fibers and planar waveguides, that excite the plasmonic phenomena in nanofilms, continuous on nanostructured. These plasmonic sensor chips are monitored using a simple experimental setup based on a white light source and spectrometer. Moreover, they can be combined with chemical and biological receptors in several application fields. In these cases, we can obtain the selectivity to the substances of interest via the use of specific Molecular Recognition Elements (MRE) in contact with the plasmonic sensing surfaces, such as those based on molecularly imprinted polymers (MIPs), antibodies, aptamers, nanoMIPs, etc. The substances that can be measured with the proposed approach are pollutants, viruses, bacteria, toxic metals, pesticides, or other molecules of interest to detect in aqueous solutions. So, the advantages and disadvantages of each biochemical sensor system are presented in detail. More specifically, plasmonic extrinsic optical fiber sensor and intrinsic optical fiber sensor types will be reported in terms of plasmonic characteristics and application fields. For instance, these selective plasmonic optical fiber sensor systems (intrinsic or extrinsic schemes) can be used for "Smart Cities" applications, as in water quality monitoring, through an IoT (Internet of Thing) approach, or, alternatively, they can be used onboard of simple robots, based on an autonomous guide, to follow increasing concentrations of pollutants in rivers or sea to identify the point of interest (the source), etc.

Audience Take away:

- How to monitor specific substances exploiting simple and low-cost plasmonic platforms.
- The capability of the plastic waveguides to realize highly sensitive biosensors and chemical sensors.
- How different types of receptors can be used combined with plasmonic probes to measure specific substances.

Biography

Nunzio Cennamo is a Professor of Electronics at the University of Campania Luigi Vanvitelli (Naples), Italy. His research interests include the design and fabrication of optical sensors, chemical sensors, biosensors and optoelectronic devices. He is the author of more than 110 international journal and conference papers and 7 patents. He is cofounder of the Spin Off "MORESENSE srl" in Milan. He is Associate Editor of "Photonics Research" (OSA) and of "Applied Sciences" (MDPI), and member of the Editorial Board and several times Guest Editor of "Sensors" (MDPI). He is an invited speaker in several Webinars and in several international conferences. He is an Organizer and General Chair of the 7th International Symposium on Sensor Science, 9-11 May 2019, Naples (Italy), and of the 2nd International Electronic Conference on Applied Sciences, 15-31 October 2021.

Fatima-Zahra Siyouri[1]*, Hicham. Ait Mansour[2]

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Robustness of Wigner function negativity under the effect of the different physical parameters related to two coupled semiconductor quantum dots System

We analyze theoretically the Wigner function negativity for thermal density matrix of analogous and equidistant two coupled semiconductor quantum dots at different temperatures. In this respect, we explore the quantum influences of the temperature, the external electric field, the Förster interaction and the exciton-exciton dipole interaction energy on its behavior. In particular, we show that the negativity of wigner function still survives for large values of temperature ensuring that the non-classicality of the two coupled semiconductor quantum dots system does not get lost under thermal effect. Moreover, we show that this negativity is hypersensitive to the external electric field effect, nevertheless, its sensitivity to this effect is extensively perturbed for higher values of Förster interaction, temperature and exciton-exciton dipole interaction energy. Further, we show that increasing this latter enhances the quantumness of system as the negativity of wigner function also increases.

Keywords: Wigner function negativity; semiconductor quantum dots; external electric field; Förster interaction; exciton-exciton dipole interaction energy.

Biography

Fatima-Zahra Siyouri is from Equipe Science de la matière et du rayonnement, Departement de Physique Universit_e Mohammed V – Agdal Av. Ibn Battouta, B.P. 1014, Agdal, Rabat, Morocco

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Designing a smart city infrastructure for luxury and disaster reduction

Modern societies pay great attention to improving the lives and comforts of their citizens. Perhaps one of the most important ways is to provide advanced digital services. This allows everyone to carry out their tasks and business requirements in an easy, both time and energy-saving manner. However, it became clear to these countries that the way to reach this advanced life is crystallizing in the provision of secure communications infrastructure and Internet services, which are known as smart cities. Smart cities are cities that provide a smart environment for both work and life. Providing an infrastructure that accommodates all available technologies and prepares for everything new technology is the heart of the desired intelligence. The combination of applications and technologies results in development and improvement, not only for a better life, but to maintain the continuity of providing services in the most difficult circumstances, and I will not exaggerate if I say even in the event of disasters. During this research, I will work on presenting the comprehensive concept of smart cities, the importance of developing current cities to keep pace with the increasing demand for smart services, and how to present them as an essential axis for sustainable development. In addition, I will review previous experiences and various development models and their effectiveness in facing risks and providing prosperity alike. In the end, I will present a mature model that depends mainly on the possibility of continuity, renewal, and development.

Audience Take away:

- Participants will gain great insight into the technical meaning and concept of smart building and smart city and how they differ and goes beyond automation.
- The research provides a general insight into the smart city application in both luxury and disaster reduction to offer open research ideas for both sides.
- Participants will learn the possibilities of how to use artificial intelligence and machine learning in providing a mature and self-evolving infrastructure solution.
- The research review relevant and related work in the past and how it made an impact, that is a great part to prepare for a solution that solves a problem in near future.
- The research provides a technical insight into the city networking infrastructure using air-blown fiber and Micro-duct solutions which is a great technical experience to make a practical solution in modern cities.

Biography

Eng. Mohamed Naeem studied communication and electronics engineering at the Arab Academy for Science, Technology, and Maritime Transport, Egypt, and graduated with an MS in 2019. He joined the computer network and data center department at Arab Academy in 2008. Alongside he has great experience in providing a network infrastructure design and delivered professional technical training for more than a decade. He has published a very important research article in the MDPI sensors journal.

Chahinaz Kandouci

Telecommunications and Digital Signal Processing Laboratory, Djillali Liabes University of Sidi Bel Abbes, 22000, Algeria

Performance evaluation of direct detection receivers in UWOC systems for different water types

For a long time, acoustic and Radio-frequency (RF) waves provide to control and command applications in underwater wireless channels at high transmission ranges. However, multimedia and high data rates applications are not compatible with such systems (the capacity in acoustic wire-less systems being in the range of few Kbits/s and few Mbits/sin wireless RF channels). In this case, the best alternative is to use optical waves which can deliver a higher speed rate underwater optical wireless communications (UWOC) at low latencies. In this work, we investigate the bit error rate (BER) of underwater optical wireless communication (UOWC) transmission link for different water types (i.e., pure seawater, clear ocean water, coastal ocean water, and turbid harbor water) by incorporating optical code division multiple access (OCDMA). Zero Cross-Correlation (ZCC) codes are used to reduce the decoder complexity by using direct detection (DD) receivers. In order to enhance the channel range and cardinality. BER variations are also examined for different modulation types: NRZ-OOK (Non-Return to Zero- On-Off Keying), RZ-OOK (Return to Zero- On-Off Keying), and QAM (Quadrature amplitude modulation). Performances are analysed by varying the number of users as well as the channel attenuation caused by different water types. The power and transmitter inclination angle limitation…etc (by which the system performance can be realized for a practical underwater channel environment) are also presented in order to determine the threshold for which the minimum bit error rate (BER) 10-9 is achievable. The system performs well at shorter distances due to the absorption and scattering of the optical signal while passing through an underwater channel. After analysing all results it is noticed that the BER performance is heavily dependent on the qualities of different water mediums and the best BER performance appears in the case of pure seawater.

Audience Take Away:

- Translating the advantages that DD-OCDMA technique provides to optical fiber systems to UWOC systems
- Presentation of a cost effective system
- Understanding the water particles effects of optical telecommunications schemes

Biography

Dr. Kandouci studied Telecommunications Systems at the Djillali Liabes University, Algeria and graduated as MS in 2012. She then joined the optical communications research group at the Telecommunications and Digital Signal Processing Laboratory (Sidi Bel Abbes, Algeria). She received her PhD degree in 2017 at the same institution. She then obtained the position of Lecturer at the electrical engineering faculty of Sidi Bel Abbes where she continues her research on optical networks.

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KEYNOTE FORUM

DAY 2

EUROPEAN LASERS, PHOTONICS AND OPTICS TECHNOLOGIES SUMMIT

SEP 22-23, 2021

ELOS 2021

Koichi Shimizu

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Functional transillumination imaging of animal body with NIR light scattering

Using a near-infrared (NIR) light with 700-1200 nm wavelength, we can visualize the internal structure of an animal body by transillumination imaging. However, the deep structure is severely blurred because of the strong scattering in body tissue. We developed some techniques to suppress the scattering effect and verified their feasibility in experiments. They are: the extraction of the near-axis scattered light and the weakly scattered light from the strongly scattered light. The deconvolution with a depth-dependent point spread function is another technique to suppress the scattering effect in a transillumination image. With these techniques we can visualize the macroscopic structure of an animal body in two dimensional (2D) images. Using the 2D transillumination images taken from different orientations, we can reconstruct the cross-sectional images and eventually the macroscopic three-dimensional (3D) image of the internal structure of an animal body. The effectiveness of the proposed technique was examined in the experiments with 3D model phantoms, and its applicability to an animal body was verified in the imaging of experimental animals. Further, we can quantify the physiological change occurred in the body as the change in transillumination images. A fundamental study has been conducted to visualize the functional change inside a living animal body using the NIR light. We have developed a technique to visualize the attenuation change occurred in a diffuse scattering medium. Transillumination images are obtained before and after the physiological change. Using these images, one can obtain the spatial distribution of attenuation change while suppressing the blurring effect of scattering. This principle was derived in theoretical analysis and its effectiveness was verified in experiments. To examine the applicability of this principle to a biological body, localized physiological changes were made in the mouse abdomen and the rat brain. The hypoxia in one of the mouse kidneys was visualized selectively from another normal kidney. The local increase in the blood volume was detected in the somatosensory area of a rat brain when its forelimb was electrically stimulated. The blood increase occurred in a symmetrical position with respect to the sagittal plane, when the forelimb of the opposite side was stimulated. The functional change occurred in a human hand and a foot was also visualized in transillumination images. Through these experiments, it was found that the changes in the tissue oxygenation and the blood volume could be detected noninvasively and that they are visualized in the transillumination images using the NIR light.

Audience Take Away:

- Audience will find the potential of a new noninvasive technique for biomedical imaging
- They can see some techniques to solve the problem of severe blurring caused by light scattering
- They can understand the basic principle of the functional trans illumination imaging
- They will see some practical applications of the proposed techniques to animal and human bodies
- They will see how the new deep learning techniques are used in trans illumination imaging

Biography:

Koichi Shimizu received M.S. (1976) and Ph.D. (1979) degrees, from University of Washington (UW), Seattle, USA. He was Research Associate in UW 1974-79. He was an Assistant-, an Associate- Professors, and a Professor in Hokkaido University, Sapporo, Japan in 1979-2016. He is currently a Professor Emeritus of Hokkaido University and a Professor of Waseda University, Kitakyushu, Japan. He has been engaged in the studies of biomedical engineering including those of wave propagation in biological media, optical measurement, biotelemetry and biological effects of electromagnetic field. He served as an associate editor of IEEE Trans. ITB in 1999–2007. He has been a Fellow of the Electromagnetics Academy, and an editorial board member of Scientific Reports, Nature.

Yang Yue*, Wenqian Zhao
Institute of Modern Optics, Nankai University, Tianjin, China

Non-zero dispersion-shifted fiber for optical orbital angular momentum communication

Nowadays, helically phased light carrying orbital angular momentum (OAM) is well known, as exciting progress on the applications of OAM modes has been made in various fields. OAM modes, as a complete set of orthogonal basis functions for spatial distribution of electromagnetic field with theoretically infinite topological states, have attracted widespread interest in the field of optical fiber-based communications. Over the past few years, researchers have been applying OAM MDM technology into fiber-based optical communication systems, in which ring fiber was introduced for supporting numerous OAM modes to significantly reduce the modal crosstalk. In order to further improve the transmission speed of information in the fiber-based communication system, the combination of OAM MDM and wavelength division multiplexing (WDM) technologies would be necessary. As when the OAM-based communication system is proposed, WDM technology and its corresponding devices have been pretty mature and widely implemented. Thus, more improvements are required for fibers supporting OAM modes to suit the needs in WDM systems. Chromatic dispersion, as one of the key parameters to impact the quality of the transmitted optical signal over wide bandwidth, is the first thing to be considered. Although the influence of chromatic dispersion can be handled by digital signal processing (DSP), the corresponding power consumption will increase with the chromatic dispersion for correction. Recently, coupled ring fiber design has also been proposed to realize large negative dispersion, which could potentially be used as a dispersion compensating element for OAM mode. But still a laudable goal would be to further simply the optical link for easier fiber management and more practical system implementation. Thus comes the demand for designing the non-zero dispersion-shifted fiber (NZDSF) for supporting OAM modes to balance the chromatic dispersion and nonlinearity. In this talk, we will first introduce the basic concept for apply the OAM modes into optical communication, the main driving force for introducing the NZDSF for OAM mode, and its applications in the fiber-based communication systems. As the ring-shaped fiber has gain encouraging improvement in supporting numerous OAM modes, and the NZDSF is building on that, the previous researches for optical ring-fiber carrying OAM modes will be also discussed. We will then discuss the novel designed NZDSF for OAM modes. The ordinary ring-shaped fiber design with low chromatic dispersion for $HE_{2,1}$ mode, which can serve as NZDSF for its corresponding OAM1,1 mode, is achieved by adjusting the fiber structure and materials. The theoretical analysis shows that a negative dispersion of -1.246 ps/(nm·km) or a positive dispersion of 1.541 ps/(nm·km) can be obtained at wavelength of 1550 nm, with the dispersion variation of less than 4 ps/(nm·km) for $OAM_{1,1}$ mode from 1530 to 1625 nm, covering the entire C-band and L-band.

Audience Take Away:

- Basic knowledge of OAM fiber-based communication
- Information for optical ring-fiber designs supporting OAM modes
- NZDSF to better support OAM modes into WDM fiber-based system
- Fiber structure optimization to meet the diverse needs for the chromatic dispersion of OAM modes

Biography:

Yang Yue received the B.S. and M.S. degrees in electrical engineering and optics from Nankai University, China. He received the Ph.D. degree in electrical engineering from the University of Southern California, USA. He is a Professor with the Institute of Modern Optics, Nankai University, China. Dr. Yue's current research interests include intelligent photonics, optical communications and networking, optical interconnect, detection, imaging and display technology, integrated photonics, free-space and fiber optics. He has published over 200 peer-reviewed journal papers (including Science) and conference proceedings with >8,000 citations, four edited books, >50 issued or pending patents, >100 invited presentations.

Gin Jose*, Paramita Pal, Eric Kumi-Barimah

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Planar optical waveguide engineering using ultrafast laser plasma doping process

Ultrafast laser plasma doping (ULPD) is a new technique developed by us to fabricate planar waveguides on glasses and silica on silicon. In this process femtosecond lasers with pulse duration <100 fs is used to ablate a target material containing ions that introduce refractive index increase as well as those suitable for light amplification such as Er^{3+} and Tm^{3+}. The ablated target materials are allowed to impact on glass substrates under specific processing conditions inside a vacuum chamber leading to formation of a waveguiding layers within the subsurface of the substrate with refractive index increase as high as 10%. The rare earth doped and undoped planar waveguide layer can be fabricated on a single substrate using this method. The Er^{3+}/Yb^{3+}- ions doped glass-modified-silica, and silica-on-silicon waveguides demonstrate well-defined homogeneous waveguiding layer without clustering and crystallization. This paper summarises the current state of ultrafast laser plasma doping technique, which is promising for active and passive waveguide integration on the same substrate.

Audience Take Away:

- Importance of planar optical waveguide devices and their applications
- It will demonstrate the use of femtosecond laser in a new way to fabricate planar waveguides
- Explore new applications of femtosecond lasers
- Laser and amplifier engineering on silica on silicon
- Active and passive waveguide integration on silica/glass
- Other application areas of the laser processing technique

Biography:

Prof. Jose's research interests are in the areas of Photonic Biosensors, photonic glasses, femtosecond pulsed laser deposition and plasma implantation, and planar waveguide devices on glass, silicon and polymer platforms. He is currently leading a £5M EPSRC-UK functional materials manufacturing research project for developing the ultrafast laser plasma doping (ULPD) process that he invented for application in advanced integrated photonics for optical data communication and sensing (www.seamatics.org). Glasses and semiconductors functionalised using ULPD are attractive for non-invasive quantum optical biosensing, integrated photonics, anti-counterfeiting/printing in glass bottles and toughening of glass for displays. He is also leading an £1.7M ESPRC Healthcare Technology project on unpconversion nanoparticles for photonic bio-sensing and imaging. He is a cofounder of a spinout company Optimus Vitrum Ltd (www.op-vi.com) which is focusing on stronger mobile screen engineering. A number of researchers and industrial partners are involved in these research and development activities of his group. I have 4 filed/granted patents and 100+ publications and his group have won Royal Academy of Engineering Entrepreneurship Award (2015), RSC emerging technologies award (2015) and Medipex- NHS innovation Award (2015). Prof. Jose received my MSc and PhD degrees in Physics from University of Calicut, India and Mahatma Gandhi University, India respectively. He was a research fellow at the Polytechnic of Milan, Italy during 2001-2002. In 2003 he joined the Department of Physics, Indian Institute of Technology Guwahati and was a Senior Lecturer/Assistant Professor there until 2007. In 2007, I joined School of Chemical and Process Engineering, University of Leeds, UK and since March 2013 he is a Professor and Chair in Functional Materials there.

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SPEAKERS | DAY 2

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Shien-Kuei Liaw[1]*, Shofuro Afifah[1], Lina Marlina[1], Chien-Hung Yeh[2], Hiroki Kishikawa[3]

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Impacts of environmental parameters to underwater optical wireless communication system

An underwater optical wireless communication (UOWC) system using 450 nm green light laser source is constructed and studied. The 450 nm blue-light laser is selected as the light source because the characteristics of low absorption in the water. The open sea water is simulated in the 1.5 m length of water tank filled with water conduct in the laboratory. The blue laser light that is collimated with collimated lens is injected into the water tank using 1.25 data rate and PRBS 31. The mirror placed inside the water tank to prevent the higher optical loss also used to reflect the light back and forth to obtain higher transmission distance. The Bit Error Rate (BER), eye diagram, and optical power were measured to analyze the UOWC system quality. According to the result the bigger angle of reflection inside the water tank, the higher BER of 2.967 x 10-8 at -13.06 dBm of received optical power will be obtained. The coupling efficiency of the laser was measured by adjust the laser spot size diameter. The experiment also measured in the OptiSystem 15.0 software using the same experimental setup. Then, the UOWC transmission system was carried out under several parameters such as temperature, turbulence, and turbidity were conduct to make the scenario of open sea water in the water tank. Artificial seawater by adding salt to simulate practical application in river or sea is also conducted. When a submerged motor with an output of 1200 L/h is used as water flow turbulence source, the impact to BER and transmission quality is little. For temperature change issue, the experiment shows that at original temperature of 25°C has the best BER as compared to low temperature of 10-20°C or high temperature of 30-50°C. We found that water flow disturbance has little impact to BER and eye diagram quality. Finally, artificial seawater is used to simulate the real seawater environment. Under such situation, the UOWC transmission system can only transmit 3 m instead of 6 m due to impure particles and water disturbance. Both may degrade the BER quality in seawater. In the end, the external parameter such as seawater experiment was conducted using the sea salt inside the water tank. A 520 nm green-light laser and 450 nm blue-light laser was compared the signal quality in the seawater experiment. The result is the blue laser has better signal quality than the green laser.

Audience Take Away:

- The research experience in this talk will share to the audience to save the time of try and error
- The presentation content can help people in the field of optical communication. Some optical and photonics components and modules will also be introduced. The talk may provide an in-depth discussion to wireless optical communication issues, improve the accuracy of optical alignment and measurement and overcome the environmental issues

Biography

Prof. Shien-Kuei Liaw received double doctorate degrees from NCTU and NCTU, Taiwan. Liaw has worked at Taiwan Tech (NTUST) since 2000. Currently, he is Chairman of the Graduate Institute of Electro-Optical Engineering, Taiwan Tech (NTUST). Prof. Liaw was an academic visitor at the University of Oxford and at the University of Cambridge, respective. He authored or co-authored for more than 300 journal articles and international conference papers. He has been contributing to many conferences as a keynote/invited speaker. he serves as a Guest Editor for several journal papers and books. He is an senior member of IEEE and OSA.

Songmao Chen[1]*, Wei Hao[2], Xiuqin Su[3], Zhenyang Zhang[4], Weihao Xu[5]

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Single photon imaging: Applications and challenges

Thanks to the single photon sensitivity and excellent surface-to-surface resolution, single-photon LiDAR has emerged as a prime candidate technology for depth imaging through challenging environments. In this talk, we will first introduce the concept and principle of single photon imaging, discussing the benefits, progresses, as well as the applications of such technique. Then, we shall discuss those problems that can not be solved by hardware alone (e.g. sparse 3D data, strong ambient light, multiple returns), which is considered as a barrier to widespread deployment in a number of applications (e.g. long-range imaging, imaging through turbid media, sensing of complex environment). Furthermore, as the above problems motivated the design of photon efficient algorithms, we shall present the iconic ideas and solutions that achieved state-of-the-art results, bring together the innovative thoughts and prospect the future development and challenges in this field.

Audience Take Away:

- Thoroughly review and discussion of advanced technique in 3D profiling and photonics. The new concepts and applications shall inspire the audience
- The audience will learn a branch of new ideas and Insights of the future development. Keeping them to be informed with latest progresses and thinking
- The ideas summarized in the talk can also inspire or combine with a variety of research filed (other 3D profiling technique, optical design, signal processing, etc.)
- Prompting the interdisciplinary research and applications, Such as computational imaging technique

Biography

Song mao Chen received the B.Eng. degree from the Xidian University, China, in 2014. Then he received his PhD degree from University of Chinese Academy of Science in 2020, major in signal and information processing. During 2017–2018, he was sponsored by China Scholarship Council (CSC) as a joint training Ph.D. student in the Single-Photon Group, Heriot-Watt University. He is currently a research associate in Xi'an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences, with particular interest single-photon imaging system, image processing and Bayesian inverse problems.

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Analysis of instantaneous poynting vector for N-Layer Lossy optical waveguides and applications in the evanescently coupled optical devices

Starting with an introduction to the Poynting theorem, we derive analytical expressions for the instantaneous Poynting vector for an N-layer lossy optical waveguide structure consisting of multiple metal-dielectric interfaces. These expressions are compared with the equivalent expressions for the average Poynting vector discussed in many textbooks on optics. Due to the lossy nature of the optical waveguide considered, the propagation constants of the modes excited in the structure are complex-valued. The modes excited are surface plasmons (SP) and transverse magnetic (TM) in nature. These modes have finite penetration depth, which is defined as the distance from any metal- dielectric interface where the electromagnetic energy reduces to 1/e of its value at the interface. These modes have finite propagation length (also called the 'range' of the mode) which is defined as the distance traveled by the modes along the direction of propagation when the electromagnetic energy reduces to 1/e of its initial value. We propose new formulae for the penetration depth and the propagation length of the instantaneous Poynting vector. These are shown to be different from the conventional formulae for the penetration depth and the propagation length defined in terms of the average Poynting vector. It is proposed that the study of the instantaneous Poynting vector is important in understanding the functionality of evanescently coupled optical devices, such as the directional couplers, surface plasmon resonance (SPR) based sensors, TE/TM polarizers. We discuss the application of the new formula proposed for the penetration depth of instantaneous Poynting vector in optimizing the design parameters of an SPR sensor to achieve maximum sensitivity. We also plot the evolution of the instantaneous Poynting vector flux lines for a five-layer SPR bi-metallic sensor in prism coupling Kretschmann configuration, displaying the finite propagation length and penetration depth to be consistent with the proposed formulae.

Audience Take Away:

- The proposed technique can be used to evaluate the design parameters of evanescently coupled optical devices such as directional couplers, plasmonic sensors, and TE/TM polarizers.
- Commercial applications: The design methodology of SPR affinity bio-sensors can be obtained by using the proposed formula for the penetration depth. The choice of the affinity layer is a very important factor in the detection of bio-molecules such as E-Coli, pseudomonas bacteria, glucose levels, and triglycerides, etc. in the blood sample. The optimum thickness of the desired affinity layer for maximum sensitivity of the sensor can be done using the proposed technique.
- Applications in Research/ teaching domain: The proposed technique can be expanded to study the directional couplers which are extensively being used in integrated optoelectronic devices, and optimize its design parameters.
- The TE/TM polarizers which are again based on the evanescent optical coupling can be studied and their extinction ratio be improved by the proper choice of the refractive indices and thicknesses of the various layers using the proposed technique.

Biography

Jagneet Kaur Anand received her B.Sc. degree (July 1992) and M.Sc. degree (July 1994) in Electronics from University of Delhi South Campus, India. She received her M.Tech. in Opto-Electronics and Optical Communication (Dec. 1995) and Ph.D. in Broadband Erbium doped fiber amplifiers (2002) from Indian Institute of Technology, Delhi, India. She joined Keshav Mahavidyalaya, University of Delhi, India, in Dec. 1998, where she is currently an Associate Professor of Electronics. Her current areas of research are Optical waveguides, Erbium Doped Fiber Amplifiers, SPR sensors, and Poynting vector applications in evanescently coupled optical devices.

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Excimer laser processing of ph and glucose sensing membranes for controlled drug delivery

pH and glucose responsive membranes can be used in controlled drug delivery applications. Controlled drug flow across the membrane is very important for such applications. It is therefore of the foremost importance to obtain membranes with uniform pore morphology. We developed a two-step membrane fabrication technique using 248 nm KrF excimer laser. In the first step uniform, ordered and well-defined porous structure is developed on polyimide (PI) film with the help of metal mask. In this step, laser fluence (energy/area), number of pulses and mesh size can be adjusted and optimized tocontrol the pore dimensions. In the second step, PI pores are further grafted with polyacrylic acid (PAAc) using the same 248 nm KrF excimer laser. Grafted membranes respond to the change in pH. The fabrication technique proves the versatility of laser as a tool to develop stimuli responsive polymeric membrane. Membrane fabrication time also reduces significantly to the order of minutes, or even, seconds. Grafting density, responsiveness and fabrication time can be tuned by appropriate selection of laser parameters and solution parameters. Two separate studies focusing on the effect of laser parameters and solution parameters on responsiveness of the membrane were carried out. Our work showed that PAAc hydrogel network remains intact inside PI pores under applied pressure. Diffusion transport studies across the membrane proved their potential application in drug delivery application. These membranes were further characterized using ATR-FTIR, fluorocense microscope and SEM. TGA was used to do the quantitative analysis of grafted membranes. We further immobilized these membranes with glucose oxidase. Diffusion studies across these immobilized membranes were carried out using caffeine as a model drug. These membranes not only detect the presence of glucose but can also respond corresponding to the amount of glucose present in the system. This opens a whole new window for potential application of the process for diabetes treatment.

Audience Take Away:

- We successfully fabricated pH and glucose responsive membranes using KrF excimer laser. These membranes not only detect the presence of glucose but can also respond corresponding to the amount of glucose present in the system. This opens a whole new window for potential application of the process for diabetes treatment. Furthermore, pH responsiveness can be exploited in delivery of specific drugs.
- Some of the very common limitations of conventional membrane fabrication techniques are 1) use of organic solvent, 2) non uniform porous structure, 3) non uniform pore distribution across the membrane, 4) slow process.
- Our fabrication technique reduced the membrane fabrication time significantly to the order of minutes, or even, seconds.
- Uniform, ordered and well-defined porous structure is developed on polyimide (PI) film with the help of metal mask, thus making drug delivery control very precise.
- We have already developed a temperature-responsive membrane using laser and extended it to develop a pH and glucose responsive membranes. Now the system can be more generalized and used to graft any monomer that can polymerize by free radical polymerization. Dual thermo-pH responsive membrane will be an interesting option to explore. NIPAM and AAc monomer can be simultaneously grafted inside polymer pores to develop such dual responsive membrane. A separate study can also focus on the rate of pore opening and closing.

Biography

Professor Emeritus (University Akron – UA, Aug. 2020) Erol Sancaktar (Ph.D.; Eng. Mechanics, Virginia Tech) is Fellow of ASME, served as ASME Technical Committee Chair for Reliability Stress Analysis, Failure Prevention (1997-2008; 2013-), Associate Editor for ASME J. Mech. Design (1995-2006) and Medical Devices (2006-2013) and organized 30 Conferences. He taught at the Mechanical Eng. Dept., Clarkson University during 1978 to 1996 before joining UA in 1996 as Professor of Polymer Engineering and Professor of Mechanical Engineering (starting 2009). He edited 24 books, authored 112 journal articles and 30 book chapters. He delivered 247 technical presentations and has 4 patents.

Orchidea Maria*, Lecian
Sapienza University of Rome, Italy

Developments and applications of the optical equivalence theorem

The optical equivalence theorem is analysed and developed for almost-infinite-valued-operator Eigen states. Pertinent expansions are presented after the calculation of new formalisms for the Optical equivalence theorem. New extensions for the Optical equivalence principle are formulated, and applied to different types of quantum systems, semi classical systems and optical systems. The optical equivalent for operators, with weighted density matrix and the spectral component f on compact support is defined in the projector operator. The definition of the first-approximation correction orders is demonstrated to depend on the definition of the parameters qualifying the definitions of the weighting-support-control function. The investigation is apt for systems constituted of intense, non-monochromatic laser fields. The power spectrum of the operators is this way decomposed as a sequence obtained after the majorization of the operators after those of the weighting function. The power spectrum is therefore not needed to be expressed as a sequence (of majorizations), where such majorization do not apply to pure states. The control of the spectral analysis is proposed, to distinguish among the several contributions. Calculations are performed for the most extreme case the long-time limit of the error estimations. Applications are proposed for cold dynamics ensembles, cold atomic trapped ions, temperature experiments for protein folding in molecular dynamics; jump processes between states; quantums separation of multispatial Gauss-Markoffmodels; uncertainty estimations in metrology, decoherence and dissipation, noisy metrology beyond the standard quantum limit.

Audience Take Away:

- New formalisms for the optical equivalence principle
- Calculations for the most extreme case of the long-time limit of the error estimations

Biography

Prof. Orchidea Maria Lecian graduated at Sapienza University of Rome ans ICRA- International Center for Relativistic Astrophysics in 2005 ad completed her International Relativistic Astrophysics Phd at Sapienza University and ICRA. She was post-doctoral Fellow at IHES (Bures-sur-Yvette, France), AEI-MPI (Potsdam-Golm, Germany) and Sapienza University of Rome. She has teken part in intensive research prgorammes at AEI-MPI (Potsdam-Golm, Germany) and The Fields Institute for Research in Mathematical Sciences (Toronto, Canada). She has been researcher for SAIA- NS'P (The National Scholarship Programme of the Slovak Republic- National Stipendium Program) as Research grantee and Erasmus Lecturer at Comenius Univeristy in Bratislava, Faculty of Mathematics, Physics and Informatics, Department of Theoretical Physics and Physics Education- KTFDF. She has been Assistant Professor at Sapienza University of Rome and is Porfessor at Sapienza University of Rome. She has contributed in national conferences and international conferences. She is author of research papers, conference papers, review papers and one book. She is reviewer and editorial-board member for several reputed Journals.

Ramon Maia Borges*, Arismar Cerqueira S. Jr
Lab. WOCA, National Institute of Telecommunications (Inatel), Santa Rita do Sapucaí, MG, Brazil

Microwave photonic techniques for 5G/6G fiber-wireless systems

The fifth-generation of mobile network (5G) and beyond requires optical-wireless convergence to cope with the new value-added applications from challenging scenarios. In this context, we report research activities conducted at the National Institute of Telecommunications (Inatel), Brazil, concerning the use of microwave photonic techniques for next-generation fiber-wireless (FiWi) systems. It includes analog radio over fiber (RoF) solutions toward multiband and photonically amplified fronthaul, simultaneously transporting microwaves and millimeter- waves in accordance to the 5G New Radio (NR) standard. The RoF techniques under discussion exploit single and dual-drive Mach-Zehnder modulators, wavelength division multiplexing (WDM) overlay, in addition to the four- wave-mixing (FWM) nonlinear effect. The integration of an innovative flexible-waveform 5G transceiver in a passive optical network (PON) infrastructure, from a commercial Internet service provider, is reported. Experimental results demonstrate Gbit/s throughput and error vector magnitude (EVM) in accordance to the 5G NR Release 15 requirements, as well as the coexistence of legacy and incoming technologies in the same FiWi architecture. Experimental results demonstrate also RoF links with power increase of about 15 dB at the photodetector output by taking advantage of FWM. Such photonics-assisted gain is uniform, stable and ultra-wideband, being valid for baseband and radiofrequency (RF) signals in both 5G NR frequency ranges (FR1 and FR2). The approaches addressed in this work are potential to favor the 5G deployment and may contribute to the sixth-generation mobile systems (6G) design.

Audience Take Away:

- The audience will learn the advantage of employing the dual-drive Mach-Zehnder modulator for combining the lower and higher 5G frequencies toward multiband RoF-based fronthauls
- The audience will know the Brazilian 5G transceiver, which has been designed mainly for covering long-reach applications
- The audience will know the feasibility of exploiting existing PON infrastructures in conjunction with WDM overlay, as an immediate solution to deploy the 5G fronthaul
- The audience will know the possibility of designing RoF links with photonics-assisted RF amplification, which may bring robustness or reduce the requirement for electrical amplifiers after photodetection
- The approaches under discussion provide practical solutions for multi-application 5G FiWi systems and could be used to other faculty to expand their research or teaching

Biography

Ramon received the B.Sc. degree in electrical engineering from the National Institute of Telecommunications (Inatel), Brazil, in 2012, the M.Sc. degree in telecommunications from Inatel, Brazil, in 2015, and the Ph.D. degree in electrical engineering from the Federal University of Itajubá (UNIFEI), Brazil, in 2020. He has worked as a Researcher with the Wireless and Optical Convergent Access Laboratory at Inatel, since 2015, acting on R&D Projects as the Radiocommunications Reference Center. He is currently a Professor with Inatel. His research interests include 5G/6G networks, optical-wireless systems and microwave photonics. He has published more than 40 scientific articles.

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Solid-surface fluorescence of polycyclic aromatic hydrocarbons on the cellulosdiacetate matrix

Solid-surface fluorescence (SSF) is a modern method which combines solid phase extraction with high-sensitive fluorimetric analysis in the solid phase of the sorbent. SSF has been successfully applied for trace quantification of organic and inorganic compounds in various media. The SSF analysis of polycyclic aromatic hydrocarbons (PAH) is of particular interest because of their toxicity. As PAHs are found in various media in very small quantities, their quantitative analysis is impossible without prior concentrating, which makes the SSF method promising for the design of test systems for environmental monitoring. The possibility of luminescent PAH analysis in aqueous media using various solid-phase matrices has been established for silica gel, zeolites, fiberglass with silica particles, foamed polyurethane, nylon membranes, and cellulose.We used cellulose diacetate (CDA) in the design of sorption matrices for the fluorescent analysis of polyaromatic compounds. The conditions of making film matrices from CDA with high sorption capacity for organic fluorophores, are presented. The set of properties of our CDA film matrix (its opacity, smooth surface, fine-pore structure, the pore size, the surface potential) was found to cause high sorption and fluorescence of pyrene in the solid phase of the sorbent. The model solutions of pyrene in water-micellar and water-organic solvent media were used. Sorption of pyrene from solutions was performed in dynamic mode. The fluorescence spectra of pyrene and other PAHs in a solution and on solid matrices were recorded on a spectrofluorimeter Fluorat-02-Panorama. The increased fluorescence intensity of pyrene and some other PAH on the solid-phase matrix was shown. The effect of the solvent nature (acetonitrile, ethanol, dimethylsulfoxide, dioxane) and its concentration on the fluorescence intensity of pyrene sorbed on the CDA film from a water-organic solution was studied. It was shown that DMSO and ethanol are the most effective solvent additives for pyrene solid-surface fluorescence. The detection sensitivity of the substance was fixed at $2 \cdot 10^{-9}$ g/L. The possibility of quantative analysis on our solid-phase matrix in a concentration range of the fluorophore in the sorbate $2 \cdot 10^{-6} - 2 \cdot 10^{-8}$ g/L was shown with pyrene as an example.The possibility of analyzing various PAHs by their SSF on the surface of the CDA matrix was tested. The maximum sorption capacity at the CDA film and the SSF intensity were noted for benzo(a)pyrene. The fluorescence spectra of the indicator pairs anthracene–phenanthrene and pyrene–fluoranthene were studied when the simultaneous presence of both isomers in the analyte, depending on the excitation wavelength. The obtained results allow us to consider this method promising for detecting the PAH contamination source.The SSF technique with the CDA matrix may be proposed for the environmental monitoring of PAH traces. Our developed polysaccharide matrices are characterized by relatively low cost, the ability of raw material reproduction and waste biodegradation, which is important for their use in test systems and rapid analytic methods.

Audience Take Away:

- Solid-surface fluorescence technique and cellulose diacetate matrix may be used for creating chemo- and biosensors
- Fluorescence chemo- and biosensors may be used for analysis of different compounds in environmental control, medicine and etc
- Modern chemo- and biosensors are products of the integration of achievements in various fields of knowledge - chemistry, biology, physics, mathematics and microelectronics. That is why the presenting information may be interesting for scientists of different research fields

- The developed cellulose diacetate matrices may be useful for the designers of optical chemo- and biosensors

Biography

Prof. Rogacheva graduated from Chemistry Faculty and took post-graduate course of Saratov State University, Saratov, Russian Federation. She received the Degree of Candidate of biological sciences (=Ph.D.) in 1998, the Degree of Doctor of biological sciences in 2009. She worked as Associate Professor in Saratov Military Institute of Biological and Chemical Safety (1998-2009), then the Head of the Chair "Nature & Technosphere Safety" in Yuri Gagarin State Technical University of Saratov (2009 –2018). Present workplace: Vice-rector for scientific work of Saratov Medical University "REAVIZ". She has nearly 200 publications and 9 patents in Russian, 40 articles in SCI journals.

Aldo Minardo*, L. zeni

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Hybrid Brillouin/Rayleigh sensors for multiparameter distributed optical fiber sensors

Distributed optical fiber sensors (DOFS) represent a very effective technology for the continuous monitoring of structures. Conventionally, DOFS make use of some form of light scattering in silica glass optical fibers. Rayleigh scattering is caused by random fluctuations in the refractive index of the fiber, and can be used to perform high-sensitivity, vibration (dynamic) sensing. In such a case, the amplitude and/or the phase of the backscattered light excited by a coherent laser pulse is acquired at one or more lasing wavelengths. Mechanical vibrations or acoustic perturbances are usually identified by comparing consecutive phase sensitive OTDR (ϕ-OTDR) acquired traces, as they induce variations in the backscattered light at the corresponding position.A different mechanism of light scattering is the Brillouin scattering, which involves the interaction between optical and acoustic fields in the optical fiber: any changes in the tensional state or temperature of the fiber alter its elastic properties, and in particular, the frequency of the acoustic wave generated either thermally (in case of spontaneous scattering) or by electrostriction (in case of stimulated scattering). This frequency coincides with the Doppler shift experienced by the incident light. Thus, the strain or the temperature of the fiber is recovered by measuring the frequency shift between the incident and scattered light, which is known as the Brillouin Frequency shift (BFS). Brillouin methods are capable of high spatial resolution (down to the mm range), and very long sensing lengths (up to one hundred km and more). Furthermore, differently from Rayleigh based sensors, they allow absolute (not reference-based) measurements. However, they cannot capture weak vibrations with nε-level strain, mainly because of the relatively poor sensitivity of the BFS to strain (50 kHz/με). Hybrid sensors, exploiting (at least) two scattering mechanisms for multiparameter sensing, may provide more valuable information and a comprehensive identification of fault events. Furthermore, the measurement schemes can share some parts, such as those required for the probe pulse generation, as well as those aimed at data acquisition. Therefore, in the last years there has been a growing interest in developing hybrid sensor schemes, capable of integrating the two technologies in the same interrogation setup. In this presentation, the recent advances in hybrid Rayleigh/Brillouin based sensors will be discussed. We will show that the integration of the two technologies permits to realize cost-effective solutions for simultaneous, multiparameter sensing.

Audience Take Away:

- Recent advances in distributed optical fiber sensors.
- Hybris schemes for multiparameter sensing.
- Recent application fields related to distributed optical fiber sensing.

Biography

Aldo Minardo received the degree (summa cum laude) in electronic engineering from the University of Naples Federico II, Naples, Italy, in 2000, and the Ph.D. degree in electronic engineering from the Second University of Naples, Aversa, Italy, in 2003. He is currently a Full Professor of Electronics with the Università della Campania "Luigi Vanvitelli." He has authored about 200 international journal and conference papers and three patents. His H-index is 24, according to SCOPUS. His main research interests include distributed and point-based optical fiber sensors. He was responsible for scientific research conventions with private bodies and European projects.

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Comparison between total volume of ZnO wurtzite, rocksalt, and zinc blend structures under isobaric and isothermal ensembles a MD computation

In this work we used Parallal Molecular Dynamics and DL_POLY_4 to compare between the total volume of ZnO wurtzite, rocksalt, and zinc blend structures under different pressures and temperatures. Our system is formed from 5832 atoms of ZnO for rock salt and zinc blend(2916 atoms of Zn^{+2} and 2916 atoms of O^{-2}) and 2916 atoms of ZnO for wurtzite, the interatomic interactions are modeled by Coulomb-Buckingham Potential for short and long-range, the range of temperature is 300-3000K and for pressure is 0-100GPa. Although no more data under previous conditions our results are in the vicinity of available experimental and theoretical information. This work is very important in Nano scale of time and space and in different sectors of industry.

Key words: ZnO, pressure, temperature, linear density, simulation

Biography

Yahia CHERGUI is an assistant Professor in Electrical & Electronics Engineering Institute, Boumerdes Algeria. He has completed his PhD from Badji Mokhtar University in Annaba, Algeria. He did all his PhD work in Cardiff University in UK. His research field is Physics (condensed matter, and soft matter simulation by molecular dynamics). He has many published articles and international conferences. He has been serving as a referee with condensed matter journal (IOP), Energy journal (Elsevier), and American Journal of Modern Physics.

Anton A. Lipovka
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Correct accounting of gas kinetics in disks of spiral galaxies, explains non-Keplerian rotation curves and makes dark matter unnecessary

Until now, it was generally accepted that the gas kinetics is not important in the formation of rotation curves (RC) of spiral galaxies (see Dalcanton and Stilp, doi:10.1088/0004-637X/721/1/547). For this reason, RC is usually calculated within the framework of a naive Newtonian mechanical model, adding dark matter to the model to fit the calculated RC to the observed one. Thus, non-Keplerian RCs are commonly calculated as Keplerian ones, but with the addition of about 90% of the mass in the form of dark matter. In this paper, it is shown that the commonly used methods of classical mechanics cannot be used to calculate RCs in the outer parts of galactic disks, where the influence of collisions in the gas on its dynamics becomes dominant. Moreover, the hydrodynamic approach also cannot be applied for these purposes, due to the extreme rarefaction of the gas in the galactic disks. It is argued that gas kinetics plays a key role in the dynamics of gas in the outer parts of galactic disks, for which non-Keplerian RCs are observed.In this work (see Lipovka doi: 10.31219/osf.io/t6754), we have developed a new method for describing the dynamics of a rarefied gas in the outer regions of galactic disks, where the gas dynamics is mainly determined by collisions. In this paper, equations describing RC are derived. In this case, the obtained equations are free from restrictions imposed on hydrodynamics. The resulting equations relate two quantities: the tangential gas velocity as a function of the distance from the galactic center (RC) and the radial gas density distribution. It is shown that if the physical properties of a rarefied gas are taken into account correctly, there is no need to introduce dark matter. In this case, the "non-physical" (not Keplerian) rotation curves for the outer parts of galaxies are tailwinds described in the framework of the usual kinetic theory of gas. To illustrate the correctness of the model obtained, two galaxies with flat rotation curves (NGC7331 and NGC3198) are considered. Excellent agreement was obtained between the densities calculated from the rotation curve and the observed values, which confirms the correctness of the model used. Thus, the "nonphysical" rotation curves of spiral galaxies, which previously required dark matter to explain, are just tailwinds formed in a rarefied gas. Therefore, their explanation does not require the involvement of the concept of dark matter. The total masses of the galaxies NGC7331 and NGC3198 have been calculated. The implications for cosmology are discussed.

Audience Take Away:

- The problem of dark matter has been solved, which has stood insoluble for more than 90 years.
- There is no more need to spend money on a laboratory search for dark matter.
- This work opens up an opportunity for constructing complete and correct dynamic models of galaxies. This, in turn, opens the door to a deeper understanding of nature.
- How will this help the audience in their job? Is this research that other faculty could use to expand their research or teaching? Does this provide a practical solution to a problem that could simplify or make a designer's job more efficient? Will it improve the accuracy of a design, or provide new information to assist in a design problem? List all other benefits.
- The proposed results radically change our understanding of the world around us, since, on the one hand, they make dark matter unnecessary, and on the other hand, they show the importance of taking into account the gas kinetics (which was previously considered insignificant) when constructing dynamic models of galactic disks. For this reason, it is safe to say

that these results will be used

- In teaching physics of galaxies and cosmology.
- In research work when building models of galaxies.
- In this work, a fairly simple equation was obtained from first principles, which allows to include the gas kinetics in models of galaxies. Therefore, the application of this equation will greatly facilitate the calculations of the dynamics of galactic systems.

Biography

Dr. Anton A. Lipovka studied Astrophysics, Cosmology and Theoretical Physics at the St. Petersburg Polytechnic University, Russia and graduated as MS in 1990. He then joined the research group of Prof. Valery Khersonsky at the Special Astrophysical Observatory (SAO). He received his PhD degree in 1994 at the same institution. In 1999 he obtained the position of Professor at Sonora University (Mexico) in the Department of Physical Research. Anton Lipovka has his expertise in Astrophysics, Cosmology, Molecular Spectroscopy, Theoretical Physics and Solid-state Physics as well. Since 2013, he is working on the Foundations of Quantum Physics.

Dror Malka
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RGB port demultiplexer using polycarbonate core polymer optical fiber technolgy

Wavelength division multiplexing (WDM) is a great solution for increasing data bitrate communication of multicore polymer optical fiber (MC-POF) system. However, this solution requires adding more optical devices to the system which can limit its performance. To solve this issue, we propose a new design for an RGB channel based on polycarbonate (PC) MC-POF structure. The new structure is based on replacing seven air-holes areas with PC layers over the fiber length which enables controlling the light propagation direction between the pc layers. The locations of the PC layers and the key geometrical parameters of the MC-POF were analyzed utilizing the beam propagation method. Results show that an RGB demultiplexer can be obtained over a light propagation of 20 mm with a good crosstalk of -19.436 to -26.474 dB, low losses of 0.901 to 1.246 dB and a large bandwidth of 5.6 to 11.3 nm. By analysis the results, it is clear that the main advance is that the new design does not require additional devices in order to function as RGB demultiplexer. This advance can be utilized to design new and very compact VLC-WDM system that can be used to obtain better performances comparing to VLC-WDM system that used bulk components.

Audience Take Away:

- They will study how manipulate the light guiding mechanism
- How to increase the data bitrate in visible light communication system
- Benefits of this study: Support visible range, High communication rate, Higher channels ratio
- Low Losses, Accurate channel spacing and compact device

Biography

Dror Malka received his BSc and MSc degrees in electrical engineering from the Holon Institute of Technology (HIT) in 2008 and 2010, respectively, Israel. He has also completed a BSc degree in Applied Mathematics at HIT in 2008 and received his Ph.D. degree in electrical engineering from Bar-Ilan University (BIU) in 2015, Israel. Currently, he is a Senior Lecturer in the Faculty of Engineering at HiT. His major fields of research are nanophotonic, super-resolution, silicon photonics and fiber optics. He has published around 40 refereed journal papers, and 40 conference proceedings papers.

Anton A. Lipovka
Physics Research Department, Sonora University, Hermosillo, Sonora, Mexico

Geometrical origin of quantization

It is well known that historically the motion of charged baryonic matter was quantized first (Schrödinger's equation), and only more than 20 years later the Gupta-Bleuler formalism was proposed, which formally described the quantization of the electromagnetic (EM) field. However, up to the present time the foundations of the constructed orthodox quantum theory were not clear, since it is based on two postulates: namely, the value of Planck's constant was postulated and the existence of the wave function was also postulated. This axiomatic approach leads to a misunderstanding of the foundations of quantum mechanics and this is the reason for the existence of a dozen different interpretations of quantum mechanics. However, back in the early 20th century, Einstein and Debye convincingly showed that the EM field is quantized by itself, regardless of the presence or absence of charged baryonic matter.In this paper, it is proved that Planck's constant is an adiabatic invariant of a free electromagnetic field propagating along a Finsler manifold characterized by an adiabatically time-varying curvature (see Lipovka DOI: 10.4236/jamp.2017.53050).It is shown that on a Finsler manifold, characterized by an adiabatically variable geometry, the classical electromagnetic field is quantized geometrically (quantization arises from the requirement to satisfy inhomogeneous boundary conditions), in such a way that the adiabatic invariant of the electromagnetic field is Planck's constant: ET = h (here E is energy of the free EM field and T is period).

Direct calculation based on cosmological parameters (Hubble constant and cosmological constant) gives the value of Planck's constant ET = h = 6x10 (-27) (erg s), which coincides with the experimental one up to the measurement errors of cosmological parameters.

It is also shown that Planck's constant (and therefore all other fundamental constants that depend on h) changes over time due to changes in the geometry of the manifold. As an example, the change in the fine structure constant is calculated. The obtained relative variation for the fine structure constant is ((da/dt)/a) = 1.0x10(-18) (1/s).

In the work under discussion, the equations of complete electrodynamics on an adiabatically varying Finsler manifold are derived. It is shown that quantization arises naturally, directly from these equations of complete electrodynamics and is due to the adiabatically variable geometry of the manifold. Two effects are discussed that immediately follow from the obtained equations: 1) the cosmological displacement of photons and 2) the Aharonov - Bohm effect. Moreover, the explanation of the Aharonov - Bohm effect was made for the first time and from first principles. It is shown that the quantization of systems consisting of electromagnetic fields and a charged baryon component (like atoms) has a simple and clear explanation within the framework of the obtained complete electrodynamics.

Audience Take Away:

- The nature of Planck's constant revealed in the work makes it possible to understand the very foundations of quantum mechanics and quantum electrodynamics, i.e. understand where and how quantization arises.
- The obtained equations of complete electrodynamics make it possible to describe the free EM field and complex systems (EM field + charged particles) both at the classical and at the quantum level.
- For the first time, a complete and comprehensive explanation of the Aharonov-Bohm effect has been obtained, which will

allow us to set up new experiments and move further in our understanding of the foundations of the universe.

- The proposed results completely remove the veil of mystery from quantum theory, since in this work, on the one hand, the nature of Planck's constant is explained, on the other hand, a complete system of equations of electrodynamics is proposed, describing both classical and quantum systems. For this reason, it is safe to say that these results will be used in:
- In teaching quantum physics and quantum electrodynamics.
- In this work, the complete equations of electrodynamics were obtained from first principles, which describe both classical and quantum systems. These equations will certainly be used by colleagues in research work to describe the dynamics of quantum systems. This work opens the door to new physics of the 21st century.
- The equations explaining the Aharonov-Bohm effect will certainly be useful to experimenters.

Biography

Dr. Anton A. Lipovka studied Astrophysics, Cosmology and Theoretical Physics at the St. Petersburg Polytechnic University, Russia and graduated as MS in 1990. He then joined the research group of Prof. Valery Khersonsky at the Special Astrophysical Observatory (SAO). He received his PhD degree in 1994 at the same institution. In 1999 he obtained the position of Professor at Sonora University (Mexico) in the Department of Physical Research. Anton Lipovka has his expertise in Astrophysics, Cosmology, Molecular Spectroscopy, Theoretical Physics and Solid-state Physics as well. Since 2013, he is working on the Foundations of Quantum Physics.

Seongwoo Woo
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Improving the fatigue of newly designed mechanical system subjected to repeated impact loading

To improve the fatigue of newly designed mechanical system subjected to repeated loading, this paper develops parametric accelerated life testing (ALT) as a systematic reliability method to produce the reliability quantitative (RQ) specifications—mission cycle—for recognizing missing design defects in mechanical products as applying the accelerated load. Parametric ALT is a way to enhance the prediction of fatigue failure for mechanical systems subjected to repeated impact loading. It incorporates: (1) A parametric ALT plan formed on the system BX lifetime, (2) a fatigue failure and design, (3) customized ALTs with design alternatives, and (4) an assessment of whether the last design(s) of the system fulfils the objective BX lifetime. A BX life concept with a generalized life-stress model and a sample size equation are suggested. A domestic refrigerator hinge kit system (HKS), which was a newly designed mechanical product, was used to illustrate the methodology. The HKS was subjected to repeated impact loading resulting in failure of the HKS in the field. To conduct ALTs, a force and momentum balance was utilized on the HKS. A straightforward impact loading of the HKS in closing the refrigerator door was examined. At the first ALT, the housing of the HKS failed. As an action plan, the hinge kit housing was modified by attaching inside supporting ribs to the HKS to provide sufficient mechanical strength against its loading. At the second ALT, the torsional shaft in the HKS made with austenitic ductile iron (18 wt% Ni) failed. The cracked torsional shaft for the 2nd ALTs came from its insufficient rounding, which failed due to repeated stress. As an action plan, to have sufficient material strength for the repetitive impact loads, the torsional shaft was reshaped to give it more rounding from R0.5 mm to R2.0 mm. After these modifications, there were no problems at the third ALT. The lifetime of the HKS in the domestic refrigerator was assured to be B1 life 10 years.

Audience Take Away:

- New design methodology for mechanical systems
- Directly applicable in field to improve the fatigue of product.
- Parametric accelerated life testing (ALT) as a systematic reliability method to produce the reliability quantitative (RQ) specifications.

Biography

Dr. Woo has a BS and MS in Mechanical Engineering, and he has obtained PhD in Mechanical Engineering from Texas A&M. He major in energy system such as HVAC and its heat transfer, optimal design and control of refrigerator, reliability design of mechanical components, and failure Analysis of thermal components in marketplace using the Non-destructive such as SEM & XRAY. Especially, he developed parametric accelerated life testing (ALT) as new reliability methodology. If there is design fault in the mechanical system that is subjected to repetitive stress, it will fail in its lifetime. Engineer should find the design faults by parametric ALT before product launches. In 1992–1997 he worked in Agency for Defense Development, Chinhae, South Korea, where he has researcher in charge of Development of Naval weapon System. In 2000-2010 he had been working as a Senior Reliability Engineer in Side-by-Side Refrigerator Division, Digital Appliance, SAMSUNG Electronics, where he focused on enhancing the life of refrigerator as using parametric the accelerating life testing. Now he is working as associate professor in mechanical department, Addis Ababa Science & Technology University.

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Gennady Kochemasov*
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Coupling orbital frequencies as a possible source of very fine radiations in the Universe

The main point of the wave planetology: "Orbits make structures". However, any cosmic body moves in several orbits with various frequencies. High-frequency oscillations are modulated by low frequency ones with production of side frequencies. The lower side frequencies in bodies terminate by the fundamental wave (wave 1) responsible for ubiquitous tectonic dichotomy (Theorem 1, [1] and others). The higher side frequencies correspond to radio waves for bodies in galaxies (remember radio galaxies) and have to be else higher frequent due to orbiting in clusters of galaxies and in clusters of galactic clusters. Orbiting velocities gradually increase from smaller systems to larger ones: the Solar (star) system (n x 10 km/s) – galaxy (n x 100 km/s) – cluster of galaxies (n x 1000 km/s) – cluster of galactic clusters (n x 10000 km/s, about c/10, c= the light velocity), where n is about 1 to 5 (on average about 3). Each step means enormous increase of the systems angular momenta as their not only velocities but also masses and radii increase enormously. Such ever increased energies and lower and lower orbiting frequencies provoke (modulate) in bodies higher and higher side frequencies. Thus, if a galactic movement gives radio waves, orbiting a cluster of galaxies gives gamma rays, orbiting a cluster of galactic clusters gives the hypothetic medium or isotropic mess of not yet measured very high frequency oscillations (nicknamed "vacuum"). This medium is a real substance where propagate the electromagnetic waves.It is interesting that well-known radio wave and gamma-ray background observations now are added by soft X-rays emitting from various celestial bodies – from cold comets to the hot Sun and measured by the Chandra X-ray Observatory [2]. Reality of Galactic influence at Earth is seen in changing geological periods and a strict 100 mln.y. Periodicity of magmatism[2]. Directed changes in the Earth geologic history should be attributed to its Galaxy movement in a cluster of galaxies.

The following discrete scheme may be considered. Modulating frequencies diminish (and cosmic velocities increase) from smaller objects to larger ones: The Solar (star) system (velocities n x 10 km/s) - leads to tectonic granules, sound Galaxy (n x 100 km/s) - radio waves cluster of galaxies (n x 1000 km/s) – gamma-rays cluster of galactic clusters (n x 10000 km/s, about c/10, c= the light velocity) –"vacuum",where n is about 1 to 5 (on average about 3).Energy (angular momentum) of existent discrete rotating cosmic systems dramatically increase as their velocities, masses, radii increase drastically. Enormous hidden energy (and mass) in "vacuum" may be treated as "dark energy" and predicted "lost mass. Thus, all cosmic bodies move in several orbits with differing orbital frequencies simultaneously: around planets, stars, in galaxies, in groups of galaxies and so on. Each orbit has own imprint in body structure and many structural features appear as a reflection of modulated side frequencies. The modulation process is the same as in radio wave physics: the lower of two frequencies modulates the higher one by it division and multiplication. Two side frequencies and corresponding them tectonic features appear. Examples are for Saturn, Pluto, Titan, the Moon, Ceres, Phobos, Deimos, Churyumov-Gerasimenko comet core [2].

[1] Kochemasov G.G. (1999) Theorems of wave planetology tectonics // Geophysical Res. Abstr., v.1,#3, 700. [2] Kochemasov G.G. (2018) Modulated wave frequencies in the Solar system and Universe // Journal of Physics and Application 12(4): 68-75, 2018. Doi:10.13189/ujpa.2018.120402.

Biography:

Gennady Kochemasov is currently working in IGEM RAS, Russian Federation

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Growth of breast cancer cells on laser-patterned surfaces

Despite the fact that numerous attempts have been made to recreate the complex extracellular matrix (ECM) that regulates cell fate, most of them have focused on three-dimensional (3D) culture models. Nevertheless, these models are not suitable for high-throughput screening and quantification of intracellular mechanics due to their structurally undefined surface characteristics. On the other hand, highly structured surfaces (2 1/2D) comprising various micro- and nano-patterns (created by physical patterning as well as chemical treatment), hold great promise as they can induce a crossover from 2D to 3D cell behavior, simulate the cellular natural microenvironment without compromising reproducibility, and facilitate the characterization of inter- and intra- cellular interactions [1].In this work, we present the results obtained from culturing MDA-MB-231 breast cancer cells on various laser-patterned and biochemically-modified silicon as well as PDMS surfaces. Silicon wafers were patterned by a nanosecond Q- switched Nd:YAG laser system (355 nm, 532 nm, and 1064 nm wavelength) to introduce a variety of surface morphologies, including microspikes, ripples, and craters. In parallel, PDMS surfaces of different Young's moduli were treated both with plasma as well as acid solutions to render them hydrophilic, but also to induce the formation of rippled nanostructures. Both types of substrates were then incubated with different proteins of the ECM. Collectively, the obtained substrates allowed for a great plethora of variables (stiffness, morphology, biochemical cues) and their effect on cell cultures was studied. Our preliminary data have shown that certain morphologies promote increased cell survival, as revealed by cell proliferation assays (cell counting kit 8 (CCK8)). In addition, the metastatic ability of the MDA-MB-231 cells was enhanced or inhibited at specific surfaces, as it was demonstrated by the rearrangement of cytoskeletal filaments (phalloidin staining), a marker of their migratory potential. The obtained results could be used to establish a pipeline towards the identification of the most appropriate structural modifications for a cell line or co-culture system and the creation of an application-specific pattern library, which could be exploited in drug screening and personalized medicine as well as in tissue engineering and regeneration.

Acknowledgements: This research is co-financed by Greece and the European Union (European Social Fund – ESF) through the Operational Programme "Human Resources Development, Education and Lifelong Learning 2014 – 2020 in the context of the project "Novel studies of cell interactions on nanostructured surfaces (MIS 5048213)".

Audience Take Away:

- Substrate morphology affects cell cultures. Cell survival and metastatic ability of cancer cells varies with substrate morphology and chemistry.
- Micro spikes, micro ripples, and micro craters were created with laser processing on silicon and cell cultures were assessed on these morphologies.

- The chemistry and morphology of PDMS substrates was modified with several methods and cell cultures were assessed on them.
- This research is useful in creating a pattern library for cell cultures, which could be exploited in drug screening and personalized medicine as well as in tissue engineering and regeneration.

Biography:

Dr. Maria Kandyla received her Diploma in Electrical and Computer Engineering from the National Technical University of Athens (NTUA), Greece, in 2000 and her M.Sc. and Ph.D. in Applied Physics from Harvard University, USA, in 2002 and 2006, respectively. She worked as a Post-doctoral Associate at the Massachusetts Institute of Technology (MIT), USA, from 2006 to 2008 and as a Marie Curie Fellow at the NTUA from 2008 to 2010. Since 2010 she has been working at the National Hellenic Research Foundation as Research Staff, where she is now a Senior Researcher. She has 50 publications on light-matter interaction.

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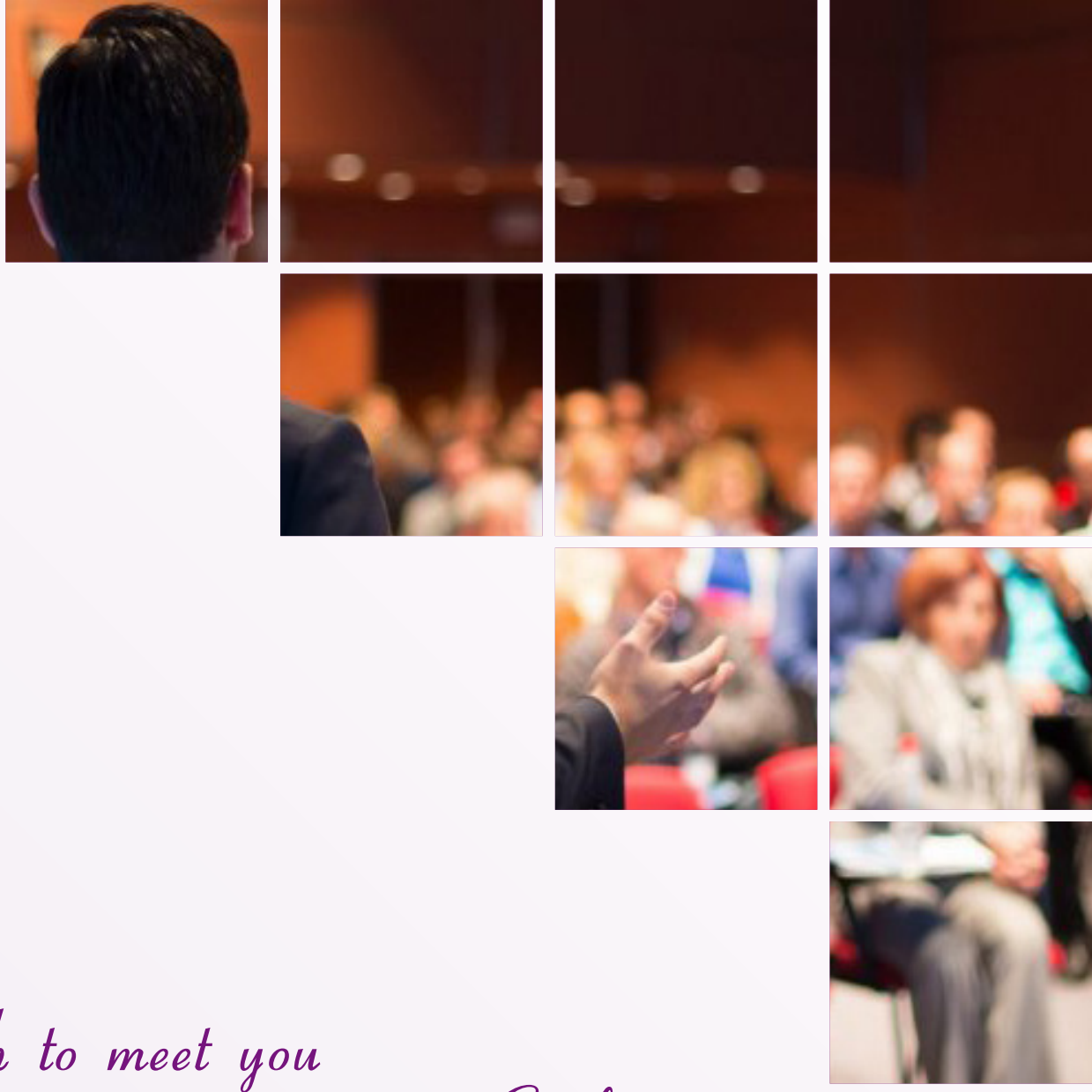

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