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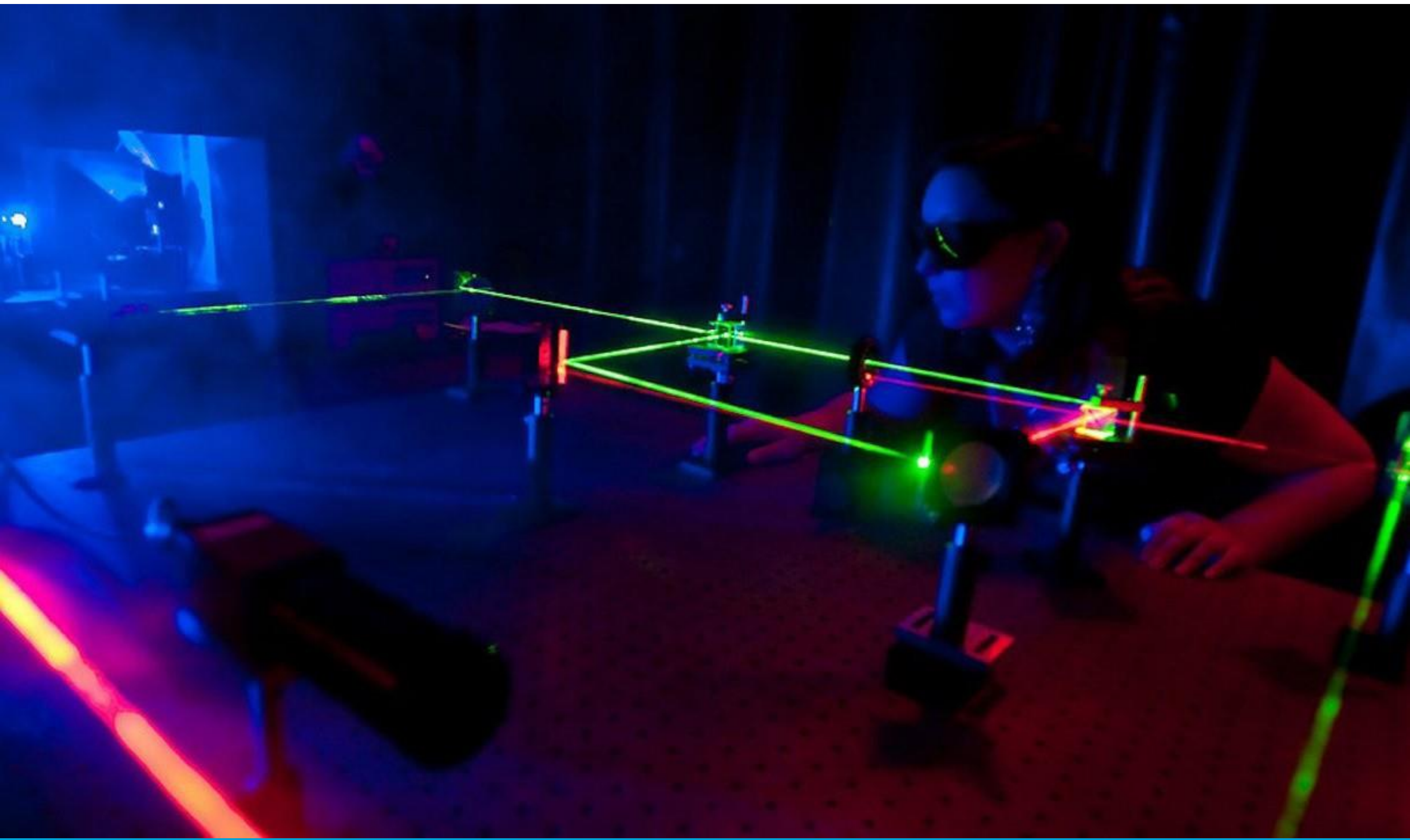
International Conference and Expo on Lasers, Optics & Photonics

November 10-11, 2022 | Valencia, Spain



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FOREWORD

It is our pleasure to invite all scientists, academicians, young researchers, business delegates and students from all over the world to attend the International Conference and Expo on Lasers, Optics & Photonics will be held in Valencia, Spain during November 10-11, 2022.

Optics-2022 shares an insight into the recent research and cutting edge technologies, which gains immense interest with the colossal and exuberant presence of young and brilliant researchers, business, delegates and talented student communities.

Optics-2022 goal is to bring together, a multi-disciplinary group of scientists and engineers from all over the world to present and exchange break-through ideas relating to the Lasers, Optics & Photonics. It promotes top level research and to globalize the quality research in general, thus makes discussions, presentations more internationally competitive and focusing attention on the recent outstanding achievements in the field of Lasers, Optics & Photonics.

We're looking forward to an excellent meeting with scientists from different countries around the world and sharing new and exciting results in Lasers, Optics & Photonics.

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Green Data Communication: Intelligent Physics and Engineering will Contribute to a Sustainable Society

[1]Dieter Bimberg and [2]Sicong Tian, Friedel Gerfers

[1]Bimberg Chinese-German Center for Green Photonics" CIOMP, Chinese Academy of Sciences, Changchun, China and Center of Nanophotonics and Institute of Solid State Physics, TU Berlin, Germany

[2]Chair of Mixed-Signal Circuit Design, TU Berlin, Germany

Abstract

Since 2014 novel consumer applications like Netflix, Block Chain, LIDAR… not known at that time have led to a huge increase of internet traffic of 60%/year, much more than then originally predicted by companies like Cisco. This increased use of the internet is increasing its electrical power consumption due to increased data traffic mostly inside data centers. New data centers have crossed the 500 MW level. 5G and 6G with their big jumps in data speed will be further enablers for new services, like LIDAR and more, we cannot think about yet, and will increase the energy consumption to an extent not further tolerable.

New research goals are followed presently focusing on energy-efficiency of data traffic at all hierarchy levels. Inside data centers advanced design of active optical cables, their electronic driver and receiver circuits and the active photonic devices are suddenly in the focus, but now with the goal to minimize their combined power consumption. Vertical-cavity surface-emitting lasers (VCSELs) for 200+ Gbit/s single fiber data transmission across OM5 multimode fiber with a record heat to bit rate ratio (HBR) of only 240 fJ/bit x wavelength @ 50Gbit/s developed in our labs are presented. Photon lifetime management is a new key to adopt the overall energy consumption to the bit rate of the data traffic (e.g. 25 Gb/s, 50 Gb/s,..).

A completely novel design approach for VCSELs will be presented based on etching multiple holes, oxidizing one or several apertures from these holes and refilling them with metal, in order to increase heat conduction and cut-off frequency and reduceparasiticeffects.Thermal roll-over is expected to appear at much larger currents compared to the present standard designs, allowing larger single mode output power and possibly dense wavelength multiplexing across distances of several hundred m to 1 km in data centers.

Finally work on high speed novel drivers based on advanced CMOS design is reported, leading to dramatically reduced energy consumption of VCSEL modules below 500 fJ/bit.A dc-coupled single-ended voltage-mode clock-less driver is demonstrated in 22-nm SOI CMOS eliminating the need for area- and energy-inefficient equalization techniques for data rates up to 60 Gb/s while maintaining error free (BER<1e-12) in our transmission experiments. The highly digitized driver architecture inherently features an impedance (voltage-level) calibration scheme to handle both driver and VCSEL-based process variations. At 60 Gb/s data rate, an energy efficiency of 420fJ/b is achieved from a single 0.9 V supply which is to the

authors knowledge a 3x improvement in terms of energy-efficiency compared to the optical TXs reported to date. The highly digital driver architecture enables the supply scalability down to 0.6 V.

Biography

Prof. Dieter Bimberg received the Ph.D. magna cum laude from Goethe University, Frankfurt, Germany. He held a Principal Scientist position at the Max Planck Institute for Solid State Research, Grenoble, France, until 1979. After serving as a Professor of electrical engineering at, Technical University of Aachen, Germany, he assumed the Chair of Applied Solid-State Physics at the Technical University of Berlin. He is the Founding Director of its Center of NanoPhotonics. He was holding guest professorships at the Technion, Haifa, U.C. Santa Barbara, CA, USA, and at Hewlett-Packard in Palo Alto, CA. He was a Distinguished Adjunct Professor at KAU, Jeddah 2012-2018. In 2018 he assumed the directorship of the "Bimberg Chinese German Center for Green Photonics" at the Changchun Institute of Optics, Fine Mechanics and Physics of the Chinese Academy of Sciences. He is a member of the German Academy of Sciences Leopoldina, the EU Academy of Sciences, a foreign member of the Russian Academy of Sciences, the US Academies of Engineering and of Inventors, a Life Fellow of the American Physical Society and the Institute of Electrical and Electronics Engineers, IEEE. He is the recipient of multiple international awards, like the UNESCO Nanoscience Award, the Max-Born Award and Medal of IoP and DPG, the Heinrich-Welker-Award, the Nick Holonyak Jr. Award, the Japanese Oyo Buturi Award of Applied Physics, the Jun-Ichi Nishizawa Medal, and Award of IEEE, and the Stern-Gerlach Award of DPG, to mention a few. He received honorary doctorates from the University of Lancaster, UK, and the St. Petersburg Academic University of the Russian Academy of Sciences. He has authored more than 1600 papers, 71 patents and applications, and six books. The number of times his research works have been cited exceeds 67,000 and his Hirsch factor is 113 (@ Google Scholar). His research interests include physics and technology of nanostructures, nanostructured photonic and electronic devices, and energy-efficient data communication.

Ultra-high Speed Directly Modulated Membrane Semiconductor Lasers for 200Gbps Modulations and Beyond

Shinji Matsuo

NTT Device Technology Labs, Japan

Abstract

Reductions of power consumption in directly modulated lasers (DMLs) are strongly desired due to the increase of Internet traffic. We have developed membrane lasers on SiO2/Si substrate, in which a thin III-V compound semiconductor layer is vertically sandwiched between low-refractive-index materials, such as air and SiO2. This is because a large optical confinement factor of membrane laser enables us to improve modulation efficiency. As a result, we achieved low-power consumption DMLs which have the same power consumption as VCSEL. However, the maximum modulation speed is limited by the increase in active region temperature due to the low thermal conductivity of the SiO2/Si substrate. To overcome this, SiC was proposed and demonstrated to be used as a substrate for membrane lasers because of its large thermal conductivity and relatively low refractive index. In addition, we employed optical feedback effects such as photon-photon resonance and detuned loading effect. These effects enable us to achieve the enhancement of modulation speed without increasing power consumption. We achieved 3-dB bandwidth of ~100 GHz and demonstrated over 200Gbps operations with low-power consumption.

Biography

Dr. Shinji Matsuo is a Senior Distinguished Researcher at NTT Corporation. He received the B.E. and M.E. degrees in electrical engineering from Hiroshima University, Hiroshima, Japan, in 1986 and 1988, and the Ph.D. degree in electronics and applied physics from Tokyo Institute of Technology, Tokyo, Japan, in 2008. In 1988, he joined NTT Opto-electronics Laboratories, Atsugi, where he was engaged in research on photonic functional devices using MQW-pin modulators and VCSELs. In 1997, he researched optical networks using WDM technologies at NTT Network Innovation Laboratories, Yokosuka. Since 2000, he has been researching InP/Si-based photonic integrated circuits at NTT Device Technology Laboratories, Atsugi. Dr. Matsuo is a Fellow of Optica and IEEE.

VCSELs and Other Extreme Optics

Jack Jewell

University of Arizona, USA

Abstract

Unprecedented demand for laser volumes (billions/year) in structured-light applications, with accompanying demands in small-size, low-power and low-cost, are satisfied only by VCSEL technology produced in the most-extreme ways. Arrays with 100's of elements are produced on sub-mm-size chips on 200-mm-diameter Ge wafers. It takes very-roughly 25,000 such wafers to produce 1 Billion VCSEL chips.

Ethernet standards are defining communication links at 800Gb/s over eight 100m-long optical fibers, used in data centers and supercomputers with 100Gb/s VCSELs (PAM4 encoded). More-mature VCSEL links, with 100,000's per machine, communicate in the world's fastest supercomputers. VCSELs have enabled hand-held Cesium clocks, and are used in Optical Coherence Tomography, highly-sensitive magnetometers, and other diagnostic tools. VCSELs successfully compete with more-powerful edge-emitting lasers in the products above, because their inherent geometry favors small, numerous devices.

A key facet of VCSEL development was the active-region thickness over time. Melngailis demonstrated a basic device in 1965.Iga introduced VCSELs in1977 with 1-3um-thick active regions that defined and dominated VCSEL research through the 1980's. Jewell spearheaded a 1989 pivotal advance, in which VCSELs attained 10-40-nm-thick active regions, much like those of edge-emitters, and ~2 orders of magnitude thinner than previous VCSELs1, achieved by introducing high-reflectivity low-optical-loss semiconductor mirrors that conducted current. That VCSEL architecture quickly became the norm and still prevails. Many significant VCSEL advances were made since 1989, but those 1989 key elements are mostly intact.

In the future, fast robotic lidar vision for very-fast manufacturing and operations is a possibility. While machine vision works well for many applications, a miniature lidar is faster. Since 2020, iPhones have included array lidars for 3-D measurements of objects in room-size volumes.

1Jack Jewell, Axel Scherer, Sam McCall, Yong-Hee Lee, S. Walker, Jim Harbison and Leigh Florez, "Low-Threshold Electrically-Pumped Vertical-Cavity Surface-Emitting Microlasers," Electronics Letters, Vol. 25, No. 17, pp. 1123-1124.

Biography

Jack L. Jewell is an independent consultant. With a Ph.D. in Optical Sciences from the University of Arizona, he worked at AT&T Bell Laboratories from 1984-1991, leaving as Distinguished Member of Technical Staff.He then co-founded Photonics Research Inc. in 1991, the first stand-alone company committed to commercializing VCSELs (later Vixel Corp., and spinoff Cielo). In 1995 he founded Picolight Inc. Both companies were leaders in VCSEL innovation and standards development (e.g. Ethernet). Vixel went public in 1999, and Picolight was acquired by JDSU (Lumentum) in 2007. A Fellow of IEEE and Optica, Jewell received the IEEE Photonics Award (2021) and the Aron Kressel Award.Jewell has 79 US patents and over 150 publications.

VCSEL Photonics for Interconnects and 3D Sensing

Fumio Koyama

Tokyo Institute of Technology, Japan

Abstract

The 40 years' research and developments opened up a new world of VCSEL photonics, including, sensors, optical interconnects in data center networks, LiDAR and high power sources. A lot of unique features have been proven. The market of VCSELs has been growing up rapidly and they are now key devices in data center networks. High speed VCSELs have been intensively developed for rapid growth in network traffics. The data rate reaches at 50 Gbps or higher. Also, 3D sensing has been attracting much attention for a wide range of applications such as face ID in mobile phones, LiDAR for automatic driving cars, distance sensor of robot, security camera, and motion sensors in virtual reality.

In this talk, the advances on VCSEL photonics will be reviewed, in particular, our recent activities on new functions and integration of VCSEL photonics. We address a lateral integration platform and new functions, including high speed coupled cavity VCSELs, high power VCSEL amplifiers, high-resolution beam scanners and their integrations.

Acknowledgement: This work was partly supported by NICT(#00101) and JST ACCEL(#JPMJTR211A).

Biography

Fumio Koyama received the Ph.D. degree from the Tokyo Institute of Technology in 1985.He is a professor of Institute of Innovative Research, Tokyo Institute of Technology. His research interest includes VCSEL photonics, photonic integrated devices, optical sensing, and so on. He has authored or co-authored more than 1,000 journal papers and conference papers, including over 100 invited papers. He received various awards, including the IEE Electronics Letters Premium in 1985 and in 1988, the Ichimura Prize in Science for Excellent Achievement in 2004, the Prize for Science and Technology from the MEXT in 2007, IEEE/LEOS William Streifer Scientific Achievement Award in 2008, Izuo Hayashi Award in 2012, Sakurai Kenjiro Memorial Award in 2017, Okawa Prize in 2018, OSA Nick Holonyak Jr. Award and IEICE Achievement Award in 2019. He is Fellow of IEEE, OSA, IEICE and the Japan Society of Applied Physics.

Cleaner than a Cleanroom: Filling Technology Gaps for Laser Optics, Space Telescopes and LIGO-First Contact Polymers as a Path Towards Atomic Cleanliness

Professor James P. Hamilton

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Abstract

Creating and maintaining unprecedented cleanliness levels has become a limiting technological requirement for projects like LIGO and future starshade technology for NASA's Great Observatories of the future. Over the last 20 years, we have developed a family of peelable residue-free, non-tearing polymer coatings that safely clean and protect surfaces. These Apply-Dry-Peelcoatings begin to fill the technology gap that exists ina) trying to clean historically uncleanable nanostructured and coated surfaces as well as inb) meeting the zero dust to lerance requirements of high energy laser optics and some semiconductor processes.

This family of First Contact Polymers (FCPs) was a critical, enabling technology in LIGO's gravitational wave discoveries of 2015,1,2 NASA's Starshades3 and can greatly extend the lifetime of current mirror coatings on large astronomical mirrors such as the 10meter class mirrors at the Keck Observatory and GTC in the Canary Islands.6

Ournovel, residue less polymeric strip coatings are applied as a liquid and subsequently peeled off the substrate as a solid, strong, non-tearing film. These novel polymers blend strip coatings safely clean and protect a wide variety of nanostructured surfaces and leave the surface almost atomically clean and "space ready." Contaminant removal was monitored by various techniques, including Nomarski Microscopy, BRDF, Atomic Force and Scanning Electron Microscopy, and XPS and Auger spectroscopy. High power laser damage (LIDT) testing results13 also demonstrate YAG laser damage thresholds on new YAG laser optics of 3 J/cm2 before AND after cleaning, clearly demonstrating no residue. Finally, the use of FCP on high-power laser optics resulted in an absorption coefficient decrease of 24.3% after cleaning, and the authors claimed that the absence of residue makes the FCP conducive to the long-term preservation of optical components.16 In addition, data demonstrates that the material safely removes particulate contamination and finger oils from microstructures such as the 300nm wide lines on diffraction gratings and similar submicron features on Si wafers

and is an excellent nanoreplicator. Another application of the polymer film is as a sample matrix for beamline studies. Use as a dry powder and biological sample support in beamline samples8 and for spectroscopy7and time-resolved photoluminescence of nanowires9has been demonstrated. Other applications in the literature include a)transfer patterned nanoparticle arrays red to a flexible polymer surface, b) use a droplet as a spherical microcavity-based membrane-free Fizeau interferometric acoustic sensor,10c)as an SEM-EDS sample matrix for embedded moon dust analysis,11 and d) for CCD and sensor cleaning.[12].

Biography

As a Wisconsin Distinguished Professor, James P. Hamilton founded two companies, is the Director of the UW System NCCRD Nano Research Center and is in the Chemistry department at the University of Wisconsin-Platteville in the USA. His research on precision contamination control in aerospace, photonic and astronomical optics has brought him to the summits of most of the large telescope sites in the world, including Hawaii, the Canary Islands, and China. His recent efforts have been focused on an $875K NASA research program for space telescopes has also led to new planetary protection research involving deep space missions. Following a B.A. and graduate work at the University of Maine-Orono in Natural Products, Inorganic Chemistry, and Surface Science, he completed a Ph.D. at UW-Madison in physical & analytical chemistry specializing in atomic, molecular, and optical physics. His research specializes in nanocomposite materials instrumentation development, nanoparticle thermodynamics, and. lecturing on research and collaborating all over the world, he also raised $4.3 million in investment funds for his companies, Xolve, Inc. and Photonic Cleaning Technologies, the manufacturer of First Contact Polymers, which has sales in 80 countries. He is a senior member of the American Physical Society and SPIE-The International Society for Optical Engineering, as well as the American Institute of Aeronautics and Astronautics (AIAA). He also is a member of the American Chemical Society, Sigma Xi, the Coblenz Society, and Sigma Pi Sigma (Honorary Physics Society). He also serves on the AIAA Space Settlement Technical Committee and as a coordinator and session chair for conferences like SPIE Optics and Photonics. He was also recently selected as the 2022-2024 Distinguished Lecturer for Sigma Xi, the international research honor society.

Electron Creation by Photon Annihilation According to Twin Physics

Anna Backerra

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Abstract

Twin physics is a new physical model in which the basic features of quantum mechanics and relativity theory are combined to a manageable, complementary description, reaching from sub-atomic to astronomic phenomena. The most important characteristics are the consideration of space as a finite physical item, the use of an elementary unit of potential energy and the use of geometry to make the results more accessible. The developed formalism is fully complementary, based on the concept that determinate and indeterminate aspects of phenomena are mutually independent and that they occur joined in nature such, that one of both dominates an observation and the other occurs as a small disturbance. The laws of Maxwell emerge from these basics, but, different from the classical view, in the physical reality the obtained magnetic fields are restricted to finite spaces.
The resulting twin physical descriptions in general are identified with elementary particles, the four forces of nature and other well-known phenomena. Also we have found descriptions of four distinct types of electrons, having features being unknown in classical physics. The first is a free electron; the second is a ground electron being one of the first two in a molecule; the third is a chemical electron being the most regular one in molecules; the fourth is a plasma electron.
The description of a plasma electron changes into that of a photon by taking a mirrored time description. The photon consists of a four- dimensional magnetic vector, attached to a point of space, and exists asymmetrically in a spherical magnetic space of molecular size. In the center of this surrounding magnetic space a potential electron is described. As soon as a mass approaches this system too closely, the photon will be annihilated and the potential electron appears as an actual electron. This implies that the absorption of the photon does not speed up an already existing electron, as is supposed in classical physics, but that the photon has been changed into a massless electron and so a new charge is generated. Thus, as soon as a photon comes close enough to a proton, the proton is transformed into an elementary solar cell.
After an introduction of twin physics without going deep into the theoretical basics, the description of the plasma electron will be explained and the step to the description of the photon is shown.

Biography

Anna Backerra has graduated in theoretical physics at the Eindhoven University of Technology in The Netherlands and worked for three years at Philips Research Laboratories. She continued independently, making a search for complementary physics. To develop a way of complementary thinking she studied composition at the Conservatory in Enschede and in Saint Petersburg. After that she constructed a complementary mathematical language and applied this on physics, obtaining twin physics. The surprisingly diverse results are published in Physical Essays (3 papers), Applied Physics Research (3 papers), Advances in Nanoscience and Nanotechnology (1), Int. J. of Nanotechnology & Nanomedicine (1), and combined in a book (Twin physics, the complementary model of phenomena, Lambert Academic Publishing, www.morebooks.shop). The most recent article is titled ‘Four types of electrons and their associated finite magnetic fields’.

Narrow Beam High Power Long Wavelength Lasers

Akihiko Kasukawa

Furukawa Electric Co., Ltd, Japan

Abstract

A semiconductor laser with single lateral mode is essential for telecommunication application utilizing single mode optical fiber. Especially, stable lateral mode operation with light output power ensures the high coupling efficiency into single mode fiber. High power as well as high efficiency operation is preferable for eco-system. Graded Index Separate Confinement Heterostructure (GRIN-SCH) was demonstrated experimentally to be effective for high efficiency operation, especially in GaInAsP/InP long wavelength region. It is found that the composition of GRIN-SCH layer effects the differential quantum efficiency. Buried Heterostructure (BH) provides the efficient confinement for both built-in refractive index difference and injection current. We demonstrated high light output power in single lateral mode operation exceeding 1W with a peak slope efficiency of 0.61 W/A was realized. A stable FFPs of 7 degrees in lateral and 12 degrees in perpendicular, respectively, were obtained. FFP shows almost independent of output power due to the built-in index difference between active layer and InP current blocking layer, which resulted in high coupled power of over 800mW in butterfly package at the temperature of 25C. We have achieved highly reliable operation, which is needed in telecom application. I will also describe the high-power operation of tunable lasers in my talk.

Biography

Akihiko Kasukawa received B.S, M.S and Ph.D. degrees in electrical engineering all from Tokyo Institute of Technology. He jointed Furukawa Electric Co., Ltd. At Furukawa, he has been engaged in R&D of long wavelength semiconductor lasers. From 1990 to 1991, he was at Bellcore for developing high performance QW lasers. He conducted R&D of high power lasers both 980nm and 1480nm for EDFA, widely tunable lasers based on arrayed DFB, and high rmance 1060nm VCSELs. He is a Senior Fellow at Furukawa Electric Co., Ltd. He serves IEEE Photonics Society as a Board of Governor. He is a General Chair of 28th International Semiconductor Laser Conference, track chair of Photonics West LASE. He served as a President of Electronics Society of the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan. He is Fellow of IEEE, Japanese Society of Applied Physics (JSAP) and IEICE of Japan.

Quantum Dot Mode-Locked Lasers for 5G and Beyond Wireless Networks

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Abstract

5G and beyond wireless networks are vastly improving high-speed Internet connectivity around the globe and opening the door to a revolution in the Internet of Things (IoT). There are already billions of IoT devices, but the wider bandwidth and more efficient spectrum usage of 5G & beyond will allow far more devices to operate in close proximity without interfering with one another. In order to achieve enhanced mobile broadband, ultra-reliable and low latency networks, the next operation band of 5G and beyond should be primarily in the millimeter-wave (mmW) range (30 to 300 GHz). Generation and distribution of mmW with traditional methods is limited by electronic bottleneck and associated complexity. Besides, mmW transmission over long distances is a real challenge. Consequently, broad bandwidth, simple, efficient, and cost-effective photonic mmW-over-fiber (mmWoF) transmission systems are solutions for future 5G & beyond wireless networks. The mmWoF link is also the best solution for the first and last mile 5G & beyond access networks. The spectral purity of mmW carriers is of high importance for future 5G & beyond. Numerous approaches have been proposed to generate pure mmW signals. Compared with other technologies, quantum dot (QD) mode-locked lasers (MLLs) have great advantages for mmW generation because the QD-MLLs with compact design, low power consumption and chip-scale integration capacity with silicon substrates can provide multiple highly correlated and low noise optical channels [1, 2]. Recently we have developed several InAs/InP QD-MLLs around 1550 nm with the channel spacing from 10 GHz to 1000 GHz and the output power up to 50 mW [3]. In my talk, I will present a buried heterostructure (BH) QD-MLL chip with 25 GHz channel spacing. This BH QD-MLL has a

compact design featuring low threshold current, high output power and flat broadband spectrum with 3-dB bandwidth of around 9 nm having 46 equally spaced highly coherent and low noise optical channels. The noise performance of each filtered individual channel of this BH QD-MLL is experimentally characterized with an optical phase noise of less than 466.5 kHz and an integrated average relative intensity noise (RIN) of less than -132 dB/Hz over the frequency range from 10 MHz to 20 GHz. Its RF beat note linewidth between any two adjacent channels is less than 3 kHz with a calculated time jitter of 5.53 fs. By using this BH QQ-MLL, we have successfully demonstrated 16-Gb/s (4-GBaud × 16-QAM) mmWoF optical heterodyne RF wireless signal delivery at 25.09 GHz with a total of 25.22 km standard single mode fiber (SSMF) and 0.5-m to 2-m wireless links achieving EVM and BER well below the standard requirements [4]. By using another InAs/InP QD laser we have experimentally demonstrated a 36-Gb/s mmWoF transmission link at 47 GHz through back-to-back and 25-/50-km of SSMF before the mmW carrier is optically synthesized remotely for data transmission and detection over up to 9-m wireless links achieving EVM and BER well below the standard requirements [5]. Those results indicate that monolithically integrated QD-MLLs with simple and compact design providing large number of highly correlated optical channels with low noise and high power performance can be a cost-efficient and promising solution for high capacity and high speed mmWoF transmission systems of 5G and beyond wireless networks.

Acknowledgments: The authors would like to acknowledge the support of National Research Council Canada's high throughput and secure networks (HTSN) research program.

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Biography

Dr. Zhenguo Lu is a Principal Research Officer, Team Lead of Photonics Devices and Project Leader of National Challenge Program "High-Throughput and Secure Networks (HTSN)" at Advanced Electronics and Photonics (AEP) Research Centre of National Research Council (NRC), Ottawa, Canada. He also serves as an Adjunct Professor at Department of Electrical

& Computer Engineering of both University of Ottawa and Concordia University in Canada since 2006. After obtaining his Ph.D. in 1992, he was the recipient of the Alexander von Humboldt (AvH) Research Fellowship to work at Institute of Semiconductor Electronics, RWTH Aachen, Germany from 1993 to 1995. Then he worked at Terahertz Research Centre of Rensselaer Polytechnic Institute, NY, USA for more than two years. Dr. Lu came to NRC as a Research Officer in 1997. From 2000 to 2002, Dr. Lu was the Director of Product Research & Development of BTI Systems Inc., Ottawa, Canada. He has re-joined NRC as a Senior Research Officer in 2002. Dr. Lu is an expert in the field of photonics devices and their applications in optical coherent networks, data center networks, 5G & beyond wireless networks and satellite communications. He has published over 250 refereed journal and conference proceeding papers, and 8 US patents. He has given over 50 invited talks in the international conferences, universities and industry companies. Dr. Lu is a Fellow of the Optical.

An X-ray Free Electron Laserseeding Optics in the Energy Range of 3.3-15 keV

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Abstract

A X-ray free electron laser (XFEL) is about 10-ordershigher brilliance than normal undulator radiation, and offer full coherent, ultra-short pulses of 10-100 fs. They find many applications, such as coherent diffraction image (CDI) for nanoparticles and recording movies of single molecules. Thedegreeof temporalcoherence of self-amplified spontaneous emission (SASE) is much less than the requirements for many applications which requirehigh time coherence. The use of an external laser light input oscillation method could improve the coherence, but tends to be more complex.We present a self-seeding scheme using X-rays from the first part of the undulator to seed the second part, based on a diamond single crystal monochromator and channel-cut Si(111) monochromator, This produces X-ray pulses with resolution increasedfrom1% to 0.01% of the bandwidth of first part undulator, and a temporal coherence increased by more than 10times. This design covers energy range 3.3-15 keV, 5-11 keV for a diamond and channel-cut Si (111) monochromator, respectively.

Biography

Dr. Xiaojiang Yu obtained his Ph.D. in synchrotron radiation applications from the University of Science and Technology of China in 2003. After graduation, he joined Singapore Synchrotron Light Source as a beamline scientist at SINS beamline National University of Singapore, Singapore. He has been long-term pursuing optical design for synchrotron radiation beamlines and spectrometers, and experimental study in the field of material science with techniques of photoemission spectroscopy (XPS), X-ray absorption (XAS), and X-ray magnetic circular dichroism (XMCD). He has designed and constructed a number of beamline optics in the energy range of EUV to hard X-ray, applied in spectroscopy, inelastic scattering, and EUV lithography optics test stand. He has been awarded excellent alumni of the National University of Singapore in 2020 and appointed as a Principal Research Fellow in 2022. He has published over 130 publications in various peer-reviewed scientific journals as well as a number of international conference proceedings and as a reviewer of over 10 international scientific journals..

Numerical Analysis of 3D Printing with Lasers

Dieter Schuocker

Vienna University of Technology, Austria

TU Wien/Austria and Argelas-Austrian Laser Association (www.argelas.at)

Abstract

3-D printing of metals with lasers is actually regarded to become one of the most important applications of high-power lasers since it has important advantages compared to conventional metal processing as immediate generation of a work piece just after design and others, as less consumption of material and energy and absence of any tool wear. The process option LMD-laser metal deposition uses material delivery by a wire or a powder jet moved across the work piece and molten down by the laser beam. With the advantage of nearly arbitrary dimensions. Nevertheless the building speed cannot compete with conventional manufacturing .In order to understand the limits of the latter building speed, modeling of the LMD process has been performed for printing with a CW beam with top hat mode based on an analytic solution of the heat conduction equation and the use of energy and mass balances. The latter model has then been evaluated for stainless steel using a laser power between 3 and 5 kW yielding a theoretical limit for the building rate of 400 cm 3 /h at a speed of 5 m/s. The latter limit is caused by the onset of boiling preventing any further temperature rise. Higher temperatures associated with enhanced building rates can possibly be reached with pulsed lasers due to mechanisms outlined in the actual paper.

Biography

Prof. Dr. Dieter Schuöcker is currently working at Vienna University of Technology in Austria, in 1965; he worked in Dip.-Ing.in Electr. Eng., TU Vienna and 1980 Voest Alpine Comp., Development of a Laser Cutting machine. In 1983, the Foundation of Argelas-Austrian Laser Association, a nonprofit industrial institution; Development of a revolutionary Multikilowatt CO2 Laser with coaxial geometry 1995 Full Prof. of Nonconv. Production, TU Vienna and 2009 Prof.em., Foundation of Upper Austria Laser Center Development of Laser-assisted bending, Temperature controlled laser hardening, 3D printing.

The NISQ and PISQ visions for the future of Quantum Computing

Koen Bertels

Computer Engineering Dept. University of Ghent, Belgium

Abstract

After spending 11 years in Quantum Computing as an academic computer engineer and given the impeding timeline of developing good quality quantum processing units, it is the moment to rethink the approach to advance quantum computing research. We should not forget that all computers are based on CMOS-transistors and that they are almost at the smallest size possible, nly. 2 nm. We are basically at the end of developing even more powerful computers.

This is why Quantum Computing is increasingly important. Currently, there are still many physical quit technologies in competition with each other and the quality of those semiconducting, superconducting, ion-traps,… quits is equally bad. In spite of these unsolved challenges for now, we need to start assessing internationally the impact of the occurrence of quantum computing in various scientific fields.

However, to this purpose, we need to use a complementary but quite different approach than proposed by the NISQ vision, which is heavily focused on and constrained by the physical computer engineering challenges.

That is why we propose and advocate the PISQ-approach: Perfect Intermediate-Scale Quantum computing based on a well-established concept of perfect qubits.

This will allow researchers to focus much more on the development of new applications by defining the algorithms in terms of perfect qubits and evaluate them on quantum computing simulators that are executed on supercomputers.

Whilst, this is not the long-term solution, it will enable universities and companies, alike, to accelerate the development of quantum algorithms, build the necessary know-how and thus addressing one of the key bottlenecks, within the quantum industry, that is the lack of talents.

Biography

Koen Bertels' scientific research focuses on quantum computing and more specifically on the definition and implementation of a scalable quantum computer system for any scientific and operational field. He is currently building a new team to continue working on all layers of the full stack which has been my work from the first day working on quantum computing. After starting 11 years ago on quantum computing, he has moved also strongly but not exclusively to the use of perfect qubits, which has no decoherence and no errors in the quantum gates performed on the qubits.

Widely Tunable, Pulsed, Narrow Bandwidth, Tm:YAP Laser for Medical Applications

Salman Noach1*, Daniel.Sebbag[1], Uzziel Sheintop[1], Eytan Perez[1], Rotem Nahear[1]

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Abstract

A Pulsed, narrow-band, tunable, end-pumped Tm:YAP laser for medical application is demonstrated. The 35 nm wavelength continuous tunability ranges from 1926 to 1961 nm, having a spectral linewidth of 0.15 nm FWHM. The tuning and spectral band narrowing were obtained using a pair of YAG Fabry-Perot Etalons. The laser was actively Q-switched using an acousto-optic modulator. At a repetition rate of 1 kHz, maximum energy per pulse of 2.3 mJ and a pulse duration of 29.5 ns were achieved, corresponding to a peak power of 80 kW. Pulse energy of mJ level was measured along with the whole laser tunability range. Slope efficiency of 31% was obtained for an absorbed pump power of 11.5 W. The combination of high pulsed energies and tunability in this special wavelength region with narrow bandwidth, allows this laser to be a suitable tool for biomedical, ablation results of different penetration depths versus wavelength will be presented.

Biography

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

Multiview Optical Projections Coupled with Filtering Strategies to Improve Reconstruction of Targets Hidden in Turbid Media

David Abookasis

EE Department, Ariel University, Israel

Abstract

Imaging objects hidden in turbid media, such as biological tissue, is challenged by the strong scattering of the media which resultsfrom discontinuities in the refractive index and variation in the size and density of the media components. Here, we present an efficient method to counter the effect of scattering noise and improve reconstruction of hidden objects. The method combines multiple speckle projections accompanied by multiple processing strategies. In the setup, the medium is illuminated by a laser beam and images of the object are obtained from multiple viewpoints using a lens array. In offline processing, each projection is digitally cropped, extracted from the array, filtered, qualitatively evaluated, and fused with the others into a single, average image revealing the shape of the object. A variety of setup conditions including medium turbidity, object shape, illumination state, and filtering processing are presented and compared here. We believe that this method has potential application in a broad range of scientific fields where target objects are obscured by scattering media.

Biography

Prof. David Abookasis is a faculty member in the Department of Electrical Engineering at Ariel University, Israel where is served as the head of the medical engineering program, deputy head of the Department, and the head of the Master's program. He joined the Department in October 2010 after post-doctoral fellow at the Beckman Laser Institute (BLI) of the University of California, Irvine (UCI). Prof. Abookasis's main research is in the area of optical medical instrumentation. He possesses a multi-disciplinary background combining engineering, optics, biomedical optics, and medical instrumentations. Prof. Abookasis holds a number of patents, is a winner of awards and scholarships, author of papers, and book chapters, and serves as a committee member in different professional associations.

Challenges toward Si Photonics Solid-State Fmcw Lidar

Toshihiko Baba

Yokohama National University, Japan

Abstract

Lightdetection and ranging (LiDAR) systems, which are 3D imaging sensors, have attracted great attention in conjunction with autonomous vehicles. In general, LiDAR systems for long and medium ranges use a mechanical beam scanner to send a high-density optical beam to target objects. In recent years, it has been actively researched to replace mechanical scanners with nonmechanical solid-state ones to make LiDAR systems more compact, fast, flexible, and stable. For example, optical phased arrays (OPAs) and focal plane arrays (FPAs) have been fabricated and demonstrated using a Si-photonics platform. As an alternative approach, we have developed a slow-light grating (SLG) beam scanner based on photonic crystal waveguides, which can also be fabricated using Si photonics. Photonic crystal SLG enable high-speed, high-resolution, and wide field-of-view 2D beam scanning via the thermo-optic effect at a fixed wavelength. This presentation reports a frequency-modulated continuous-wave (FMCW) LiDAR system on a chip by combining this beam scanner with Ge photodiodes for delay homodyne coherent detection. Emitting and scanning frequency-swept laser beam, point cloud images of $154 \times 32 = 4928$ points were obtained. The real-time operation and velocity imaging were also demonstrated using FPGA circuit. This device is expected to detect Lambertian targets over long distances in the 100-m class by reasonablyreducing chip and optics losses and suppressing internal noise components. Toward this purpose, this presentation also discusses possible reductions of optical losses in this LiDAR system, and compares its pros & cons with those of OPAs and FPAs.

Biography

Toshihiko Baba received his PhD Degree from Yokohama National University in 1990. He became an associate professor and a full professor of this university in 1994 and 2005, respectively. He has studied Si Photonics, photonic crystals, micro/nanolasers, and slow light. In these years, he is particularly developing Si photonics FMCW LiDAR incorporating a slow light grating beam scanner. He is a fellow of IEEE, Optica, and JSAP.

Advances in silica devices

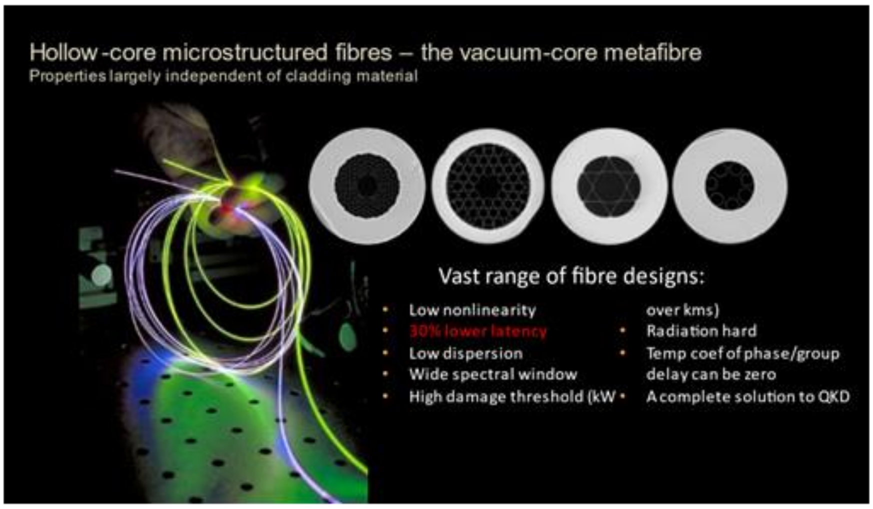
David N Payne

Director, Optoelectronics Research Centre,

University of Southampton, United Kingdom

Abstract

Conventional opticalfibres guide light through transparent solid glass cores. Since their invention in in the 1960s, they have become the backbone of global communications with around 500 million km installed every year. 45 years later, we have a new low-loss hollow core fibre (HCF).We are now able to the use air as the transmission medium with guidance provided by a carefully structured metamaterial in the fibre cladding. This provides all the advantages of solid fibres, but without the limitations associated with the core glass. We can have 30% lower latency, >1000 times lower nonlinearity and the potential for 30-50% lower propagation loss than conventional fibres. When commercially cabled and produced in large volumes, this will enable a significant increase in the transmitted data transmission capacity and reduction in the cost-per-bit, which will revolutionise global optical communications once again.



As you might expect from a “vacuum-core” fibre, its properties are extremely stable, suiting it to many applications such as sensors (gyros in particular), timing distribution and financial trading. Moreover, because it shares attributes with metamaterials, we have the additional geometric freedom to build in properties not found in nature, such as custom designed dispersion and loss windows well outside those of the constituent materials.

With the huge increase in data traffic comes a headache in how to store the information for the requisite period of time that is often mandated by banks and government – up to several hundred years. Once again, silica comes to the rescue and a new storage medium based on silica disks appears a leading contender to replace today’s tape units. The technique, known

as 5D storage because of the way each bit can be written and read, provides both high storage density and an extraordinary lifetime estimated at thousands of years.
The talk will outline some of the remarkable properties of these silica devices, together with the design space available.

Biography

Prof D. N. Payne is a research pioneer in photonics, having been in the field for over 45 years. Payne's contributions are acknowledged as seminal in many areas of optical telecommunications, one of the greatest scientific successes of the last three decades. His work spans many other areas of photonics, from optical sensors to nanophotonics and optical materials. He has made several of the key technical achievements in almost every area of optical fibre technologies and his work has had a direct impact on telecommunications, as well as nearly all fields of optical R&D. He is the most highly honoured UK scientist in photonics. Payne's pioneering work in fibre fabrication in the '70s resulted in almost all of the special fibres in use today. He led the team that in 1985 first announced the silica fibre laser and the Erbium-Doped Optical Amplifier (EDFA), the device that fuelled an explosive growth on the internet through its ability to transmit and amplify vast amounts of data. The EDFA is widely regarded as being one of the foremost and most significant developments in modern telecommunications. The fibre laser is now also undergoing rapid growth for application in manufacturing and defence. Payne led the team that to international acclaim broke the kilowatt barrier for fibre laser output. Unusually, David combines world-leading science with commercial activities and has been the driving force behind several spinout companies, creating wealth and employment in the surrounding area. He has been awarded the top American, European and Japanese prizes in photonics, a very rare achievement. He is a Fellow of the Royal Society, the Royal Academy of Engineering, the Russian and the Norwegian Academy of Sciences, the IET, the Optical Society of America and SPIE. He is also a Fellow of the Indian National Science Academy and the Indian Academy of Engineering.

Imaging through Scattering media: Applications in Lidar and Polarimetric Imaging

Santiago Royo

Director-Center for Sensor, Instruments and System Development, Spain

Abstract

Seeingthroughscatteringmedia (such as smoke or fog,butalsobiologicaltissue) has been a long desire of mankind, whichnoveloptoelectronicimagingdevicesmake possible. Severalimagingmodalities, from lidar to conventional RGB imaging, present stronglosses in performance whenscatteringmediaare present, singnificantlyreducingtheir performance . The questforautonomousvehicles,though,anditsassociatedsensorneeds,hasbroughttheissueforward as long as robòtic vehicles need be fullyperformant in all environmentalconditions, ncludingfog, smoke, smog or evensandstorms. Withinthiscommunicationwe'll present ourresearchactivities in imagingthroughscatteringmedia, whichhaveinvolveddiferent lines of activity. We'lldescribeourwork in polarimetric imagingthroughfog, includingthedevelopment of detailedpropagation models of polarimetric light in scatteringmediaandthecharacterization of thebehaviour of light in suchmedia. We'llalsoexplorethe performance of lidar imagers, and in particular of polarimetric lidar imagers, withinscatterngenviroments, showingpolarizationadds on an extra benefitwhichenhances lidar performanceinfog.We'llalsoexploretheuse of deeplearningalgorithms in order to developperceptiontechniquesthoughfog. Finally, we'llproposesolutionsbased on multimodal imaging for detectionandperception in all imagingconditions as a simple, notepensivesolution for imagingthroughscatteringenvironme nts, and show some relevant applications.

Biography

Santiago Royo, Ph.D., is currently a Full Professor in Optical Engineering at Universitat Politècnica de Catalunya, and Director of the CD6 (Centre for the Development of Sensors, Instrumentation, and Systems), a Research Centre devoted to research and innovation in the field of Optical Engineering. He is also a member of the Board of Stakeholders of Photonics21, and co-secretary of the Spanish Platform for Photonics Fotónica21. He is the author of over 80 peer-reviewed publications, and 7 book chapters, and has directed 11PhD Thesis. He has been a leading researcher in 63 research projects on Optical Metrology, publicly and privately funded, with a total income of 8,3M€. It is especially remarkable that he has filed a total of 17 patents, with 11 of them licensed to six different companies. He is co-founder of three photonics-based spin-off companies: SnellOptics(2002,Terrassa, Spain), devoted to marketing quality plastic optical components; ObsTech SpA (2012, Santiago, Chile) commercializing systems for internet-controlled telescopes, and Beamagine SL (Castellbisbal 2016), commercializing lidar and advanced imaging solutions. His current research interests are lidar imaging, imaging in scattering media, and Monte Carlo models of light propagation for polarized light n scattering media.

New Concepts for Fiber-Optical 3D Shape Sensing

Wolfgang Schade

Clausthal University of Technology, Fraunhofer HHI, Germany

Abstract

Fiber optical shape sensing is a technology that finds several applications ranging from medical catheter navigation over industrial endoscope tracking to monitoring of flexible tubes in oil and gas exploration. The dynamic range of bending radii covers millimeters up to several hundreds of meters. Compared to state-of-the art navigation technologies fiber-optical sensing has several advantages, such as immunity to electromagnetic fields, chemical resilience and high potential of miniaturization. However, multiple eccentric fiber Bragg gratings (FBG) applied in single or multicore fibers have shown not to be able estimating accurately the shape of complex bending structures. Reasons are bending-induced effects, torsion and temperature effects. On the other hand, recent investigations have shown that especially bending-induced effects also contain shape deformation information that can be used for reconstruction of shape. Applying deep learning models for the interpretation of complete spectral information will be used for a more accurate shape prediction. This new concept is done in collaboration with the group of Philippe Cattin from University of Basel, Switzerland. First results will be presented and discussed.

Biography

Wolfgang Schade is Professor at Clausthal University of Technology and Chair of the Department Fiber Optical Sensor Systems at Fraunhofer Heinrich Hertz Institute (HHI) in Goslar, Germany. His research interests are femtosecond laser materials processing and fiber sensors for applications in energy storage and conversion.

Are we wrong about the Michelson Morley experiment?

Hans Deyssenroth

University of Basel, Germany

Abstract

The answer could be yes, because of a small detail that has been overlooked for decades and that was not known in 1905. Lorentz, Poincare and Einstein assumed that photons behave like tennis balls shot onto a moving 45° board and get a lateral moment in the direction of motion along the x-axis. Therefore, the light beam in the Michelson Morley experiment (MME) from the half transparent mirror to the upper mirror in the y-axis is oblique (observed from a rest frame). But R. Feynman concluded that a mirror is a light source where new photons are emitted, and together with the second postulate of the STR this light beam should therefore be perpendicular to the direction of motion and parallel to the y-axis.

In this case there is no time dilation due to Pythagoras and the postulated length contraction would destroy the null result of the MME. Therefore, the application of the Lorentz transformation would be wrong, and the observed relativistic effects must have another cause,

E.g. by an interaction with the non-empty space. A time dilation without a length contraction would have great impacts to the Theories of Relativity, though there are overwhelming confirmations by complex experiments, because the physical basis to the mathematical space-time modeling by the Lorentz transformation would be wrong.

Several experiments with the newest technology are proposed to test this alternative view on the fundamental MM-experiment.

Biography

Hans Deyssenroth studied electrical engineering at the TH Karlsruhe in Germany and physics with a Diploma degree at the University of Basel in Switzerland. He worked as an IT manager and biometrician in the Pharma industry in Switzerland and was the co-author of about 20 publications. After retirement he studied again the basics of physics and got increasing doubts that the existing models are correct, though they have been verified by many and many fold experiments. Now he is proposing new experiments that could confirm these doubts and is thinking about alternative models that can explain the observed facts better.

The Speed of Light Might be not the Upper Limit for Communication

Pieter Dekker

Institute for Theoretical and Applied Micro Magnetics, The Netherlands

Abstract

At the on-line platform of Optics-2021 an interesting lecture was presented on the subject of the limits of optical communication. The notion was, that transmission over glass fiber will run against its limits. This was supposed to be related to the speed of light. A.C.M. Backerra had a remarkable inquiry as to why, in order to move the reasoning in a new direction. At the time, this discussion unfortunately was not continued.

In the field of entangled electrons, ample evidence exists that they are utilizing communication over a different channel than that of electromagnetic lightwaves, or that of its nano ingredient, the photon. In notably experiments the quantum state of entangled electrons are verified by optical means, measuring the state of emitted photons which are traveling long-distance over glasfiber. These photons seem to tell us that electrons keep their spin state, once established, “forever” and “however far separated”. Hence these electrons are supposed to be “in touch with each other”, even as their distance does not allow for electromagnetic communication, as the speed of light is far too low. It is very unsatisfactory to utilize entangled spins for quantum computing without understanding the above mentioned phenomenon and trying to formulate a healthy mathematical basis.

The speed of light seems to be not the upper limit for spin or dipolar particles to communicate. In this lecture the existing quantum theories and postulates, as well as too easy notions such as “Einstein was wrong”, are abandoned. A novel approach, based on Twin Physics is followed. This seems to give an explanation why certain types of magnetic spin are communicating much speedier than the speed of light.

Biography

Pieter Dekker, born in 1946 in Rotterdam The Netherlands, finished his studies in Applied Physics with honors at the institute now known as Eindhoven University of Technology. From then on, he worked on research of materials for deflection of laser beams by ultrasound and materials for use in Magneto-Optic memories. In 1974 he was granted the doctorate title by Delft University of Technology. He holds three patents in the field of magnetic memories and was co-author of a review volume on the Physics of Computer Memory Devices. From 1979 he worked in product development in the electronics industry and in the field of LCD displays. After his retirement, he became attracted to the physical background of quantum computing. Intrigued by the phenomenon of entangled electrons, he follows a theoretical path in the realm of Twin Physics to investigate the interaction between entangled quantum particles.

Digital and Optical Signal Processing for Fiber Communication Systems

Shiva Kumar and Xiaojun Liang

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Abstract

An optical back propagation (OBP) technique is investigated to compensate for nonlinear impairments in point-to-point fiber optic communication systems as well as in networks with reconfigurable optical add-drop multiplexers (ROADMs). An OBP module consisting of an optical phase conjugator (OPC), amplifiers and dispersion-decreasing fibers (DDFs) fully compensates for the dispersion and nonlinear impairments of a transmission fiber. The dispersion profile of the DDF is calculated analytically by demanding that the OBP module compensates fully the nonlinear impairments due to the transmission fiber. The OBP module can be placed after each transmission fiber (inline OBP case) or at each network node (node OBP case). Although the digital back propagation can compensate for inter-channel nonlinear impairments in point-to-point systems, it would be impossible to mitigate these effects in digital domain in fiber optic networks since the the channel path information is not available to the receiver. In contrast, OBP can compensate for inter-channel nonlinear effects in optical networks. Our simulation result shows that the OBP brings a significant performance advantage as compared to digital back propagation techniques in optical networks. In our simulations, non-ideal effects of the OBP module such as dispersion fluctuations of DDF, laser phase noise and relative intensity noise (RIN) of the laser used in OPC are included. We find that the node OBP outperforms the inline OBP since the noise introduced by the OPC in the case of inline OBP leads to performance degradations.

Biography

Shiva Kumar has completed his Ph.D. degree (1997) from Osaka University, Japan. He worked as a postdoctoral fellow at University of Jena, Germany, supported by Alexander von Humboldt Foundation from 1997-98. He worked at Corning Incorporated, NY as a Senior Research Scientist (1998-2001) .Currently he is a Professor at McMaster University, Canada. In 2001, he obtained circle of excellence award from Photonics Spectra, and R&D 100 award by R&D magazine. Dr. Kumar has published about 72 papers in refereed journals, authored a book on fiber-optics, 7 book chapters, edited a book on nonlinear fiber-optics, and holds 8 US patents.

Professor Kennel was awarded a doctor honoris causa (Dr. h.c.) from Universitatea Stefan cel Mare in Suceava (Romania), received the Harry Owen Distinguished Service Award from PELS, and the Distinguished Service and Outstanding Achievement Awards from EPE.

ILIDS Method for Long Range Measurements in Naval and Aeronautics Fluid Dynamics Experiments

Adelaida Garcia-Magariño, Suthyvann Sor, Javier Muñoz-Campillejo, Rafael Bardera

Experimental Aerodynamic Area at INTA, Spain

Abstract

Both in naval and aeronautical fluid dynamics experiments, tests are conducted in either wind tunnels or water channels where the instrumentation needs to be placed outside, and therefore the measurement range of the instrumentation used is large. In the case of the ILIDS technique, the main challenge of the implementation for long range measurement seems to be the minimum object distance needed and the degree of overlapping between droplets' interferograms. Due to the first limitation, and in order to comply with the Nyquist criterion and obtain successful droplet size measurements, a very high resolution is needed. On the other hand, to reduce the second limitation, a novel approach developed by the authors is presented. This approach is based on the droplets not being fully defocused, thus reducing its image size and minimizing the overlap problem. Therefore, two whole overlapping circles appear instead of the usual ILIDS circular interferogram, where the fringe pattern emerges within the overlap region. A novel image processing software and the experimental study conducted at the laboratory to assess their limitations is presented and discussed. This could be applied to study the interaction of biphasic flows on surfaces such as to measure the bubbles generated to reduce drag in ships.

Biography

Adelaida García-Magarino studied Aeronautical Engineering at the Polytechnic University of Madrid finishing her studies in November 2009. She started working at INTA in Spain in February 2010 as an external consultant and approved the exam to become a civil servant at INTA in November 2016, taking possession on December 15, 2017. When she started working, she also started the University Master's Degree in Aerospace Engineering that gave access to the doctorate, finishing the Master's studies in November 2011. He began his research career in the field of deformation and breakup of droplets in the vicinity of the leading edge of an airfoil for ice formation on aircraft wings, within the framework of INTA-NASA collaboration. In September 2014 she began her doctorate entitled "Water Droplet Deformation and Breakup in the vicinity of the leading edge of an incoming airfoil" directed by A. Velázquez at the Polytechnic University of Madrid, finishing her Ph.D. in November 2016. Since 2017, she has expanded her field of study to other areas of experimental aerodynamics and engineering such as aerodynamics on the deck of aircraft carriers, the flow field around the Martian Rover, the study of filters to be embarked on aerial research platforms, the ILIDS method for long-range measurements, or the naval hydrodynamics. She has participated in the projects PHOBIC2ICE (Super-IcePhobic Surfaces to Prevent Ice Formation on Aircraft), SENS4ICE (Sensors and certifiable hybrid architectures for safer aviation in ICing Environment), DFLOW (Droplet deformation and breakup in normal and super cooled conditions in aeronautics related flows), MICRAS (Scientific missions from manned and unmanned aerial platforms), ELECTROBIOTA (Development and implementation of sampling equipment for the study of airborne microorganisms at altitude: one stage electrostatic precipitators in Aerial Research Platforms), MEDA (Science and Technology of space instruments for the characterization of the martian environment in multiple NASA missions: REMS, TWINS and MEDA. Phase C/D), MINEOLICA (Promotion of small power wind technology), EnviroPlanet (Thematic Network of Micro- and Nano plastics in the Environment) and CAMELIA-MICRO (The Cycle of Aerosols on Mars and Earth, a comparative study. Implications for Life and Planetary Protection). Up to now, she has published more than 20 scientific papers in journals belonging to the JCR rank, she has participated in a patent and in works presented in more than 40 conferences.

Efficient SLG Optical Beam Scanner and 4D LiDAR Action

Saneyuki Suyama

Yokohama National University, Japan

Abstract

Doubly periodic photonic crystal waveguides with surface gratings, which we call slow light gratings (SLGs), work as high-resolution, wide-FoV and high-speed optical beam scanners. Efficient SLG enables Si photonics on-chip light detection and ranging (LiDAR), which can measure the distance of Lambertian scattering objects. High upward emissivity and narrow beam divergence are important for improving the performance of SLG. It is known that the upward emissivity can be enhanced by multi-layer grating waveguides. A narrow beam divergence is obtained by an appropriately low radiation coefficient in the direction along the waveguide. In the direction across the waveguide, a beam divergence within ±15° is required to facilitate collimation. In this study, we employed an SLG consisting of through-hole grating and shallow surface grating and optimized its structure for LiDAR applications using covariance matrix adaptive evolution strategy (CMA-ES) algorithm. We improved the upward emissivity from previous 60% to a maximum of 95% and almost adjusted the radiation coefficient to the required100 dB/cm. This emissivity reduces the round-trip loss by 4 dB in the on-chip LiDAR. Furthermore, operating this on-chip LiDAR based on frequency-modulated continuous-wave (FMCW) method enables velocity and vibration imaging from Doppler shifts as well as 3Dprofiles. We also succeeded in demonstrating such multimodal LiDAR operation for moving objects such as turntable, speaker and human.

Biography

Mr. Saneyuki Suyama received his B.E. degree from Yokohama National University in 2021, and now he is studying 4D LiDAR device fabricated by Si photonics at graduate school of the same university. He is a member of JSAP.

SSH Topological Photonics Integrated Circuit in Si Photonics

Toi Nakama

Yokohama National University, Japan

Abstract

In recent years, topological insulators, which behave like insulators in the bulk but produce metallic states at their edges, have attracted much attention in physics. As an analog Topological photonics, in periodic structures exhibiting photonic bands has also been studied widely. If its unique features, i.e., unidirectionality and robustness owing to topological invariants, can be realized, this field goes into device applications beyond the physical interest. In topological photonics, Su-Scrieffer-Heeger (SSH) model, which is one of the basic concepts of topological invariants? The SSH structure is a sequence of resonators with periodically modulated coupling constant. It shows edge modes with topological protection and bulk modes without topological protection. The distribution and localization of these modes has been investigated using topological laser with arrays of mirroring resonators, in which the robustness of the edge states localized at rings left behind with a weak coupling constant has particularly been discussed. However, there is no direct observation of localized mode profiles and bulk modes. In this study, we fabricated an SSH optical integrated circuit with 15 microring resonator arrays, each of which can be excited, tuned, and monitored externally. The device chip was fabricated using Si photonics CMOS process, and a compact module including the chip, wire bonding and fiber connection was constructed. We selectively excited one or some microrings and observed the internal modal profiles, which well agreed with simulated results of the topological states.

Biography

Mr. Toi Nakama is now studying topological photonics devices in Yokohama National University toward his B.E. degree. He is a member of JSAP.

Core-Shell Nanowire Lasers on Silicon

Bahram Nabet

Materials Science and Engineering, USA

Abstract

We report GaAs/AlGaAs core-shell nanowires (CSNWs) as-grown on Silicon substrate can lase at room temperature with optical pumping. We show that upward (absorption) and downward (emission) transition rates are enhanced due to one-dimensional (1D) electronic structure at vortices, and two-dimensional (2D) facets of these hexagonal CSNW and demonstrate the influence of dimensionality on optoelectronic properties of heterojunction CSNWs as sub-wavelength optical cavities. We discuss how the transition rates change with respect to electron distribution and identify changes in oscillation strength, joint optical density of states, and overlap wave functions as factors which contribute to orders-of-magnitude increase in transition rates. These results explain the great increase in optical gain and quantum efficiency of CSNWs, and enable new classes of sub-micron scale optoelectronic devices that can be formed on various substrates including Silicon.

Biography

Bahram Nabet is a Professor of Electrical and Computer Engineering at Drexel University, in Philadelphia, Pennsylvania, USA, with affiliated appointment in Materials Science and Engineering Department. His main research interest is in optoelectronic devices and systems. He approached this field by finding parallels between the interaction of light and matter in biological systems and in synthetic materials, resulting in one of the first integrations of photodetectors and neural networks circuitry based on models of insect vision. He has been working on unconventional optoelectronic devices for their use in very high-speed, very low-noise and low power applications, using reduced dimensional systems such as quantum wells, wires and dots. More recently he has combined transition metalcarbides or carbonitrides, 2D MXenes, with two-dimensional electron gas (2DEG) systems to produce photodetectors which overcome transit time as well as gain-bandwidth-product limitations. He is co-author of >200 refereed publications, and three books. The full e-book of his edited volume on Photodetectors, published by Elsevier in 2016 was downloaded >20K times, with its second edition scheduled for publication in 2022.

Photonic Crystal Nanolasers and High-Performance Biosensing

S. Hachuda

Yokohama National University, Japan

Abstract

High-sensitivity and easy-to-use biosensors are increasing importance for point-of-care clinics and early detection of serious diseases and infections. We have demonstrated a GaInAsP photonic crystal nanolaser biosensor simply operated by photo pumping. When biomolecules adhere to the nanolaser chip, the laser wavelength sensitively shifts. This is considered to be due to iontronic effects of the bimolecular more than the refractive index effect. Furthermore, the emission intensity and wavelength can electrically be controlled by putting the nanolaser chip inside a simple electro-chemical circuit. In this study, we investigated the biosensing performance of the photonic crystal nanolaser. First, we applied the nanolaser sensor to detecting prostate specific antigen (PSA) without the electro-chemical circuit. We tried the PSA sesing in pure sample and in impure sample, and detected 1 fM PSA with a selectivity of 10 billion. We confirmed the performance higher than widely-used standard enzyme-linkedimmunosorbent assay (ELISA). Such high sensitivity will be useful for checking the recurrence of prostate cancer from thechanges in ultralow concentration PSA after prostate cancersurgery. Next, we investigated the biosensing performance of the photonic crystal nanolaser with an electro-chemical circuit. We stabilized antibody (Ab) modification and antigen (Ag) detection in the nanolaser in a photo-electro-chemical circuit with an appropriate bias applied. Then, we cross-detected four different biomarker proteins, PSA, CRP, IL-6, and ferritin, with the same or different combinations of Ag and Ab. We also detected spike protein of COVID-19. We observed extremely low detection limit concentrations and sufficient selectivity and reliability in all the experiments.

Biography

Dr. Shoji Hachuda received his B.E., M.E., and PhD Degrees all from Yokohama National University in 2010, 2012, and 2016, respectively. He has studied biosensing applications of GaInAsP semiconductor nanolasers. Currently he is a posdoc of Prof. Baba's group and continuing the same research. He is a member of JSAP.

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Lasers, Optics & Photonics
November 10-11, 2022 | Valencia, Spain

On the Reliability of the Spectral Response of Photovoltaic Modules Using Bias and Modulated Light

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Abstract

Luminescent downshifting (LDS) is an optical approach to increase external quantum efficiency (EQE) and the power conversion efficiency (PCE) by using luminescent materials to convert high energy photons to lower energy ones just before light reach the solar cells stacking. The exploitation of LDS in real photovoltaic devices requires its implementation in photovoltaic modules. Values of EQE measurements in modules typically differ from those in single cells. In this work, within the frame of the project IDEAS, it is investigated a methodology to determine the spectral response and EQE values with modulated light measured in CdTe with size of 4x4 cm2 and amorphous Silicon. A modulated monochromatic spot of light illuminates one region at the central cell, added to a continuous bias light illuminating the whole module, it produces an increment of the EQE measurements by factor 3. Results of spectral response under large-area illumination by using arrays of LEDs with different band wavelength are also compared with the first method. Additionally, IV curves under solar simulator are also performed to determine PCE of those modules. The previous methodologies allow to determine the impact of the LDS in large-area modules.

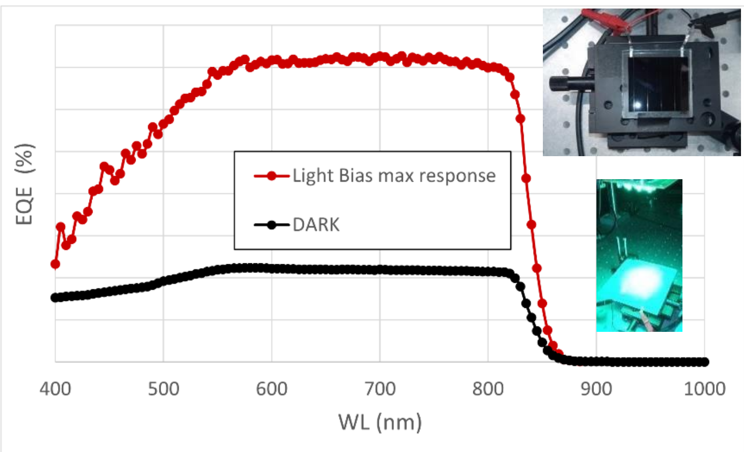

Figure: Plot of EQE with and without bias light.

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1. Non-Destructive Technique for Measurement of Quantum Efficiency of Encapsulated Solar Cells in PV Modules. K. Naga Bhavya Jyothi et.al. IEEE journal Proceedings 2019.
2. Non-Intrusive Cell Quantum Efficiency Measurements of Accelerated Stress Tested Photovoltaic Modules. Brett Knisely et. al. IEEE journal Proceedings 2014

Biography

Dr. Diego F. Gutiérrez Yatacue completed PhD. in Material Science with more than 10 years of experience in the research of functional materials. During the last stage of my career, I have had the opportunity to work on European projects in new photovoltaic technologies in order to improve the TRL of the devices. Previously, I had been involved in the optical characterization of organic mono layers interesting for optoelectronic. During my Ph.D., I acquired a background in photo responsive materials and low-power measurements.

New Photonic Technologies

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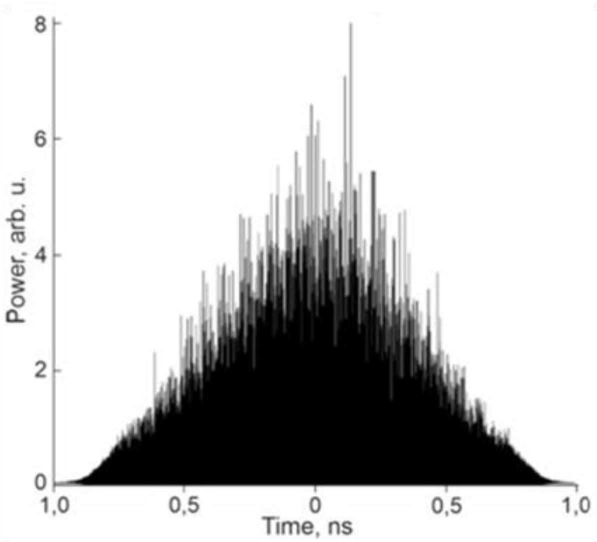
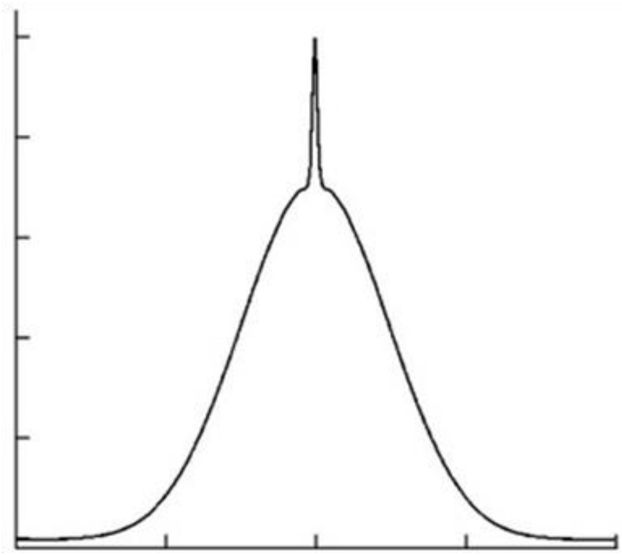
Abstract

Low-coherence pulses produced in regimes of noise-like pulse generation [1, 2] may become the basis of new photonic technologies. Noise-like pulses exhibit a number of peculiarities: they may carry fairly high energy and/or average power of radiation (up to 12 uJ [3]), they may be amenable to highly efficient non-linear conversion [4]. Despite their name, noise-like pulses may exhibit various degrees of radiation coherence. In essence, the degree of regularity of the electromagnetic field distribution within a noise- like pulse may vary. As an alternative to the classical approach to measurement of radiation coherence, in the case of noise-like pulses one may use an auto-correlation set-up for measurement of relative magnitude of the central narrow peak in the auto-correlation function of the studied pulses. Relatively fast characterisation of noise-like pulse properties will make it possible to use them in various applications, including development new photonic technologies relying on such pulses



Common Pattern Of Pulse



Common pattern of autocorrelation function

Fig. 1. Characteristic shape of noise-like pulse envelope and its autocorrelation function.

Optical pumping technologies:
One of the promising approaches is application of noise-like pulses as a more universal source of pumping radiation, which may be used for synchronous (or quasi-synchronous) pumping of lasers and/or amplifiers, for instance. This conclusion may be drawn not only on the basis of fairly high energy parameters of noise- like pulses produced directly in master oscillators, but also due to simplicity of their amplification up to the level of the average power exceeding 10 W and due to comparatively high slope efficiency of their generation. The generation efficiency of noise-like pulses cannot be called record-high, but in combination with relative simplicity of their amplification, such pumping may be practically justified.

Laser projection technologies:
Interference arising as a result of interaction between the reflected and incident radiation constitutes an unwanted effect in many applications related to laser imaging. A consequence of this interference is so called speckle pattern, a superimposed spotty structure that reduces the image quality. It is possible to form speckle-free images with incoherent radiation of noise-like pulses. Using noise-like pulses in laser projection systems will bring considerable improvement of image quality.

High-precision laser machining of materials:
Interference resulting from interaction between the leading portion of a pulse reflected from a metallic surface and its incident rear part may substantially alter the intensity of the incident radiation and detrimentally affect the quality of surface machining, making it noticeably non-uniform. Machining of materials with incoherent laser radiation is one of the new promising technologies. Development of a powerful source of incoherent laser radiation is required by many novel advanced technologies. The introduction of the necessary laser source may be envisaged within the coming 2–3 years.

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Acknowledgments:
This research was supported by the Ministry of Science and Higher Education of the Russian Federation (FSUS-2020-0036)

Relative Position and Attitude Measurement Method of Space Target based on TOF Camera

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Abstract

Attitude measurement is one of the important tasks of satellite attitude and orbit control in space missions. Spacecraft attitude measurement is divided into absolute attitude measurement and relative attitude measurement, which can be divided into starlight measurement and inertial measurement. In recent years, with the increasing complexity of space tasks, tasks such as space manipulation and space rendezvous and docking are increasing, and the relative pose measurement of space targets has become an important topic in space measurement tasks. At present, the commonly used spatial relative pose measurement methods include binocular cameras, laser rangefinders, and TOF cameras. Laser rangefinders can provide target distance information, and have the characteristics of low power consumption, low price, simple structure, and insensitivity to light. However, it needs to have strong target tracking and recapturing capabilities; binocular stereo vision has the characteristics of high resolution, low power consumption, and low price, but there are still short range, complex calibration, complex algorithm, poor real-time performance, Poor adaptability to light conditions. TOF (Time of flight) literally translates to "time of flight". The principle of ranging is to continuously send light pulses to the target, and then use the sensor to receive the light returned from the object, and obtain the distance of the target object by detecting the flight (round-trip) time of the light pulse. This paper mainly introduces the application methods of the TOF camera in the two scenarios of space rendezvous and space target measurement in detail, and shows the outstanding points of the TOF camera in the spatial relative pose measurement task and the technical defects that still exist. With the complexity and change of space tasks and the continuous upgrading of the intensity of space situation, new technologies continue to emerge, traditional technologies are rapidly iterated, and the measurement methods of relative spatial poses will inevitably move towards a diversified development direction. TOF cameras rely on its unique technical characteristics. And many advantages, destined to be an indispensable part of it. In several important space missions that have been launched, the advantages of TOF cameras have emerged. Since then, more and more important mission models have adopted the TOF camera method.

Nanostructures Open up a New Future for Optoelectronic Devices

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Abstract

Various nanostructures have been successfully developed to control the mechanism of photons, electrons, phonons, surface plasmon polariton and their interactions, led to whole new optoelectronic properties and provided the possibility to explore unique optoelectronic devices. This report reviews the achievements of our research group in this field. We discovered and verified that Cherenkov radiation (CR) could be excited in multilayer hyperbolic metamaterial no matter how slow the electrons moves (namely threshold-less CR), and realized on-chip free electron light source with wavelength covering 500~900nm at the electron energy only of 250~1400eV, which is two to three orders of magnitude lower than previous reports. The measured output light power reaches 200nW, which is two orders of magnitude higher than free electron light source reported using other nanostructures. On the other side, we proposed and demonstrated one-shot ultraspectral imaging by fitting thousands of micro-spectrometers on a chip with reconfigurable metasurfaces. Ultraspectral imaging (□□/□□0.001) coveringa 300- nm-wide visible spectrum with an ultra-high center-wavelength accuracy of 0.04-nm standard deviation and spectral resolution of

0.8 nm was reconstructed. More importantly, this scheme is based on CMOS-compatible processing technology completely and can be extended to almost any commercial camera with different spectral bands to seamlessly switch between image and spectral image. These studies show the potential of nanostructures. We are exploring further to make them bring more breakthroughs in the field of optoelectronic devices.

QuantumMechanical Method for Calculating the Permittivity of Rhodamine 6G

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Abstract:

The method for quantum-mechanical calculation of the dielectric permittivity of organic molecules is presented by using the example of Rhodamine 6G. Approbation of the technique was carried out in Matlab 2019. The values of permittivities for the frequency domains corresponding to absorption and fluorescence were obtained. A comparison was made with the permittivities obtained by numerical simulation in the Gaussian 9.0 program. The comparison showed good agreement between the data.

Keywords—Rhodamine 6G, Luminescence, Fermi's golden rule, dyes, phosphor permittivity, Yablonsky scheme.

Introduction (Heading 1)

Dyes include polyatomic molecules that have an intense absorption band in the visible and ultraviolet regions of the spectrum [1]. The structural basis of such molecules is benzene, pyridine or other rings [2]. Interest in such structures is dictated by the phenomenon of luminescence and by radiation that is excess over thermal and has a duration greater than the period of the light wave [3]. One of the most studied dyes is Rhodamine 6G. Exactly this xanthene dye ($\lambda \approx 0.5 - 0.7\mu m$) Rhodamine 6G is distinguished in the efficiency of laser radiation [4].

To understand the spectra of generation of laser radiation, it is necessary to construct a quantum mechanical model and suggest ways to verify it. This task is intended to be solved by this work.

Energy levels in dyes consist of singlet S and triplet T electronic states [5], which contain vibrational and rotational levels [6]. Schematically, the energy levels of the dye are shown in

Fig. 1. The energy state between vibrational levels is about 0.19 eV, and between rotational levels is about 0.01 eV [7]. If we take into account the broadening of the electronic energy level in the solution, it turns out that it is larger than the energy gap between the rotational levels. For this reason, rotational levels are not allowed, and the electronic states are practically continuous zones of allowed energy [8].

When a light is absorbed, the molecule makes a transition from the lower energy level S_0 to the excited level S_1. At the energy level S_1 a rapid thermal relaxation($\tau r \sim 10^{-12}$s) [3] of the molecule to the lower vibrational levels takes place, and then a spontaneous transition to the level S_0 with fluorescent radiation. Thus, in dye solutions, under optical excitation, it is possible to obtain a population inversion for the lower vibrational states of the S_1 band with respect to the upper vibrational states of the S_0 band, and to observe amplification of light at the frequencies corresponding to fluorescence. To create such a circuit, we can create a high-quality resonant structure [9–10], however, this approach requires the calculation of the Rhodamine 6G dielectric constant, which is the aim of this work.

Calculus Method

The large size of the dye molecule [11] determines the large value of the matrix element of the dipole moment μ of the molecule [12], since the electrons involved in the absorption of light are "smeared" almost over its entire volume. Consequently, the absorption coefficient $k \sim |\mu|^2$ [13] also has values that lead to a significant absorption of light in solutions even with a low carrier concentration, which gives the solution a color that is supplemented to the absorption spectrum. But it also implies the fact that with an increase in fluorescence associated with allowed dipole transitions $S_1 \rightarrow S_0$.

Modeling of such a mechanism of fluorescence that is associated with the permittivity will be carried out in the following way:

1. Let us represent the luminescence in Rhodamine 6G as a two-level scheme
2. Let us write the dipole moment operators for each transition, while presenting the wave functions for the particle in the ring [14]
3. The level population is calculated with the help of the Fermi Golden Rule [15]

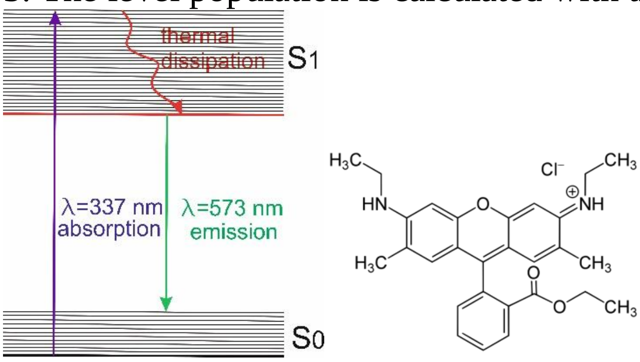


Diagram of Yablonsky of energy levels of Rhodamine 6G and its block diagram.

4. Let us apply the known relation to calculate the permittivity [16]
5. We will carry out the calculation using Matlab 2013 [17]
6. We will check using Gaussian 9.0 [18]

The permittivity of the medium, taking into account quantum mechanical effects, can be represented as [19]:

$$\tilde{\varepsilon} = 1 + \frac{32\pi^2 N\varepsilon_0}{3\hbar}\sum_j \frac{|\overrightarrow{d_{ji}}|^2}{\omega_{ji}^2-\omega^2+i\Gamma\omega} =$$

$$=1+\frac{32\pi^2\varepsilon_0}{3\hbar}\left[\frac{N_1|\overrightarrow{d_{13}}|^2}{\omega_{13}^2-\omega^2+i\Gamma\omega}+\frac{N_2|\overrightarrow{d_{21}}|^2}{\omega_{21}^2-\omega^2+i\Gamma\omega}+\frac{N_3|\overrightarrow{d_{32}}|^2}{\omega_{32}^2-\omega^2+i\Gamma\omega}\right] \quad (1)$$

where N is the population of the level
$\varepsilon_0$is vacuum permittivity
$\hbar$ - Planck's constant
d_{ji} - transition dipole moment operator
ω_{ij} - Frequency of transition from level i to level j

In the first approximation, we can consider the transition to excited vibration sublevels of the S_1 level with dipole moment d_{13} and transition frequency ω_{13}. Then it is followed by nonradioactive relaxation to the lower vibration sublevels of the S_1 level with dipole moment d_{32} and transition frequency ω_{32}. The last, radioactive, transition is carried out from the lower vibration sublevels of the S_1 level to the upper vibration sublevels of the S_0 level with a dipole moment d_{21} and a transition frequency ω_{12}. Herewith, the broadening of the energy levels depends on the lifetimes in states i and j [20]:

$$\Gamma = \frac{1}{2}\left[\frac{1}{\tau_i}+\frac{1}{\tau_j}\right] \quad (2)$$

The dipole moment operator is calculated from the volume of the entire molecule [21]:

$$d_{ji}=\left\langle\varphi_j\middle|\vec{d}\middle|\varphi_i\right\rangle=\int_V \varphi_j(ea+\vec{D}_s)\varphi_i \quad (3)$$

where a is the radius of the orbit of the excited electron and $\vec{D}_s$ is the dipole moment of the structure
The wave functions of a particle in a ring can be written in the following way [14]:

$$\varphi_n = \frac{1}{\sqrt{2\pi}}e^{in\frac{\vec{r}}{R}} \quad (4)$$

R-ring radius,
n=0, ±1,±2, … quantum numbers of state

$$\vec{d} = ea + \vec{D}_s \qquad (5)$$

The population of the N_1,N_2,N_3 levels is calculated with the help of the Fermi golden rule [22]:

$$W^{(1)} = \frac{2\pi}{\hbar}\left|V_{ij}\right|^2 \delta(\omega_j - \omega_i\omega) \qquad (6)$$

$$N_i = W^{(1)}\tau_i \qquad (7)$$

Where $\hat{V}_{ij}$ is the matrix element of the interaction of the incident wave with an electron can be calculated:

$$\hat{V}_{ij} = \frac{1}{2}\vec{E}\vec{d} \qquad (8)$$

The nonradiative transition is described by the third term in the formula (1) of the permittivity, taking into account thermal radiation, can be represented [22]:

$$\varepsilon = \frac{2}{\varepsilon_0}\frac{cu}{|E|^2} \qquad (9)$$

Where u is electromagnetic density of thermal radiation [22]:

$$u = \frac{h\omega^3}{\pi^2 c^3}\frac{1}{e^{\frac{\hbar\omega}{kT}-1}} \qquad (10)$$

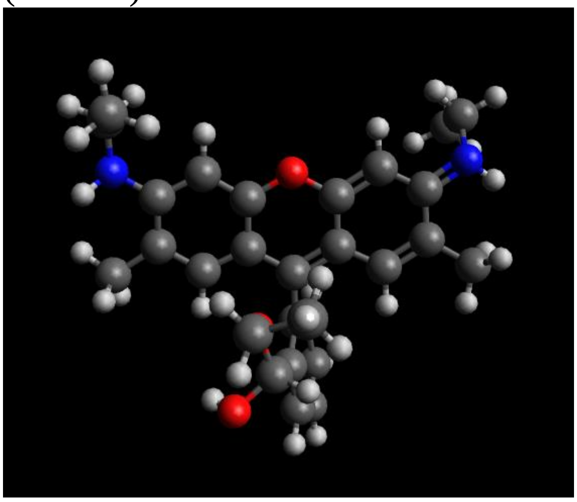
Where $k$is Boltzmann's constant.
T- Thermodynamic temperature
E - electric field tension can be found as a superposition of the electric field that is created by the nucleus and the rest of the core of electrons that do not participate in the radiationless transition.

Results and Descution
For the numerical calculation of the permittivity, a program was compiled in Matlab 2019. The input data for the program are given in Table 1.

Radius of the Rhodamin ring	9102e10 -9
Lifetime on the ground vibration S0 level	10e10-6 s
Lifetime on the S1 ground vibration energy level	10e10-8 s
Lifetime on the S1 higher vibration energy level	10e10-9 s
Absorption frequency	5.589e+ 15 s-1
Emission frequency	3.287e+ 15 s-1
Nonradiation transition frequency	2.302e+ 15 s-1

To verify the data obtained during the simulation in Matlab 2019, calculations were carried out in Gaussian 9.0. The structural scheme of the molecule is shown in fig. 2. The calculation was

carried out using a quantum-mechanical method based on the Hartree-Fock theory without imposing symmetry restrictions using the DFT functional, which is an economical method for including electron correlations with a three-parameter density functional - Becke3LYP (B3LYP).



The structural scheme of the moleculeRhodamine 6G.

The geometry was also optimized using the opt method using the basis set of cc-pVDZ orbitals. The calculated values of the permittivity that were carried out using the technique implied in Matlab and calculated in Gaussian 9.0 are shown in Table 2.

	B3YP/cc-pVDZ	Matlab
ε	2.85 (λ=337 nm)	2.89
ε	6.23(λ=573 nm)	6.27(λ=573 nm)

Conclusion:

The work is presented a method for numerical calculation of the dielectric using the quantum mechanical approach. The obtained data were compared with the calculations that were carried out using the Gaussian 9.0 program. The data obtained are in good agreement with each other, which confirms the correctness of the chosen numerical calculation method.

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