Mahindra University
Global Thinkers. Engaged Leaders.

ÉCOLE CENTRALE
SCHOOL OF ENGINEERING

Engineering Education 4.0
Lasers, Optics & Photonics

A VIRTUAL CONFERENCE

EE4.0

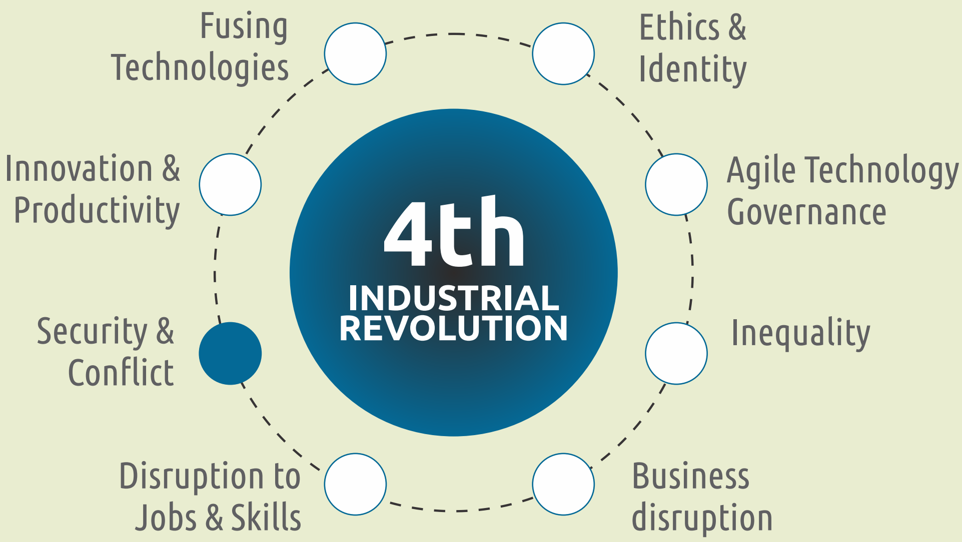
EVENT DATE
22 JULY, 2020
04.00 pm TO 09.00 pm IST

Engineering Education 4.0: Lasers and Optics & Photonics

Historically, the first industrial revolution began in 1712, which transformed hand-based to steam or water powered mechanized production for better productivity, while the second that began in late 1800 exploited electric power and new work culture for attaining mass-scale production e.g. automobiles.

Electronics and Information Technology along with computing and communication technologies underpinned the third industrial (or digital) revolution that began in 1950s and gathered pace in mid-1960s targeting automated production post-two world wars till about 2015.

According to the World Economic Forum, building on the digital revolution, the current emerging Fourth Industrial Revolution or 4.0, in short, is evolving at an exponential pace heralding in the transformation of entire systems of production, management, and governance.



Technologies/buzz words like Artificial Intelligence, Robotics, the IoT, Cloud Computing, Lasers, Fiber Optical Communication, Wi-Fi, Autonomous Vehicles, 3-D printing, Nanoscience and Technology, Biotechnology, Plasmonics, Artificial Materials e.g. Metamaterials, Energy Storage, Quantum Computing, and more, are going to play a major role.

These technologies have opened up huge opportunities for innovation and entrepreneurship and hence require a suitably trained and a diverse work force to handle these newest technologies.

This conference "Engineering Education 4.0: Lasers, Optics and Photonics" has been planned to emphasize and share with the audience a need for including appropriate topics in these areas in engineering education as many of the technologies mentioned above would exploit laser-based optics and photonics technologies.

Several high-profile scientists from around the globe have agreed to share their expertise and knowledge in these contemporary technologies as well as fundamental science that underpins these technologies.

The newly notified Mahindra University proudly announces this virtual conference to present a bouquet of state-of-the-art lectures as a pre-launch event before its formal launch as a research university on 24th July 2020.

Source: Adaptation/World Economic Forum

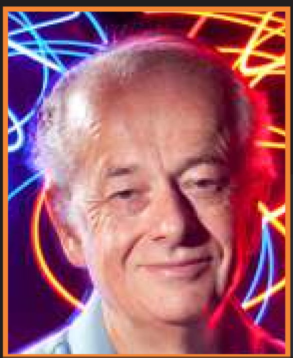
Speakers

KEYNOTE SPEAKERS

DONNA STRICKLAND
NOBEL LAUREATE - PHYSICS 2018
UNIVERSITY OF WATERLOO, CANADA

SIR DAVID PAYNE
DIRECTOR OPTOELECTRONICS RESEARCH CENTRE, UNIVERSITY OF SOUTHAMPTON, UK

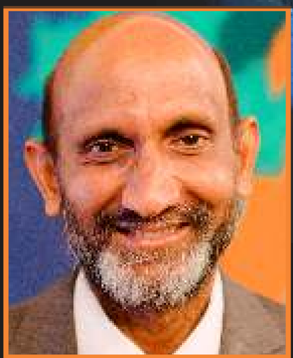
PLENARY SPEAKERS



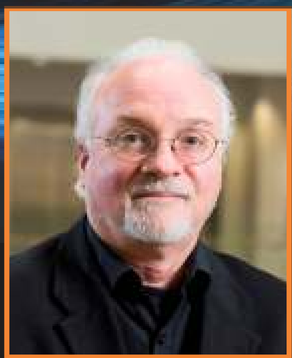
FEDERICO CAPASSO
Harvard University
USA

JOHN M DUDLEY
University Bourgogne Franche-Comté, France

KTV GRATTAN
City, University of London
UK



CHENNUPATI JAGADISH
The Australian National University, Canberra, Australia



WAYNE H. KNOX
University of Rochester
USA

AK SOOD
Indian Institute of Science, Bangalore, India

DONNA STRICKLAND

Donna Strickland is a Professor in the Department of Physics and Astronomy at the University of Waterloo and is one of the recipients of the Nobel Prize in Physics 2018 for developing chirped pulse amplification with Gérard Mourou, her PhD supervisor at the time. They published this Nobel-winning research in 1985 when Strickland was a PhD student at the University of Rochester in New York state. Together they paved the way toward the most intense laser pulses ever created. The research has several applications today in industry and medicine — including the cutting of a patient's cornea in laser eye surgery, and the machining of small glass parts for use in cell phones.

Strickland was a research associate at the National Research Council Canada, a physicist at Lawrence Livermore National Laboratory and a member of technical staff at Princeton University. In 1997, she joined the University of Waterloo, where her ultrafast laser group develops high-intensity laser systems for nonlinear optics investigations.

Strickland was named a Companion of the Order of Canada. She is a recipient of a Sloan Research Fellowship, a Premier's Research Excellence Award and a Cottrell Scholar Award. She received the Rochester Distinguished Scholar Award and the Eastman Medal from the University of Rochester. Strickland served as the president of the Optical Society (OSA) in 2013 and is a fellow of OSA, the Royal Society of Canada, and SPIE (International Society for Optics and Photonics). She is an honorary fellow of the Canadian Academy of Engineering as well as the Institute of Physics. She received the Golden Plate Award from the Academy of Achievement and holds numerous honorary doctorates. Strickland earned a PhD in optics from the University of Rochester and a B.Eng. from McMaster University.

DAVID NEIL PAYNE

David Neil Payne CBE FRS FREng is Director of the Optoelectronics Research Centre at the University of Southampton UK. His work has had a great impact on telecommunications and laser technology over the last forty years.

The vast transmission capacity of today's internet results directly from the erbium-doped fibre amplifier (EDFA) invented by David and his team in the 1980s.

His pioneering work in fibre fabrication in the 70s resulted in almost all of the special fibres in use today including fibre lasers. With US funding, he led the team that broke the kilowatt barrier for fibre laser output to international acclaim and now holds many other fibre laser performance records.

He has published over 650 Conference and Journal papers. As an entrepreneur David's activities have led to a cluster of 11 photonics spin-out companies in and around Southampton. He founded SPI Lasers PLC, which was acquired by the Trumpf Corporation of Germany.

He is an Emeritus Chairman of the Marconi Society and a foreign member of the Russian Academy of Sciences, the Royal Norwegian Academy of Sciences, the Indian National Science Academy and the Indian National Academy of Engineering.

David is a fellow of the Royal Society and the Royal Academy of Engineering.

FEDERICO CAPASSO

Federico Capasso is the Robert Wallace Professor of Applied Physics and Vinton Hayes Research Fellow in Electrical Engineering at the School of Engineering and Applied Sciences, Harvard University which he joined after a 27-year career at Bell Labs, where he was a researcher, department head and Physical Research VP.

He holds a Doctor's degree in Physics for the University of Rome, Italy. He pioneered band gap engineering of semiconductor heterostructures, leading him to the invention of the cascade laser. He did seminal work on metasurfaces including the discovery of the generalized laws of refraction and reflection and flat optics. He reported the first measurement of the repulsive Casimir force. He is co-author of over 600 papers. He holds 70 US patents and is co-founder of two startup companies EOS Photonics, now part of Pendar Technologies, and Metalenz.

His wards include the Balzan Prize, the Rumford Prize of the American Academy of Arts and Science; the Gold Medal of the SPIE, the King Faisal International Prize for Science, the IEEE Edison Medal, the American Physical Society Arthur Schawlow Prize, the Optical Society of America Robert Wood Prize; The Franklin Institute Wetherill Medal, the Material Research Society Medal, among many others.

He is a Member of the National academy of Sciences and National Academy of Engineering (US) and a Fellow of the American Academy of Arts and Sciences and of the National Academy of Inventors.

JOHN DUDLEY

John Dudley is a Professor of Physics at the University of Bourgogne Franche-Comté working at the CNRS Institute FEMTO-ST in Besancon, France.

His research covers broad areas of optical science and he has published extensively in fields of ultrafast source development, nonlinear optics, and extreme events and rogue waves. He has received a number of national and international distinctions, including the CNRS Médaille d'Argent, the Edgerton Award from SPIE, and the Wood Prize from OSA. He is a Fellow of OSA, IEEE, EOS, SPIE, IOP and an Honorary Fellow of the Royal Society of New Zealand. He has worked on international outreach initiatives with UNESCO since 2014, and currently chairs the International Day of Light Steering Committee.

KENNETH GRATTAN

Kenneth T.V. Grattan received the B.Sc. (Hons.) degree in physics in 1974 and the Ph.D. degree in laser physics from Queen's University, Belfast, UK in 1978 and the D.Sc. degree from City University in 1992 for his work in sensor systems.

After spending about 5 years at the Imperial College of Science and Technology as a Research Fellow he joined City, University of London in 1983 as a "new blood" Lecturer in physics and became a Professor of Measurement and Instrumentation there in 1991. He served City in various capacities as the Head of the department, Associate Dean, the Deputy Dean of the School of Engineering and the first Conjoint Dean of the School of Engineering and Mathematical Sciences and the School of Informatics. He was appointed the Inaugural Dean of the City Graduate School and as a George Daniels Professor of Scientific Instrumentation in 2013 and as the Royal Academy of Engineering Research Chair in 2014.

Prof. Grattan holds several patents for instrumentation systems for monitoring in industry using optical techniques and has authored/ co-authored over 700 refereed publications in major international journals and conferences and co-edited a five-volume topical series on Optical Fiber Sensor Technology. He received the Callendar Medal of the Institute of Measurement and Control in 1992, and twice the Honeywell Prize for published work, as well as the Sir Harold Hartley Medal in 2012 for distinction in the field of instrumentation and control.

Prof Grattan served as Chairman of the Science, Education and Technology of the Institution of Electrical Engineers (now IET) and the Applied Optics Division, Institute of Physics and was the President of the Institute of Measurement and Control during 2000. He has served on the Councils of all three of these professional bodies. He was elected as the President of the International Measurement Confederation in 2014, serving from 2015 to 2018. He was elected to the Royal Academy of Engineering, the U.K. National Academy of Engineering, in 2008 and received the national honour of Officer of the Order of the British Empire (OBE) in 2018 from Her Majesty the Queen.

CHENNUPATI JAGADISH

Jagadish is a Distinguished Professor and Head of Semiconductor Optoelectronics and Nanotechnology Group in the Research School of Physics, Australian National University.
He has served as Vice-President and Secretary Physical Sciences of the Australian Academy of Science during 2012-2016. He is currently serving as Past President of IEEE Photonics Society, Past President of Australian Materials Research Society. Prof. Jagadish is the Editor-in-Chief of Applied Physics Reviews, Editor of 3 book series and serves on editorial boards of 19 other journals. He has published more than 930 research papers (660 journal papers), holds 5 US patents, co-authored a book, co-edited 13 books and edited 12 conference proceedings and 17 special issues of Journals.

He has won the 2000 IEEE Millennium Medal and received Distinguished Lecturer awards from IEEE NTC, IEEE LEOS and IEEE EDS. He is a Foreign Member of US National Academy of Engineering, Fellow of the Australian Academy of Science, Australian Academy of Technological Sciences and Engineering, The World Academy of Sciences, US National Academy of Inventors, Indian National Science Academy, Indian National Academy of Engineering, Indian Academy of Sciences, IEEE, APS, MRS, OSA, AVS, ECS, SPIE, AAAS, FEMA, APAM, IoP (UK), IET (UK), IoN (UK) and the AIP.

He received many awards including IEEE Pioneer Award in Nanotechnology, IEEE Photonics Society Engineering Achievement Award, OSA Nick Holonyak Jr Award, Welker Award, IUMRS Somiya Award, UNESCO medal for his contributions to the development of nanoscience and nanotechnologies and Lyle medal from Australian Academy of Science for his contributions to Physics, Beattie Steel Medal from Australian Optical Society and IEEE Education Award from Electron Devices Society. He has received Australia's highest civilian honor, AC, Companion of the Order of Australia, as part of 2016 Australia day honors from the Governor General of Australia for his contributions to physics and engineering, in particular nanotechnology.

Speaker Bios

WH KNOX

Wayne H. Knox obtained BS (1979) and PhD degrees (1983) at The Institute of Optics, University of Rochester in Rochester, NY. He went to Bell Labs in Holmdel NJ in 1984 and worked as a Postdoctoral Fellow, was promoted to Member of Technical Staff in 1985 and to Distinguished Member of Technical Staff in 1990.

In 1997, he was promoted to Director of the Advanced Photonics Research Department where he was responsible for forward-looking research in a number of areas related to advanced technologies in telecommunications in long-haul, access and Metro networks. He is a Fellow of the Optical Society of America and a Fellow and Life member of the American Physical Society, in 1990 won the National Academy of Sciences W.O. Baker Award for Initiatives in Research.

In 1999 he won the Richtmyer Award for Physics teaching from the American Association of Physics Teachers. He has authored over 200 publications and has 51 or more patents granted or pending, and has chaired many international professional society meetings. In April 2001 he returned to The Institute of Optics as Director (2001-2011) and Professor of Optics where he currently carries out a research program in ultrafast nonlinear optics and applications in vision correction. He is also Professor of Physics, Materials Science and Vision Science, and Chief Science Officer at Clerio Vision, a company that he co-founded in 2014. He was recently inducted as Fellow of the National Academy of Inventors.

A. K. SOOD

A.K. Sood, FRS is Year of Science Chair Professor in Department of Physics at Indian Institute of Science, Bangalore. He was the President of the Indian National Science Academy (2017-2019), President of the Indian Academy of Sciences (2010-2012) and the Secretary General of The World Academy of Sciences (TWAS) (2013-2018). Currently, he is a member of the Science, Technology and Innovation Advisory Council of the Prime Minister of India.

Prof. Sood's research interests include Physics of Nano systems such as graphene and other 2D materials and soft condensed matter, with a strong focus on innovative experiments. The latter includes the flow behavior such as rheochaos, nonequilibrium phase transitions, deconstruction of glass physics using colloid experiments, active matter and stochastic thermodynamics. The experimental probes used for exploring physics at nanoscale are Raman spectroscopy, Ultrafast time resolved spectroscopies including terahertz spectroscopy, transport measurements and x-ray diffractions He has published more than 415 papers in international journals and holds a few national and International patents.

His work has been recognized by way of many honors and awards .These include the Fellowship of the Royal Society (FRS), all the three science academies of India and TWAS; the civilian honor, Padma Shri by Government of India, S.S. Bhatnagar Prize, G.D. Birla Award, TWAS Prize in Physics, FICCI Prize, Goyal Prize, M.N. Saha Award and Millennium Gold Medal of Indian Science Congress, Sir C.V. Raman Award of UGC, Homi Bhabha Medal of Indian National Science Academy, DAE Raja Ramanna Award of JNCASR, National Award in Nanoscience and Nanotechnology by Government of India, Nano Award by Government of Karnataka, G.M. Modi Award of Science and R D Birla Award for Excellence in Physics by Indian Physics Association. He is Associate Editor of ACS Nano and Executive Editor of Solid-State Communications.

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Physics, Mahindra University,
Hyderabad, India

ANURAG SHARMA
JC Bose Fellow, Emeritus
Professor, IIT Delhi, India

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Moderator: **Bishnu P Pal**
Dean (Academics),
Mahindra University, Hyderabad, India

PROGRAM

ENGINEERING EDUCATION 4.0: LASERS, OPTICS & PHOTONICS
(A Virtual Conference)

INAUGURATION: 22nd JULY, 2020 / 4.00 pm – 4.10 pm

Session I - Nanophononics and Light-Matter interactions [4.10 pm – 5.20 pm]
Chair: **Anurag Sharma**, J C Bose Fellow, Emeritus Professor, Physics Department IIT Delhi, India

Plenary talk 1: **Chennupati Jagadish**, Past President of IEEE Photonics Society, Australian National University Canberra Australia - 4.10 pm - 4.45 pm (Australia: 8.40 pm – 9.15 pm)
Semiconductor Nanowires for Optoelectronics and Energy Applications

Plenary talk 2: **Ajay Sood**, FRS, Past President of Indian National Science Academy - New Delhi, Indian Institute of Science Bangalore, India - 4.45 pm -5.20 pm
Unravelling Dance of Electrons and Atoms in Solids using Ultrafast Spectroscopy

Session II - Lasers in optical sensing and fundamental research [5.20 pm - 6.30 pm]
[BST 12.50 pm – 2.00 pm]
Chair: **Brian Culshaw**, Past President SPIE, EEE Department, University of Strathclyde, Glasgow UK

Plenary talk 3: **Ken Grattan**, OBE, City, University of London, UK - 5.20 -5.55 pm (BST: 12.50 pm – 1.25 pm)
Optical fiber sensors: better solutions for Challenging Industrial Measurement Problems

Plenary talk 4: **John Dudley**, Chair of IDL2020 Steering Committee, University of Bourgogne Franche-Comté, CNRS Institute FEMTO-ST in Besancon, France - 5.55 pm – 6.30 PM (France: 2.25 pm – 3.00 PM; BST 1.25 pm - 2.00 pm)
Light, Lasers and the Nobel Prize

Session III - Exotic lasers and Biophotonics [6.30 pm - 7.40 pm]
Chair: **Dibakar Roy Chowdhury**, Physics Department, Mahindra University Hyderabad India

Plenary talk 5: **Federico Capasso**, SEAS, Harvard University, Cambridge, Boston, USA - 6.30 pm – 7.05 pm (EDT: 9.00 am – 9.35 am)
From quantum cascade lasers to compact widely tunable molecular lasers spanning the THz gap

Plenary talk 6: **Wayne Knox**, Institute of Optics, Rochester, NY, USA - 7.05 pm – 7.40 pm (EDT: 9.35 am – 10.45 am)
Nonlinear Optics and Femtosecond Lasers Power Non-invasive Vision Correction

Session IV - High-power Lasers & Optical Fiber Internet [7.40 pm – 8.50 pm]
Chair: **Ajoy Ghatak**, M N Saha Distinguished Chair Professor of NASI and Former Professor IIT Delhi

Keynote talk 1: **Donna Strickland**, Nobel Laureate, Department of Physics and Astronomy, University of Waterloo, Ontario, Canada - 7.40 pm – 8.15 pm (EDT: 10.45 am – 11.20 am)
From Nonlinear Optics to High-Intensity Laser Physics

Keynote talk 2: **Sir David Neil Payne**, ORC, University of Southampton, UK - 8.15 pm – 8.50 pm (BST 3.45 pm – 4.20 pm)
Silica and the Global Internet

VALEDICTORY: 8.50 pm -9.00 pm

From Nonlinear Optics to High-Intensity Laser Physics

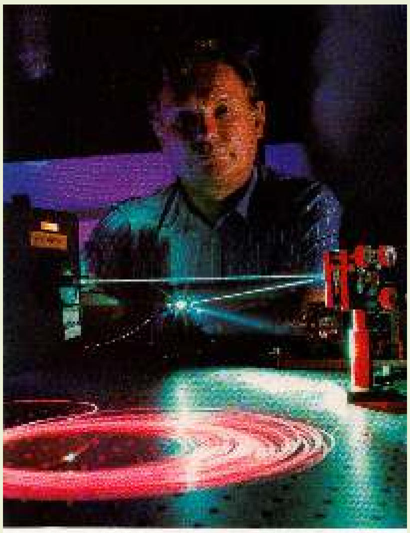
Donna Strickland
Department of Physics & Astronomy
University of Waterloo (Nobel Laureate), Ontario N2L 3G1 Canada
email: strickland@uwaterloo.ca /
https://uwaterloo.ca/physics-astronomy/people-profiles/donna-strickland

The laser increased the intensity of light that can be generated by orders of magnitude and thus brought about nonlinear optical interactions with matter. Chirped pulse amplification, also known as CPA, changed the intensity level by a few more orders of magnitude and helped usher in a new type of laser-matter interaction that is referred to as high-intensity laser physics. In this talk, I will discuss the differences between nonlinear optics and high-intensity laser physics. The development of CPA and why short, intense laser pulses can cut transparent material will also be included. I will also discuss future applications.

Silica and the Global Internet

David N. Payne
Optoelectronics Research Center, Southampton University
Southampton, UK, SO17 1BJ email: dnp@orc.soton.ac.uk
https://zepler.soton.ac.uk/people/dnp

The internet is perhaps the most important and life-changing invention of the 20th century. It required the invention of a new global communication medium capable of carrying vast quantities of information across trans-oceanic distances, reliably, cheaply and efficiently. Unpredictably, this turned out to be optical fibres made from the two most common elements of the earth's crust, silicon and oxygen (silica). As the internet traffic grows by some estimates at 60%/annum there is constant pressure to find more fibre capacity, although at $8/km the option remains to simply install more fibre, rather than find better fibres. However, in some applications where small volume, reduced transit time or better phase stability is critical, there will be a role for advanced designs such as hollow-core or multi-core fibres. Transit time and stability is becoming increasingly important for global timing, time-stamping for financial trading, 5G wireless (where the density of masts is determined by the delay between them) and autonomous vehicles.



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. A new storage medium based once again on silica 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 the extraordinary lifetime estimated at 1020 years.

The parallel field of high-power fibre lasers also relies on silica fibre. This field has seen a revolution in industrial laser processing and the market has grown to several $B/annum. Because of its robust, monolithic nature and its efficiency, the fibre laser is finding favour in defence applications as well. With its extraordinary combination of low expansion coefficient and high optical damage, silica is the unassailable material of choice for this hugely important industrial market.

Light, Lasers and the Nobel Prize

John M Dudley
Department of Optics, Institut FEMTO-ST, CNRS-University of Franche-Comté
15B Avenue des Montboucons, Besançon, France email: john.dudley@univ-fcomte.fr
https://members.femto-st.fr/john-dudley/en

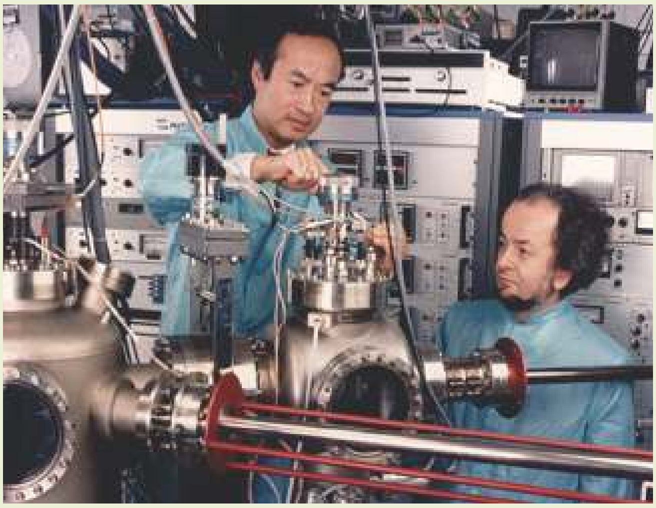
The Year 2020 represents the 60th anniversary of the first successful operation of the laser, and is a timely reminder of how basic science has the power to impact dramatically on society. Indeed, the United Nations now recognizes the date of first laser operation as the International Day of Light,

celebrated annually on 16 May. The 60th anniversary of the laser provides an ideal occasion to reflect on the many ways that lasers have revolutionized the world. Moreover, from a fundamental perspective, light science and technologies are key components of basic research, and are regularly recognized at the highest level by award of the Nobel Prize. This talk will review some elements from the history of the laser, which will take us on a tour of 120 years of Nobel Prize history, allowing us to appreciate how the study of light has allowed us to understand the world around us - from the fundamental properties of atoms to the cosmological scale and the study of new exoplanets orbiting distant stars.

From Quantum Cascade Lasers to Compact Widely Tunable Molecular Lasers Spanning the THz-gap

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

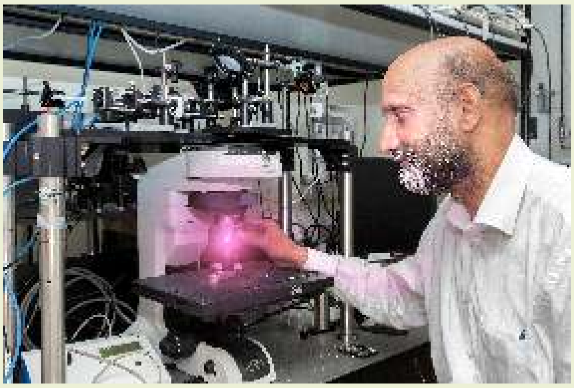
Quantum Cascade Lasers have become in the last ten years the dominant source of mid-IR radiation



with a wide range of applications in the molecular fingerprint region. The THz region (100 GHz to 3 THz) has on the other hand been conspicuously devoid of suitable efficient compact and tunable lasers. We have realized compact, widely frequency-tunable, bright THz lasers: gas-phase molecular laser based on rotational population inversions optically pumped by a quantum cascade laser. By identifying the essential parameters that determine the suitability of a molecule for a terahertz laser, almost any rotational transition of almost any molecular gas can be made to lase. Nitrous oxide is used to illustrate the broad tunability over 37 lines spanning 0.251 to 0.955 terahertz, each with kilohertz linewidths. Our analysis shows that laser lines spanning more than 1 terahertz with powers greater than 1 milliwatt are possible from many molecular gases pumped by quantum cascade lasers. We expect a wide range of scientific and technological applications to be opened by such lasers.

Semiconductor Nanowires for Optoelectronics and Energy Applications

Chennupati Jagadish
Research School of Physics
The Australian National University, Canberra, ACT 2601, Australia
email: c.jagadish@ieee.org
https://physics.anu.edu.au/contact/people/profile.php?ID=106



Semiconductors have played an important role in the development of information and communications technology, solar cells, solid state lighting. Nanowires are considered as building blocks for the next generation electronics and optoelectronics. In this talk, I will introduce the importance of nanowires and their potential applications and discuss about how these nanowires can be synthesized and how the shape, size and composition of the nanowires influence their structural and optical properties. I will present results on axial and radial heterostructures and how one can engineer the optical properties to obtain high performance lasers, THz detectors, solar cells and to engineer neuronal networks. Future prospects of the semiconductor nanowires will be discussed.

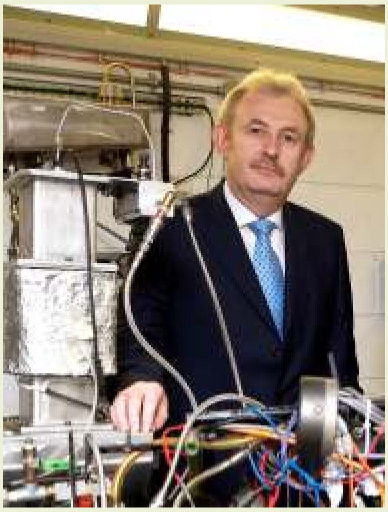
Nonlinear Optics and Femtosecond Lasers Power Non-invasive Vision Correction

Wayne H. Knox
Professor of Optics, Physics, Materials Science and Vision Science
University of Rochester, and Chief Science Officer Clerio Vision, Inc. Rochester NY 14627
email: wknox@optics.rochester.edu
www.whknox.com

The field of femtosecond micro-machining has rapidly grown from early observations of laser induced damage in various materials to an important application area today. In this talk, I discuss one specific application area: vision correction. We have demonstrated that focused femtosecond laser pulses over a wide range of laser parameters such as wavelength, repetition rate, power, pulse width and numerical aperture can produce strongly localized refractive index changes in important ophthalmic materials such as human cornea and hydrogels for custom contact lens and adjustable intraocular lens applications. We discuss a nonlinear optics-based photochemical model that we have developed. It has been successfully applied over a wide range of parameters. We also discuss device results sand applications.

Optical Fibre Sensors: Better Solutions for Challenging Industrial Measurement Problems

K T V Grattan and T Sun
Photonics & Instrumentation Research Centre
City, University of London London, EC1V 0HB, United Kingdom
email: K.T.V.Grattan@city.ac.uk
https://www.city.ac.uk/people/academics/ken-grattan



Optical Fibre Sensors have been developed extensively now over some four decades – created to address a range of challenging industrial applications where conventional sensors often are badly conditioned for important monitoring needs. Systems are required to enhance safety, to allow assets to be used for longer, to schedule repair and maintenance better and to create a more cost effectively and improve the working environment for us all. As an example, the demands of electric and autonomous transport, be it on land, sea or air, as well as energy generation and distribution and robotics make enormous demands for better sensor systems.
This talk will review the essential background to and history of optical fibre sensors and then look at how a range of optical fibre-based techniques can be applied to problems such as those highlighted and offer alternative, and better solutions to those from current technologies be they electronic, hydraulic, electrochemical, and analogue or digital – revealing solutions which have the potential readily to be adopted by industry. The work will review a number of 'case studies', where working in collaboration with industry and researchers across the world, new and practical solutions to key problems have been found and implemented in-the-field, not just as laboratory demonstrations.

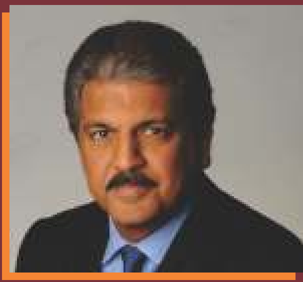
Unravelling Dance of Electrons and Atoms in Solids Using Ultrafast Spectroscopy

A.K. Sood
Department of Physics, Indian Institute of Science
Bangalore, India.
Email: asood@iisc.ac.in
www.physics.iisc.ac.in/~asood

In recent years, ultrafast time-resolved spectroscopies have proved to be excellent probes to understand photo-physics of quantum materials - be it in bulk or in nano-dimensions. Ultrafast lasers offer unique possibilities to control and probe transient processes in nano materials. Following photoexcitation by a femtosecond laser pulse, the carrier dynamics includes many important processes like thermalization, energy relaxation, exciton formation and spin dynamics which are impacted by dimensionality. Their understanding is crucial not only for many optoelectronic applications, but also to gain a deeper understanding of physical processes in nanomaterials.

My talk will discuss our recent work on a novel system, namely an excitonic insulator (EI) which hosts a condensate of electron-hole pairs in its ground state. We use a spatially resolved pump-probe microscopy technique to investigate the propagation of photoinduced excitations in a proposed EI, Ta2NiSe5. Below the critical temperature for the EI phase (328 K), we observe the propagation, for distances of up to 1 m, of coherent oscillatory modes at velocities typical of electronic excitations [1]. We show that the origin of this effect is the mixing between the phonon mode and the phase mode, which supports the excitonic origin of the ordered state in Ta2NiSe5.

[1] Paolo Andrich, Hope M. Bretscher, Yuta Murakami, Denis Gole, Benjamin Remez, Prachi Telang, Anupam Singh, Luminita Harnagea, Nigel R. Cooper, Andrew J. Millis, Philipp Werner, A. K. Sood, and Akshay Rao, arXiv:2003.1079902 (March25,2020)



VINEET NAYYAR
Chairman, Mahindra Educational Institutions
Chairman, Executive Committee, MEC

ANAND MAHINDRA
Chairman
Mahindra Group

CP GURNANI
Member, Executive Committee (MEC)
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Engineering Education 4.0
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