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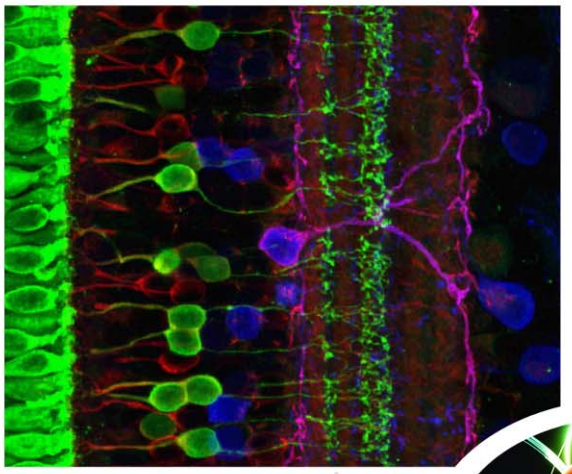

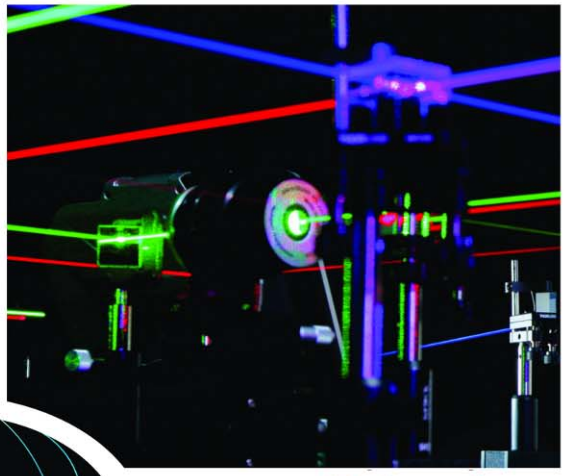

International
LightSciences

School on
and Technologies

ISLiST

June 25-29, 2018

Santander (Spain)

# Core: Light in Communications and Sensing


DIRECTOR:

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# Summary

Photonics is the science and techniques of generating, controlling, propagating, storing and detecting light waves and photons, which are particles of light. Photonics is the field of Light Sciences and Technologies.

Light plays a vital role in our daily lives and is being an imperative cross-cutting discipline of science in the 21st century. It has revolutionized medicine, made possible international communication via the Internet, enabled sustainable development and provided solutions to global challenges in education, energy, environment and agriculture. It continues to be a key discipline to link cultural, economic and political aspects of the global society. Today, it is widely accepted that the present century will depend as much on Photonics as the 20th century depended on electronics.

The United Nations Organization (UN) has recognized the **key or essential** role of Light Sciences and Technologies to raise global awareness and proclaimed 2015 as the International Year of Light and Light-based Technologies (IYL 2015). Aware of the key role of Photonics in the economies and in the societies of the XXI century, the UIMP has decided to create the "**International School on light Sciences and Technologies (ISLiST)**".

This school is envisioned to be a worldwide top International forum (every fourth week of June) on *Light Sciences and Technologies* in the framework of a *"special top university" that is recognized as the "university of universities"* and in a privileged environment "the Royal Magdalena Palace" in Santander, Cantabria, Spain. Each edition of this international school will have an intensification or main core in a specific application area and additional current hot topics. ***Light in communications and sensing*** is the core of this 2018 edition.

ISLIST has been conceived as a great opportunity to review, actualize and improve the knowledge of ***scientists, professionals and technicians***; to contribute to the education and to enhance the motivation of ***PhD students***; to offer an ideal frame for ***networking*** and also to contribute to the education of the **citizens.** It is also a great opportunity to ensure that **policymakers, entrepreneurs**, and other key "actors" will be aware of the problem-solving potential of Photonics.

Sixteen (16) **highly renowned** professors and researchers from the most prestigious worldwide institutions and, as well, presidents of the most reputed international Photonic Scientific Organizations and some politicians will participate in this meeting.

The City Council of Santander, will offer to ISLIST attendees a **Reception** at the Royal Palace of Magdalena**.** This Santander Happy Hour (with snacks and drinks) will be an optimum time to networking.

In this edition, the UIMP has distinguished Prof. **Yablonovitch** with its **Doctor Honoris Causa**. This prestigious honor will be given at a solemn ceremony to be held in the Royal Hall of the Palace of Magdalena at the end of the morning, June 28, 2018.

To be able to reach this ambitious program this International School of UIMP is supported by several sponsors: **Gobierno de Cantabria**, **Fundación ACS,** the **Optical Society of America, OSA** and **ENSA.**

It is also supported by several collaborators such as: the Spanish Optical Society, **SEDOPTICA**; **AMBAR Telecommunications**, **Fyla Lasers**, **B-Phot Brussels Photonic Team, Alava Engineers**, **OZ Optics, INNOVA Scientific**, ERZIA, Semicrol, **Hotel Santemar** and the **Photonics Engineering Group** of the University of Cantabria.

Without these Sponsors and Collaborators, this top quality school and over 26 International Student Grants (already allocated from over 18 different nationalities) would not have been possible. The UIMP, the direction of this event and the scientific community using Light are grateful with the generosity of all these Organizations and all the Invited Speakers. Thank you so much!

## Goals

To actualize and improve the knowledge of ***scientists, professionals and technicians***; to contribute to the education and to enhance the motivation of ***PhD students***; to offer an ideal frame for ***networking***. It is also a great opportunity to ensure that policymakers, politicians and common citizens become aware of the problem-solving potential of Photonics.

## Overview

The event will take place from Monday (June 25, 2018) to Friday (June 29, 2018). The first part of the week will be focused on key subjects concerning Light in Communications, while the second part of the week will be focused on key subjects concerning Light in Sensing. As an important technology for communications and sensing, a special session on photonics crystals is programmed with the two inventors of the technology that, probably, will be the first time that both speakers are invited for the same session. It is planed that both researchers will be proposed as a join candidature for the Princesa de Asturias 2018 award that is being promoted by this ISLIST director. Two round tables looking for Challenges on Optical Communications and Photonic sensing are also planned.

# General Schedule

| Time | Monday 25th | Tuesday 26th | Wednesday 27th | Thursday 28th | Friday 29th |
|---|---|---|---|---|---|
| 9:30 | | Prof. **Sir John Pendry**<br>**Inventor of the Metamaterials**<br>Imperial College London, UK | Prof. **JM López Higuera**<br>**Head,** Photonic Engineering Group<br>University of Cantabria, Spain | Prof. **Hugo Thienpont**<br>**Director**, Brussels Photonics Team, Vrije Technology, Belgium | **Photonic Crystal´s** Special Session<br>Prof. **Eli Yablonovitch**<br>**Director,** NSF Center for Energy Efficient Electronics Science Univ. of California, Berkeley, USA |
| 10:15 | **Opening Remarks** | | | | |
| 10:40 | **Coffee Break** | **Coffee Break** | **Coffee Break** | **Coffee Break** | **Coffee Break** |
| 11:00 | **Opening talk**<br>Prof. **Sir John Pendry**<br>**Inventor of the Metamaterials**<br>Imperial College London, UK | Prof. **Harald Haas**<br>**Director,** LIFI Research Development Centre, Scotland, UK | Dr. **Nikolaus P. Schmitt**<br>**Senior Researcher,** Airbus Group Innovations Muenchen, Germany | Prof. **David D. Sampson**<br>**Vice-Provost,** Research& Innov. University of Surrey, UK<br>**Head,** OBEL, University of Western Australia. | **Photonic Crystal´s** Special Session<br>Prof. **Philip Russell**<br>**Director,** Max Planck Institute for the Science of Light, Erlangen, Germany |
| 12:10 | Prof. **Peter Andrekson**<br>**Director** FORCE, Chalmers University of Technology, Sweden | Dr. **Joel Carpenter**<br>University of Queensland, Australia | Prof. **Pavel Cheben**<br>**Principal Researcher**<br>National Research Council of Canada | 12:00<br>**To be Defined** | 12:45 **Diploma Delivery**<br>13:00 **Closing Remarks** |
| 13:30<br>15:00 | **Lunch** | **Lunch** | **Lunch** | **Lunch** | |
| 15:30 | Dr. **Peter Winzer**<br>**Chair,** Optical Transmission Systems and Networks Bell Labs, USA | **Round Table I**<br>**Optical communications challenges**<br>(tentative)<br>*Peter. Winzer*<br>*Peter Andrekson*<br>*José Capmany*<br>*Harald Haas*<br>Moderator: **JM López-Higuera** | Prof. **Manuel López-Amo**<br>**Head,** Optical Communications Group of Public University of Navarre, Spain | 10:45 **Round Table II**<br>**Photonic sensing challenges**<br>*Hugo Thienpont*<br>*David Sampson*<br>*N.P. Schmitt*<br>*Pavel Cheben*<br>Moderator: **JM López-Higuera** | |
| 16:40 | Prof. **José Capmany**<br>**Head,** Photonics Research Labs Technical University of Valencia, Spain | | Prof. **Miguel González**<br>**Head,** Photonics Engineering Group of Univ. of Alcalá de Henares, Spain | | |
| 17:55 | | | **Family Photo**<br>**Santander City Council Reception** | | |

# PROGRAM

## Monday, 25

### Why Light matters for Communications and Sensing?

10:15 h

**Opening Ceremony**

10:40 h / **Break**

11:00 h / Opening Invited Talk

**The Science of Invisibility Cloaks and Metamaterials**

**Prof. Sir John Pendry**

**Inventor of the Metamaterials.** The Blackett Laboratory, **Imperial College London**, UK.

12:10 h / Invited Talk

**Optical fiber communication: Challenges and opportunities**

**Prof. Peter Andrekson**

**Director** FORCE, Laboratory at the Microtechnology and Nanoscience Department Chalmers University of Technology, Sweden

13:30-15:00 h / **Lunch Time**

Afternoon: **Light in Communications**

15:30 h / Invited Talk

**Breaking the Optical Fiber Shannon Limit Through Full Control of the Optical Field**

**Prof. Peter Winzer**

**Chair** Optical Transmission Systems and Networks Bell-Nokya Labs, USA

16:40 h / Invited Talk

**Advances in Analog and RF Photonics**

**Prof. José Capmany**

**Head** Photonics Research Labs at iTEAM Institute, Technical University of Valencia, Spain

# Tuesday, 26

## Morning: Light in the nanoscale and Communications

9:30 h / Invited Keynote

### Controlling Light on the Nanoscale

**Prof. Sir John Pendry**
**Inventor of the Metamaterials.** The Blackett Laboratory, **Imperial College London**, UK.

10:40 h **/ Break**

11:00 h / Invited Talk

### LiFi-High Speed Wireless Networking using Nano-Metre Waves

**Prof. Harald Haas**
**Director** of LIFI Research Development Centre, Scotland, UK

12:10 h / Invited Talk

### Spatial mode manipulation in communications and imaging

**Dr. Joel Carpenter**
School of Information Technology, University of Queensland, Australia.

13:30-15:00 h / **Lunch Time**

## Afternoon: Challenges on Communications

15:30 h- 17:45 / Round Table I

### Light on Communications: Challenges to face

**Prof. José Capmany,** **Head** Photonics Research Labs at iTEAM Instutute, Technical University of Valencia, Spain
***Challenges on Analog and RF Communications***

**Dr. Peter Winzer**, **Director** Optical Transmission Systems and Metworks Research Dept, Bell-Nokya Labs in Holmdel, USA
***Challenges on Digital Communications***

**Prof. Peter Andrekson**, **Director** FORCE, Chalmers University of Technology, Sweden.
***Challenges on Fiber Nonlinearities and their use in mixed Photonic-Digital Systems***

**Prof. Harald Haas,** **Director** of LIFI Research Development Centre, University of Edinburgh, Scotland, UK.
***Challenges on LIFI Communications***

**Prof. JM López-Higuera**, Director ISLiST, **Moderator**

## Wednesday, 27

### Morning: Light in Silicon Photonics and Sensing

9:30 h / Invited Talk

**Smart Light based Sensors**

**Prof. JM López-Higuera**
**Head,** Photonic Engineering Group of University of Cantabria, CIBER-BBN and IDIVAL, Spain.

10:40 h / **Break**

11:00 h / Invited Talk

**Forward-looking LIDAR for aircraft: research results, lessons learned and trends**

**Dr. Nikolaus P. Schmitt**
Past **Senior Expert, Optronic Systems,** Airbus Group Innovations, Muenchen, Germany.

12:10 h / Invited Talk

**Advanced Silicon Photonics for Communications and Sensing**

**Prof. Pavel Cheben**
**Principal Researcher,** National Research Council of Canada, Canada.

13:30 -15:00h / **Lunch Time**

### Afternoon: Light on fiber based Sensors

15:30 h / Invited Talk

**Optical fiber Sensor Networks: State of the art and trends**

**Prof. Manuel López-Amo**
**Head,** Optical Communications Group of Public University of Navarre, Pamplona, Spain.

16:40 h / Invited Talk

**Optical fiber Distributed Sensors**

**Prof. Miguel González Herráez**
**Head,** Photonics Engineering Group of Univ. of Alcalá de Henares, Madrid, Spain

17:55 h ISLiST Family Photo

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**18:05 h / Special Event**

**Santander Council Reception**

The Santander City Council will offer to ISLiST attendees a special reception that, in addition, will be an optimum time to share experiences and promote networking.

## Thursday, 28

Morning: **Light based sensors**

9:30 h / Invited Talk

### Light based sensing techniques for SORTING/SCANNING Food

**Prof. Hugo Thienpont**

**Director**, Brussels Photonics Team Vrije Universiteit Brussel, Brussels, Belgium.

10:35 h / **Break**

10:50 h / Invited Talk

### Biomedical Optical Sensors

**Prof. David D. Sampson**

**Vice-Provost,** Research&Innovation, University of Surrey, UK; **Head,** OBEL, University of Western Australia.

12:00 h / To be Defined

13:30-15:00 h / **Lunch Time**

Afternoon: **Challenges in Sensing**

16:00h- 17:50 / Round Table II

### Challenges in Sensing Using Light

**Prof. Hugo Thienpont,** **Director** of Research, Brussels Photonics Team Vrije Universiteit Brussel, Brussels Belgium

*General Challenges on Photonic Sensing to face on XXI century*

**Prof. Pavel Cheven**, **Principal R. Officer,** National, Research Council (NRC), 1200 Montreal Rd., Ottawa, Canada

*Challenges on Silicon Photonics for Communications and Sensing*

**Dr. Nikolaus P. Schmitt,** Past Senior Researcher of Airbus Group Innovations, Muenchen, Germany

*Challenges to face on Photonic sensing for the aerospace*

**Prof. David Sampson**, Vice-Provost, Research & Innovation, University of Surrey, UK

*Challenges on Biomedical Optical Sensors*

**Prof. JM López-Higuera**, Director ISLiST, **Moderator**

# Friday, 29

## Special Session on Photonic Crystals

9:30 /Invited keynote I

**The Birth of the Photonic Bandgap Concept and its Application in Technology, as well as in Nature**

**Prof. Eli Yablonovitch**

**Inventor of Photonic Crystal**

**Director,** NSF Center for Energy Efficient Electronics Science, University of California, Berkeley, USA

10:35 h / **Break**

11:00 /Invited keynote II

**The birth of photonic crystal fibre and its many scientific and technical applications**

**Prof. Philip Russell**

**Inventor of Photonic Crystal Fibers**

**Director,** Max Planck Institute for the Science of Light, Erlangen, Germany. **2015 OSA President.**

12:20 h

**Closing Remarks and Announcement of ISLiST 2018 and Diploma Delivery**

The UIMP official diploma will be delivery to each attendee by Professors Russel, Yablonovitch, Sampson and Thienpont.

# Abstracts/Bios

Highly renowned Professionals and Scientists from the most prestigious Organizations will highlight the importance of Photonics for a new world. Key trends and challenges will be identified in several areas of paramount importance.

| Invited Speaker | Talk | Biography |
|---|---|---|

Prof. **Sir John Pendry**

**Inventor of the Metamaterials Dan David Prize 2016**

**Imperial College London, UK**

June 25, 2018/11:00 h

**Opening Invited Talk**

## The Science of Invisibility Cloaks and Metamaterials

Electromagnetism encompasses much of modern technology. Its influence rests on our ability to deploy materials that can control the component electric and magnetic fields.

A new class of materials has created some extraordinary possibilities such as a negative refractive index, and lenses whose resolution is limited only by the precision with which we can manufacture them.

Cloaks have been designed and built that hide objects within them, but remain completely invisible to external observers. The new materials, named metamaterials, have properties determined as much by their internal physical structure as by their chemical composition and the radical new properties to which they give access promise to transform our ability to control much of the electromagnetic spectrum.

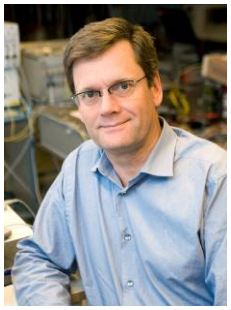
**Sir John Pendry is worldwide recognized by** his outstanding contribution to physics through seminal research in surface science, photonics and metamaterials.

John Pendry has the rare distinction among scientists of having established a completely new and unexpected area of research – metamaterials. The electromagnetic properties of materials – such as electrical conductivity – were standardly thought to depend upon the properties of the materials of which they are composed. In the case of metamaterials, however, their electromagnetic properties depend upon their structure: this has had a tremendous impact, enabling the identification of new properties not found in nature.

Pendry's perfect lens makes use of such a novel property – negative refraction – and is a remarkable example of the revolutionary nature of metamaterials. Negative refraction had been postulated in the 1960s by Victor Veselago, but no examples of the phenomenon had been found in nature. Using the metamaterials proposed by Pendry, David Smith's team, then at the University of California, San Diego, combined magnetic and electrical metamaterials to construct the first negatively refracting metamaterial. Moreover, Pendry discovered that a lens manufactured from negatively refracting material would circumvent Abbe's diffraction limit to spatial resolution, which has stood for more than a century. In this way he gave the first prescription for a perfect lens – one whose resolution is limited only by the perfection of manufacture.

More recently, in collaboration with a team of scientists at Duke University, he has deployed transformation optics to develop a cloak of invisibility that has attracted worldwide public interest. The cloak can hide objects from electromagnetic fields, and a version of this design working at radar frequencies has now been implemented experimentally.

He has received numerous honours including the IOP's Isaac Newton Medal in 2013, the Kavli Prize of the Norwegian Academy of Science and Letters in 2014 and the Dan David Prize in 2016. In 2004 he was honoured with a knighthood for his services to science.



**Prof. Peter Andrekson**

**Director**

FORCE (Fiber Optic Communications Research Centre)

Photonics Laboratory at the Microtechnology and Nanoscience Department Chalmers University of Technology, Sweden

June 25 / 12:10 h
Invited Talk

June 26 /15:30
Round Table I

## Optical fiber communication: Challenges and opportunities

The data throughput and transmission reach in optical fiber systems is primarily limited by noise and by the transmission fiber nonlinearity (Kerr effect). The former is fundamental, while the latter is largely deterministic and is possible to mitigate at least partially. A key element in any long-haul optical transmission system is the optical amplifier. The Erbium-doped fiber amplifier is widely used to compensate for the transmission losses, but suffers from a quantum-limited noise figure of 3 dB as do all conventional optical amplifiers.

In this talk, I will review the current limitations, challenges, and opportunities in optical communication. One highlight includes the use of phase-sensitive amplifiers. These amplifiers are not only capable to amplify light with lowest possible noise figure (0 dB quantum limit, 1 dB reported) but can also simultaneously mitigate transmission fiber nonlinearity impairments, a result of the coherent superposition of the signal and idler waves in the amplifier.

**Prof. Andrekson** received his Ph.D. from Chalmers in 1988. After three years with Bell Laboratories, USA, he returned to Chalmers where he is a full professor. He was Director of Research at Cenix Inc. and with Lehigh University in Allentown, USA, during 2000-2004. He co-founded Picosolve Inc. in 2004, now part of EXFO. He has authored about five-hundred publications in the area of optical communications, including four tutorials at OFC. He served on the Board of Governors for the IEEE Photonics Society and on several program committees, most recently as program chair of the European Conference on Optical Communication in 2017. He also served as expert evaluator of Nobel prizes in physics and held an ERC advanced grant (2012-2017) on phase-sensitive optical amplifiers.
Andrekson is a Fellow of the OSA and the IEEE, and a member of the Royal Swedish Academy of Engineering Sciences.

**Dr. Peter Winzer**

**Chair**
Optical Transmission Systems and Networks Bell Labs, USA

**Editor-in-Chief**
IEEE/OSA Journal of Lightwave Technology, JLT

June 25, 2018 /15:30 h
Invited talk
June 26 /15:30
Round Table I

## Breaking the Optical Fiber Shannon Limit Through Full Control of the Optical Field

Over the past decade, optical transmission systems have been closely approaching the nonlinear Shannon limit of conventional telecommunications fiber, which, unless resolved through completely new methods, threatens to soon result in an optical network "capacity crunch," with repercussions throughout our information-centric society.

New possibilities in ultra-fast digital electronic signal processing, coupled with our increasing abilities to digitally electronically control the full optical field across all its physical dimensions, including its spatial mode content, allow not only for new ways of optical communications but open up a new era in optical instrumentation far beyond telecom.

**Peter J. Winzer** Peter J. Winzer received his Ph.D. from TU Vienna, Austria. Supported by ESA, he investigated space-borne Doppler lidar and laser communications. At Bell Labs, where he heads Optical Transmission Research, he contributed to many high-speed transmission records. He pioneered spatial multiplexing and multiple-input-multiple-output to scale optical transport systems. He has widely published and patented and is actively involved with IEEE and OSA, currently the Editor-in-Chief of the IEEE/OSA Journal of Lightwave Technology. Program Chair of ECOC in 2009 and Program/General Chair of OFC in 2015/2017, he is a Highly Cited Researcher, Bell Labs Fellow, Fellow of IEEE and OSA, and Member of the US National Academy of Engineering. He has received multiple awards for his work, including the 2018 John Tyndall Award.

**Prof. Jose Capmany**

**Head**
Photonics Research Labs at iTEAM Instutute, Technical University of Valencia, Spain

**Editor-in-Chief**
IEEE Journal of Selected Topics in Quantum Electronics

June 25 / 16:40 h
Invited talk

June 26 /15:30
Round Table I

# Advances in Analog and RF Photonics

RF or Analog Photonics is required for interfacing two information domains that operate under digital and analog information coding schemes respectively. 5G Fiber-wireless and the internet of Things are two representative examples that call for this technology in communication systems but there are many other which can benefit from this approach. In this talk I will address the basic principles behind Analog Photonics and review the recent advances, paying special attention to developments in integrated optic chips and Space Division Multiplexing Access techniques. The talk will also address the potential applications in emerging application fields, such as neurophotonics, quantum communications and programmable multifunctional photonic systems.

**Prof. Capmany** was born in Madrid, Spain. He received the Ingeniero de Telecomunicación degree from the Universidad Politécnica de Madrid (UPM) in 1987 and the Licenciado en Ciencias Físicas in 2009. He holds a PhD in Electrical Engineering from UPM and a PhD in Quantum Physics from the Universidad de Vigo. Since 1996 he is a Full Professor in optical communications, systems, and networks. From 2002 to 2016, he was the Director of the Institute of Telecommunications and Multimedia (iTEAM) at UPVa (www.iteam.upv.es). He is now the head of the Photonics Research Labs (www.prl.upv.es) at ITEAM.

His research activities and interests cover a wide range of subjects related to optical communications including microwave photonics (MWP), integrated optics, optical signal processing, fiber Bragg gratings, and more recently quantum cryptography and quantum information processing using photonics. He has published over 520 papers in international refereed journals and conferences and has been a member of the Technical Program Committees of the European Conference on Optical Communications (ECOC), the Optical Fiber Conference (OFC), the Integrated Optics and Optical Communications Conference (IOOC), CLEO Europe, and the Optoelectronics and Communications Conference (OECC). Professor Capmany is a Fellow of the Institute of Eelectrical and Electronic Engineers (IEEE), the Optical Society of America (OSA) and the Institution of Electrical Engineers (IEE). He is also a founder and chief innovation officer of the spin-off company VLC Photonics (www.vlcphotonics.com) dedicated to the design of photonic integrated circuits and EPHHOX (www.ephoox.com) dedicated to MWP instrumentation.

Professor Capmany is the 2012 King James I Prize Laureate on novel technologies, the highest scientific distinction in Spain, for his outstanding contributions to the field of microwave photonics. In 2016, he was awarded an ERC Advanced Grant to develop on-chip universal microwave photonics processors. He is currently the Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics and the Action Chair of COST A 16220 European network on High Performance Integrated Microwave Photonics (www.euimwp.eu) .

Prof. **Sir John Pendry**

**Inventor of the Metamaterials Dan David Prize 2016**

**Imperial College London, UK**

June 256, 2018/9:30 h

**Invited Keynote Talk**

## Controlling Light on the Nanoscale

Our intuitive understanding of light has its foundation in the ray approximation and is intimately connected with our vision: as far as our eyes are concerned light behaves like a stream of particles. Here we look inside the wavelength and study the properties of plasmonic structures with dimensions of just a few nanometres: a tenth or even a hundredth of the wavelength of visible light, where the ray picture fails utterly. In this talk we show how the new concept of transformation optics that manipulates electric and magnetic field lines rather than rays can provide an equally intuitive understanding of sub wavelength phenomena and at the same time be an exact description at the level of Maxwell's equations. The concepts are applied to a number of plasmonic structures

**Sir John Pendry is worldwide recognized by** his outstanding contribution to physics through seminal research in surface science, photonics and metamaterials and through service to the Institute.

John Pendry is a leading UK physicist of international renown. He has the rare distinction among scientists of having established a completely new and unexpected area of research – metamaterials. The electromagnetic properties of materials – such as electrical conductivity – were standardly thought to depend upon the properties of the materials of which they are composed. In the case of metamaterials, however, their electromagnetic properties depend upon their structure: this has had a tremendous impact, enabling the identification of new properties not found in nature.

Pendry's perfect lens makes use of such a novel property – negative refraction – and is a remarkable example of the revolutionary nature of metamaterials. Negative refraction had been postulated in the 1960s by Victor Veselago, but no examples of the phenomenon had been found in nature. Using the metamaterials proposed by Pendry, David Smith's team, then at the University of California, San Diego, combined magnetic and electrical metamaterials to construct the first negatively refracting metamaterial. Moreover, Pendry discovered that a lens manufactured from negatively refracting material would circumvent Abbe's diffraction limit to spatial resolution, which has stood for more than a century. In this way he gave the first prescription for a perfect lens – one whose resolution is limited only by the perfection of manufacture.

More recently, in collaboration with a team of scientists at Duke University, he has deployed transformation optics to develop a cloak of invisibility that has attracted worldwide public interest. The cloak can hide objects from electromagnetic fields, and a version of this design working at radar frequencies has now been implemented experimentally.

Pendry has also made a full contribution to the wider scientific community through roles at the IOP and other organisations. Between 2007 and 2011 he served on the Institute's Council as vice-president for publishing and as chair of the IOP Publishing board. At the Royal Society, he was elected a fellow in 1984, was a member of council over 1992-4 and was editor of Royal Society Proceedings A between 1996 and 2002. He also served as chair of the physics sub-panel of the 2008 UK Research Assessment Exercise from 2005.

He has received numerous honours including the IOP's Isaac Newton Medal in 2013, the Kavli Prize of the Norwegian Academy of Science and Letters in 2014 and the Dan David Prize in 2016. In 2004 he was honoured with a knighthood for his services to science.

**Prof. Harald Haas**

**Director**

LIFI
Research Development Centre, Scotland, UK

June 26 / 11:00 h
Invited talk

June 26 /15:30
Round Table I

## LiFi - High Speed Wireless Networking using Nano-Metre Waves

The visible light spectrum is 1000 times larger than the entire radio frequency spectrum of 300 GHz, and this simple fact provides the motivation to use the visible light spectrum to augment RF cellular communications. We will set the scene by motivating the need for new wireless spectrum. Then we will go on to provide a general background to the subject of optical wireless communications. We will discuss the relationship between VLC and LiFi, introducing the major advantages of VLC and LiFi and discuss existing challenges. Recent key advancements in physical layer techniques that led to transmission speeds greater than 10 Gbps will be discussed. Moving on, we introduce channel modelling techniques, and show how this technology can be used to create fully-fledged cellular networks achieving orders of magnitude improvements of area spectral efficiency compared to current technologies. The challenges that arise from moving from a static point-to-point visible light link to a LiFi network that is capable of serving hundreds of mobile and fixed nodes will be discussed. An overview of recent standardization activities will be provided – primarily focusing on the new IEEE 80211 LC (light communication) Study Group activities. Lastly, we will moot commercialization challenges of this disruptive technology.

**Prof. Haas** received the PhD degree from the University of Edinburgh in 2001. He currently holds the Chair of Mobile Communications at the University of Edinburgh, and is co-founder and Chief Scientific Officer of pureLiFi Ltd as well as the Director of the LiFi Research and Development Center at the University of Edinburgh. His main research interests are in optical wireless communications, hybrid optical wireless and RF communications, spatial modulation, and interference coordination in wireless networks. He first introduced and coined spatial modulation and LiFi. LiFi was listed among the 50 best inventions in TIME Magazine 2011.

**Dr. Joel Carpenter**

School of Information Technology;
University of Queensland, Australia

June 26 / 12:10 h
Invited Talk

## Spatial mode manipulation in communications and imaging

The ability to analyse and control light's spatial properties is a fundamental requirement in many disciplines throughout optical physics. Imaging is an obvious example, where how light occupies space is measured directly to reveal details of the object being imaged. However other applications such as telecommunications and the field of Space Division Multiplexing are also increasingly looking to the spatial properties of light as a means of increasing information capacity.

In this talk, research will be presented on measuring and manipulating light's spatial properties. This includes the creation of 'pre-scattered' light states which can propagate through a scattering media, only to form a desired image on the other side. As well as work on the creation of devices capable of splitting a light beam up into the spatial modes it is composed of, a functionality for the spatial domain that is analogous to how a dispersive prism splits white light up into its constituent colours.

**Dr. Joel Carpenter** received his PhD in Electrical Engineering from the University of Cambridge, UK in 2012 for his work on Mode Division Multiplexing in optical telecommunications before working as a postdoctoral researcher at The University of Sydney, Australia. He is now a Lecturer at his alma mater, The University of Queensland. His research focuses on the measurement and manipulation of fiber modes using spatial light modulators and computational holography.

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**June 26 / 15:30-17:45 h**, Round Table I:

## Light on Communications: Challenges to face

**Prof. José Capmany,** **Head** Photonics Research Labs at iTEAM Instutute, Technical University of Valencia, Spain
***Challenges on Analog and RF Communications***

**Dr. Peter Winzer**, **Director** Optical Transmission Systems and Metworks Research Dept, Bell-Nokya Labs in Holmdel, USA
***Challenges on Digital Communications***

**Prof. Peter Andrekson**, **Director** FORCE, Chalmers University of Technology, Sweden. (tentative)
***Challenges on Fiber Nonlinearities and their use in mixed Photonic-Digital Systems***

**Prof. Harald Haas,** **Director** of LIFI Research Development Centre, University of Edinburgh, Scotland, UK. (tentative)
***Challenges on LIFI Communications***

**Prof. JM López-Higuera**, Director ISLiST, **Moderator**

**Prof. José Miguel López-Higuera**

**Head**
Photonic Engineering Group of University of Cantabria, CIBER-BBN and IDIVAL, Spain

June 27 / 9:30 h
Invited Talk

Round Tables I &II moderator

## Smart Light based Sensors

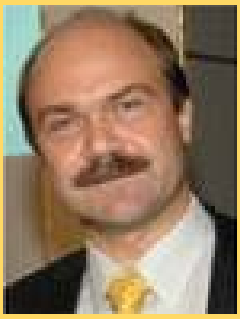
Photonics is considered a Key Enabling Technology (KET) or an Essential Technology for the development of Europe, USA and others main nations around the world. Photonic Sensing is understood as any sensing approach that employs light sciences and technologies and it is becoming an area with very substantial expectations of annual growths and with strong socio-economic impacts in the first decades of this XXI century.

In the talk, after a mention of what it must be understood, in wide sense, as the general and comprehensive concept of Sensing Using Light and also Smart Light Sensors, SLS, we will do a "flight" over several significant cases of their use on real structures inside a wide number of sector application. The trends for the near future will be also addressed and discussed.

**Prof. López-Higuera** is the founder and head of the Photonics Engineering Group of the University of Cantabria, CIBER-BBN of Institute of Health Carlos III and IDIVAL of Hospital Universitario Marqués de VAldecilla, Spain. He is a Member of a wide set of international Committees of Conferences, R&D Institutions, and Companies in the area of photonic sensing. His work is focused on optical sensor systems and instrumentations for any sector application. He has worked in a wide range of R&D&i projects, acting in more than 90 of them as manager.

He has contributed with more than 700 research publications including 20 patents closely related to optical and fiber techniques for sensors and instrumentations. He has worked as an editor and co-author of four R&D international books, as a co-editor of several conference proceedings and Journals and he has been the director of 17 PhD theses. He is co-founder of three technology-based companies.

Prof. López-Higuera is a Fellow of OSA, Fellow of SPIE, Senior of IEEE and a Member of the Royal Academy of Medicine of Cantabria.



**Dr. Nikolaus P. Schmitt**

**Senior Expert**
**Optronic Systems**
Airbus Group Innovations
Muenchen, Germany

June 27 / 11:00 h
Invited Talk

June 29/ 15:30
Round Table II

## Forward-looking LIDAR for aircraft: research results, lessons learned and trends

Measurement of air data is vital to control an aircraft. Since decades this is done using fluid flow pressure sensors. Recent optical air data sensors (OADS) based on backscatter Laser Doppler LIDAR provide a unique technology to precisely measure the air flow vector even remotely outside the aircraft boundary layer. Beside air flow, laser backscatter further allows for remote measurement of air temperature and density as well. Replacing conventional sensors, the required measurement distances for such OADS LIDAR are typically in the order of meters, measuring just outside of the aerodynamic boundary layer or at the edge thereof. But LIDAR can provide more than that:

The optical remote sensing of airflow at larger distances ahead of an aircraft enables additional future new functionalities such as real-time feed-forward of signals to the flight control, based on 3D measured air flow disturbances (e.g. turbulences, gusts) before the aircraft reaches them. In this new way of forward control, the impact of turbulences on the aircraft could be reduced in future with the help of LIDARs. Major LIDAR principles as well as results of LIDAR air data sensors on-board aircraft will be discussed.

**Dr. Nikolaus P. SCHMITT** has more than 30 years of experience in lasers and optronics for aerospace and defence. He studied physics and philosophy at Tuebingen and Muenchen and received a diploma and Dr. rer. nat. degree in Physics both from Ludwig-Maximilians-University Muenchen.

He mainly worked on diode pumped solid state lasers, MOEMS, LIDAR systems and optical communications (free space and fiber) for aeronautics, space and defence. He is Senior Expert Optronic Systems at Airbus (formerly EADS) and chairman of the AIRBUS Research Technology Group on Optics/Optronics.

Dr. Schmitt is a reviewer for several funding bodies, scientific magazines, member of conference technical committees and steering boards.

**Prof. Pavel Cheben**

**Principle Researcher**
National Research Council of Canada

June 27/ 12:10 h
Invited Talk

June 29/ 15:30
Round Table II

## Advanced Silicon Photonics for Communications and Sensing

By locally engineering the refractive index of silicon by forming a pattern of holes at the subwavelength scale, it is possible to manipulate the flow of light in silicon photonic integrated circuits. This powerful concept has resulted in a plethora of advanced integrated photonic devices with unprecedented performance for applications in optical interconnects, telecommunications and sensing.

Subwavelength engineered silicon waveguide structures are likely to become the key building blocks for the next generation of integrated photonic circuits. We will present an overview of this surging field, including the fundamental principles, recent advances and applications.

**Prof. Pavel Cheben** is a Principal Research Officer at the National Research Council of Canada. He is also an Honorary Professor at University of Malaga, Adjunct Professor at Carleton University, McMaster University, University of Ottawa, and University of Zilina. He was one of the lead scientists starting up Optenia Inc. and developed the first commercial echelle-grating wavelength multiplexer. Prof. Cheben's research focusses on silicon photonics, subwavelength metamaterial nanophotonic structures, and on-chip spectrometers and biosensors. He has co-authored more than 400 journal and conference papers, has 30 patent applications and over 180 invited presentations. He is the most published scientist of the National Research Council of Canada 2010-17. He is an elected Fellow of the European Optical Society, Fellow of the Optical Society of America and Fellow of the Institute of Physics.

**Prof. Manuel López-Amo**

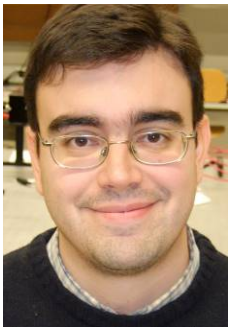
**Head of the** Optical Communications Group of Public University of Navarre, Pamplona, Spain

June 27 /15:30 h
Invited talk

## Optical fiber Sensor Networks: State of the art and trends

One of the main goals in fiber optic sensor technology is to multiplex together a high number of sensors in the same network, in order to reduce the costs by sharing expensive terminal equipment, developing a system that includes multiple measuring points.
The presentation will deal with multiplexing networks for point and quasi- distributed optical fiber sensors (avoiding distributed sensors) and explain what they are and why they are unique; this would include a brief historical perspective on their development. It would then deepen into the principles of these systems and define broad categories based on the measurand and the underlying physics.
Different kind of multiplexing networks for optical fiber sensors would be described and compared here, including networks that use optical amplification, and also lasing multiplexing systems. State of the art in multiplexed sensor networks would be also presented, including robust and remote ultralong networks. Finally, selected application examples of such networks will be described.

**Prof. López-Amo** is a professor in photonics at Universidad Pública de Navarra (Spain). He participated in the first demonstrations of optical amplifiers in optical signal processing and in optical fiber sensing. Also in optical fiber tapers for sensing and in the experimental demonstration of multiwavelength random fiber lasers using Rayleigh backscattering. His research is focused nowadays in optical fiber lasers and remote sensing using optical fiber networks. He has been the leader of more than 60 research projects and he has coauthored more than 300 works in international refereed journals and conferences. He is a member of the technical committees of the International Conference on fiber optic sensors (OFS) and the European Workshop on optical fiber sensors (EWOFS), among others.



**Prof. Miguel González Herráez**

**Head** of Photonics Engineering Group of Univ. of Alcalá de Henares, Madrid, Spain

June 27 /16:40 h
Invited Talk

## Optical fiber Distributed Sensors

Distributed optical fibre sensors are increasingly used in civil engineering, for the monitoring of large critical infrastructure such as large pipelines, dams, bridges, tunnels, etc. In these sensors, the entire length of the optical fibre is used as sensing element, and a large number of physical variables (strain, temperature, vibration, pressure, etc.) can be monitored at each point along the fibre. This way, a single optical fibre can replace thousands of point sensors, the same fibre acting as transducer and transmission element. The fact that the optical fibre is the sensing element also offers additional advantages, since the fibre is inherently immune to electromagnetic noise; it is also small and lightweight, and stands well humidity and corrosion, which makes it an appealing option for very harsh environments. This talk will review the basic principles and limitations of these sensors, and will provide a roadmap to the future developments in this area.

**Miguel Gonzalez-Herraez** (Senior Member, OSA) is currently a Full Professor in Photonics at the University of Alcala (Spain). His research interests are primarily related to distributed optical fiber sensing systems. He is the author or co-author of >110 journal papers and >200 conference contributions. He has received several important recognitions to his basic research activity and technology transfer contributions in this area, including the European Research Council Starting Grant, the “Miguel Catalan” Prize given by the Regional Government of Madrid, and the “Agustin de Betancourt” prize of the Spanish Royal Academy of Engineering.

**Prof. Hugo Thienpont**

**Chair**
Department of Applied Physics and Photonics

**Director**
of Research, Brussels Photonics Team Vrije Universiteit Brussel, Brussels Belgium

June 28 / 9:30 h
Invited Talk

June 28/ 15:30
Round Table II

## Light based sensing techniques for SORTING/SCANNING Food

To be completed

**Prof. Thienpont** Hugo Thienpont chairs the Applied Physics and Photonics Department and is director of its photonics research group, which he built over the years and which today counts about 50 scientists, engineers, and administrative and technical staff. Over the years Hugo and his team have made research efforts in a large variety of fundamental and applied research topics, most of them situated in the domain of micro-photonics and micro-optics. He authored more than 180 SCI-stated journal papers and around 400 publications in international conference proceedings. He was invited or key-note speaker at more than 50 international conferences and is (co)-inventor of 13 patents. His has been recognized with several awards such as the International Commission for Optics Prize ICO'99, the Ernst Abbe medal from Carl Zeiss and the prestigious status of Methusalem top-scientist from the Flemish government for his research track record in photonics, just to mention three of them.

Hugo Thienpont is also recognized for his contributions to Photonics in Education and also appreciated by his peers for his service to the photonics community. Besides academic-oriented research projects he has successfully managed more than 15 large-scale micro-photonics-related industrial projects with companies.

Recently, he became vice-coordinator of the European Network of Excellence on Biophotonics Photonics for Life.

He currently serves on the board of directors of SPIE and is a member of the Board of Stakeholders of the Technology Platform Photonics21, a high-level advisory board for optics and photonics in EC FP 7.

Prof. **David D. Sampson**

**Vice-Provost,** Research and Innovation
University of Surrey, UK

**Head,** OBEL, University of Western Australia, Australia

June 28 / 10:55 h
Invited Talk

June 28 /15:30
Round Table II

## Biomedical Optical Sensors

To be completed

**Prof. Sampson** is Director of the Centre for Microscopy, Characterisation & Analysis (CMCA), a core infrastructure facility of the University of Western Australia, and heads the Optical+Biomedical Engineering Laboratory (OBEL) in the School of Electrical, Electronic and Computer Engineering. As CMCA Director, he directs the Western Australian nodes of the Australian Microscopy & Microanalysis Research Facility and the National Imaging Facility and leads the Western Australian Centre for Microscopy, a consortium of the four publicly funded universities in Western Australia.
Winthrop Prof. Sampson has over twenty years research experience in the fields of optics, photonics, and microscopy, and applications in communications, sensors, and Biomedicine.

June 28/ 15:30-17:45 h, Round Table II:

## Challenges in Sensing Using Light

**Prof. Hugo Thienpont,** **Director** of Research, Brussels Photonics Team Vrije Universiteit Brussel, Brussels Belgium
*General Challenges on Photonic Sensing to face on XXI century*

**Prof. Pavel Cheven**, **Principal R. Officer,** National, Research Council (NRC), 1200 Montreal Rd., Ottawa, Canada
*Challenges on Silicon Photonics for Communications and Sensing*

**Dr. Nikolaus P. Schmitt,** Past Senior Researcher of Airbus Group Innovations, Muenchen, Germany
*challenges to face on photonic sensing for the for aerospace*

**Prof. D. Sampson**, Vice-Provost, Research & Innovation, University of Surrey, UK; **Head** OBEL, University of Western Australia.
*Challenges on Biomedical Optical Sensors*

**Prof. JM López-Higuera**, Director ISLiST, **Moderator**

# Special Session on Photonic Crystal

**Prof. Eli Yablonovitch**

**Inventor of Photonic Crystals**

**Director**
NSF Center for Energy Efficient Electronics Science, University of California, Berkeley, USA

June 29 / 9:30 h

Invited Keynote

## The Birth of the Photonic Bandgap Concept and its Application in Technology, as well as in Nature.

Photonic crystals are also part of everyday technological life in opto-electronic telecommunication devices that provide us with internet, cloud storage, and email. But photonic crystals have also been identified in Nature, in the coloration of peacocks, parrots, chameleons, butterflies and many other species. In spite of its broad applicability, the original motivation of photonic crystals was to create a "bandgap" in which the spontaneous emission of light would be inhibited. Conversely, the opposite is now possible. The "optical antenna" can accelerate spontaneous emission. Over 100 years after the radio antenna, we finally have tiny "optical antennas" which can act on molecules and quantum dots. Employing optical antennas, spontaneous light emission can become faster than stimulated emission.

**Prof. Yablonovitch** introduced the idea that strained semiconductor lasers could have superior performance due to reduced valence band (hole) effective mass. With almost every human interaction with the internet, optical telecommunication occurs by strained semiconductor lasers.

He is regarded as a Father of the Photonic BandGap concept, and he coined the term "Photonic Crystal". The geometrical structure of the first experimentally realized Photonic bandgap, is sometimes called *"Yablonovite"*.

In his photovoltaic research, Yablonovitch introduced the 4(n squared) (*"Yablonovitch Limit"*) light-trapping factor that is in worldwide use, for almost all commercial solar panels.

His mantra that "a great solar cell also needs to be a great LED", is the basis of the world record solar cells: single-junction 28.8% efficiency; dual-junction 31.5%; quadruple-junction 38.8% efficiency; all at 1 sun.

**Prof. Philip Russell**

**Inventor of Photonic Crystal Fibers**

**2015 OSA President**

**Director**
Max Planck Institute for the Science of Light, Erlangen, Germany

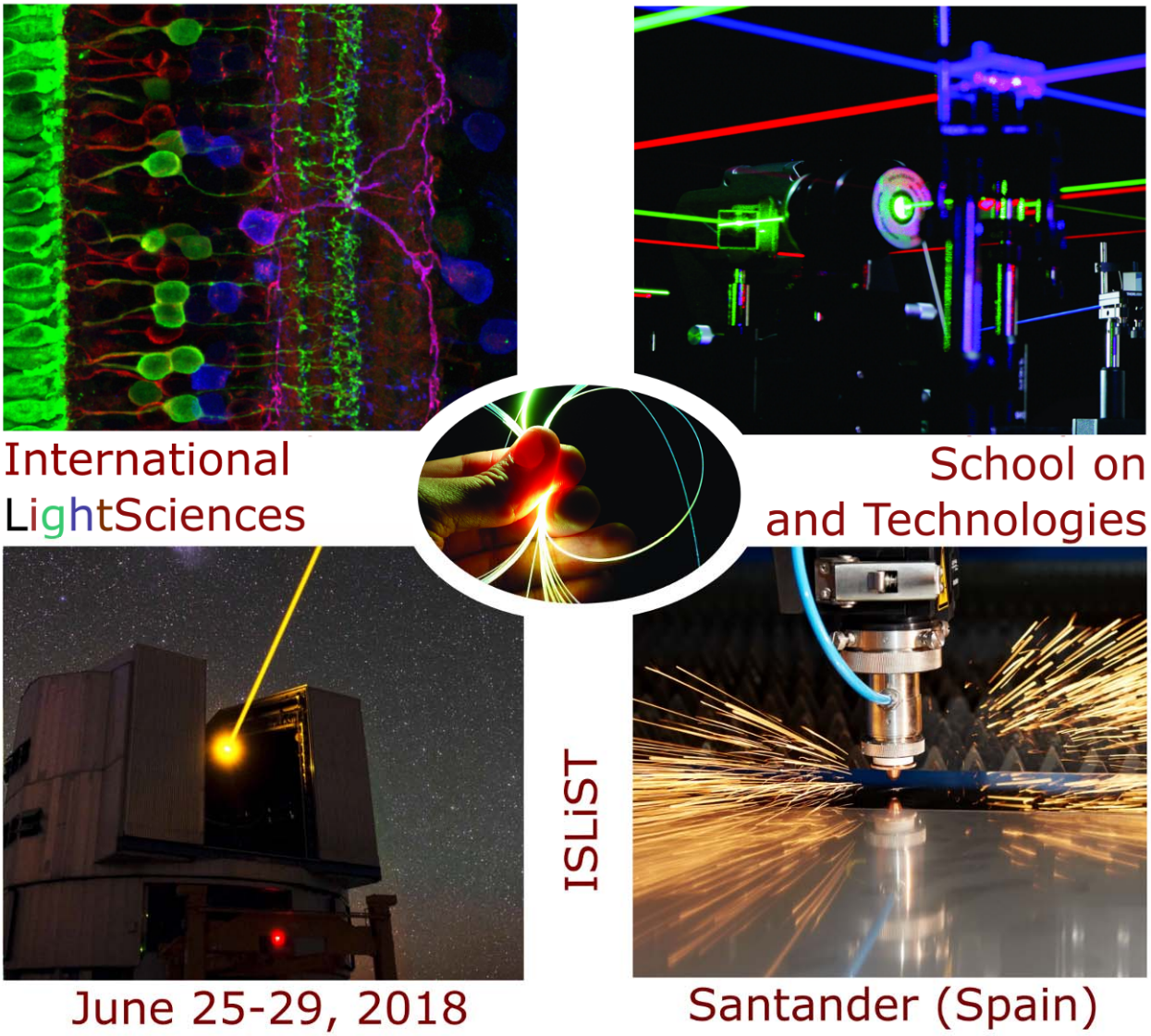
June 29 / 11:00 h

Invited Keynote

## The birth of photonic crystal fibre and its many scientific and technical applications

The idea for a new kind of optical glass fibre photonic crystal fibre (PCF)—first emerged in 19 [Science 299, 358 (2003)]. The aim was to realise fibre with a two-dimensional periodic array microscopic features (typically hollow channel running along its entire length. This would allo light to be tightly confined within a tiny solid c more remarkably, hollow core while providir control of dispersion. The first working PCF left th drawing tower in 1995 and now, more than tw decades later and after many breakthroughs, PC has already moved into real-world applications. F example, solid-core PCFs are being use commercially to convert infrared pulses into whi light supercontinua 10 million times brighter tha an arc lamp, and hollow core PCF filled with gas is underpinning a range of extremely bright source of tunable deep and vacuum ultraviolet light, drive by ultrashort pulses of infrared light.

**Prof. Russell** is a founding Director of the Max-Planck Institute for the Science of Light and Krupp Professor of experimental physics at the University of Erlangen-Nuremberg. He obtained his D.Phil. (1979) degree at the University of Oxford. His interests currently focus on light-matter interactions in microstructured and photonic crystal fibres. He is a Fellow of the Royal Society and the Optical Society (OSA) and the recipient of a number of awards including the 2000 OSA Joseph Fraunhofer Award/Robert M. Burley Prize, the 2005 Thomas Young Prize of the Institute of Physics (London), the 2005 Körber Prize for European Science, the 2013 EPS Prize for Research into the Science of Light, the 2014 Berthold Leibinger Zukunftspreis, the 2015 IEEE Photonics Award and the 2018 Rank Prize for Optoelectronics. He was OSA's President in 2015, the International Year of Light. In June 2016 he received an honorary doctorate from the Universidad Internacional Menéndez Pelayo in Santander, Spain.


International
LightSciences
School on
and Technologies
ISLiST
June 25-29, 2018
Santander (Spain)

# NOTEBOOK

June 25 / 11:00 h / **Prof. Sir John Pendry**

## The Science of the Invisibility Cloaks and Metamaterials

**NOTES:**

June 25 / 12:10h / **Prof. Peter Andrekson**

**Optical fiber communication: Challenges and opportunities**

**NOTES:**

June 25 / 15:30 h / **Dr. Peter Winzer**

**Breaking the Optical Fiber Shannon Limit Through Full Control of the Optical Field**

**NOTES:**

June 25 / 16:40 h / **Prof. José Capmany**

## Advances in Analog and RF Photonics

**NOTES:**

June 26 / 9:30 h / **Prof. Sir John Pendry**

## Controlling Light in the Nanoscale

**NOTES**

June 26 / 11:00 h / **Prof. Harald Haas**

**LiFi - High Speed Wireless Networking using Nano-Metre Waves**

**NOTES:**

June 21/ 12:10 h / **Dr. Joel Carpenter**

**Spatial mode manipulation in communications and imaging**

**NOTES:**

June 26/15:30 h / **Round Table I:**

## Light on Communications: Challenges to face





**NOTES:**

June 27 / 9:30 h / **Prof. JM López-Higuera**

**Smart Light based Sensors**

**NOTES:**

June 27 / 11:00 h / **Dr. Nikolaus P. Schmitt**

**Forward-looking LIDAR for aircraft: research results, lessons learned and trends**

**NOTES:**

June 27/ 12:10 h / **Prof. Pavel Cheben**

**Silicon Photonics for Communications and Sensing**

**NOTES:**

June 27 / 15:30 h / **Prof. Manuel López-Amo**

**Optical fiber sensor Networks**

**NOTES:**

June 27 / 16:40 h / **Prof. Miguel González Herráez**

**Optical fiber Distributed Sensors**

**NOTES:**

June 28 /9:30 h / **Prof. Hugo Thienpont**

**Light based sensing techniques for SORTING/SCANNING Food**

**NOTES:**

June 28 / 11:00 h / **Prof. David Sampson**

**Biomedical Optical Sensors**

**NOTES:**

June 28/15:30 h / **Round Table II:**

## Light on Sensing: Challenges to face