8th SU2P Symposium – 5th and 6th April 2017 Heriot Watt University

Speaker Information

Caroline Nichol - Edinburgh University

Energy & Environment

Multi spectral lidar for forest mapping: current capabilities and technological challenges

Laser altimetry, or Light detection and ranging (LIDAR) is a well established and powerful tool used both in terrestrial and airborne platforms to provide detailed measurements of vegetation structure, and to support a range of themes from sustainable forest management to carbon accounting. This talk will focus on the technical development of LiDAR from single frequency to multiple frequencies, for improving quantification of forest structure. A history of the engineering and scientific developments with a forward looking projection of where the field is moving will be presented.

Caroline Nichol received her PhD in 2000 from the University of Edinburgh and is currently Senior Faculty in the School of GeoSciences at the University of Edinburgh. Caroline's research utilises both optical and LiDAR remote sensing to understand canopy-level (particularly forests) physiology and biosphere-atmosphere processes. Caroline's recent research has centred on investigations into retrievals of solar induced fluorescence, utilizing optical data to monitor and track disease development in UK forests and investigating new airborne multi spectral LiDAR data in north American and Canadian forest canopies.

Energy & Environment

Jenny Nelson - Imperial College London

Light harvesting and solar energy conversion in molecular electronic materials

Molecular electronic materials such as conjugated polymers have attracted intense interest for applications in light emission, energy conversion, thin-film electronics and other fields. They have been studied intensively for photovoltaic energy conversion, where their appeal lies in the potential to tune material properties (electronic, optical, mechanical and thermal) through control of chemical structure and molecular packing, whilst using facile fabrication methods. In this talk, we will address the relationship between the optical properties of the materials and the performance of photovoltaic devices, considering the effects of optical gap and of specific optical absorption on the practical limits to power conversion efficiency. We use experimental characterization and molecular modelling to investigate the origin of the optical absorption in terms of molecular structure and conformation, and use our results to propose design rules for enhanced light harvesting in solar energy conversion devices.

Jenny Nelson is a Professor of Physics at Imperial College London, where she has researched novel varieties of material for use in solar cells since 1989. Her current research is focussed on understanding the properties of molecular and hybrid semiconductor materials and their application to solar energy conversion. This work combines fundamental electrical, spectroscopic and structural studies of molecular electronic materials with numerical modelling and device studies, with the aim of optimising the performance of solar cells and other devices based on molecular and hybrid materials. She also works with the Grantham Institute for Climate Change at Imperial to explore the mitigation potential of renewables energy technologies. She is an ISI Highly Cited Researcher in Materials Science and has published over 250 articles in peer reviewed journals, several book chapters and a book on the physics of solar cells. She holds a number of awards including the 2016 Institute of Physics Faraday medal and was elected as a Fellow of the Royal Society in 2014.

Healthcare & Medicine

Lambertus Hesselink - Stanford University

A Novel Differential Phase Contrast X-Ray Imaging System with Applications in Medicine and Aviation Security

Differential Phase Contrast (DPC) Imaging provides measurement of X-ray absorption, phase and small angle scatter. We have developed a unique system, 3-Fates, with a wide field of view (FoV), single step exposure and high contrast. A novel Photon Electron Source Array (PeXSA) enables motionless DPC imaging, with a FoV similar to traditional X-ray sources. We demonstrate the potential for high resolution medical imaging and improved object discrimination for aviation security applications

Professor Hesselink's research is focused on 3-D X-ray imaging and nano photonics in the visible and X-ray regimes. He pioneered Holographic Data Storage, and invented the C-aperture for highly efficient nano- photonics applications, among several other major research accomplishments. In addition to DPC X-ray 3-D imaging his group currently focuses on DNA synthesis using the Nano Optical Conveyor Belt incorporating C-apertures. Among other significant awards he is a Fulbright scholar, a Fellow of the OSA and SPIE, and a member of the Royal Dutch Academy of Arts and Sciences.

Healthcare & Medicine

Robert Henderson - University of Edinburgh

CMOS sensors for photonic molecular fingerprinting of disease pathology

Currently poor and slow identification of pulmonary infections results in the use of broad spectrum multi-drug treatment regimes, unfavourable for patients in critical care and exacerbating the antimicrobial resistance problem. The UK EPSRC Proteus project is developing a medical device that can sense physiological parameters such as pH through the use of fluorescent or Surface Enhanced Raman Sensors (SERS) on the end of custom multicore optical fibres, while time resolved single photon counting spectroscopic techniques based on single photon (SPAD) sensors are being applied to aid in the disambiguation between bacterial fluorescent probes and tissue auto-fluorescence signals.

Robert of Henderson is a Professor of Engineering at the UoE, where he holds an ERC advanced grant for his world leading work on CMOS single photon avalanche diode (SPAD) detectors. After his PhD, he spent 16 years in industry at CSEM, VLSI Vision Ltd and ST Microelectronics designing image sensors for mobile phone applications before joining the UoE in 2005. He has since developed some of the world's first SPAD detectors in nanometer CMOS technology and is leading SPAD sensor related biomedical, microscopy and quantum imaging projects.

Communications & IT

Tommaso Calarco - University of Ulm

From Quantum Science to Quantum Technologies

The first quantum revolution – understanding and applying the physical laws of the microscopic realm – resulted in ground-breaking technologies such as the transistor and the laser. Now, our growing ability to manipulate quantum effects is paving the way for a second quantum revolution.

The long-term horizon is a “Quantum Web”: quantum computers, simulators and sensors interconnected via quantum networks distributing information and quantum resources such as coherence and entanglement, yielding unprecedented computing power, guarantee data privacy and communication security, and provide ultra-high precision synchronization, measurements and diagnostics for a range of applications available to everyone locally and in the cloud.

Tommaso Calarco has pioneered the application of quantum optimal control methods to quantum computation and to many-body quantum systems. Currently he is the director of the Institute for Complex Quantum Systems at the University of Ulm and of the Center for Integrated Quantum Science and Technology, which involves the University of Ulm, the University of Stuttgart and the Max Planck Institute for Solid State Research. He is an author of the “Quantum Manifesto", and a member of the Strategic Advisory Board of the ERANet QuantERA as well as of the European Commission Expert Group on the Quantum Technology Flagship.

Communications & IT

Dieter Jaksch - Oxford University

Early Applications of First Generation Quantum Information Devices

I will provide an overview of recent progress in developing the first generation of quantum devices that promise to outperform classical computers in solving challenging computational tasks. Possible applications range from acting as a quantum co-processors capable of taking on a limited set of specific tasks to machines that solve hard optimization problems efficiently. My talk will focus on the potential of early quantum devices, which are expected to consist of only tens to hundreds of qubits, to tackle ‘useful’ problems that may be of interest beyond the immediate academic community.

Prof Dieter Jaksch is the Head of Atomic & Laser Physics at the University of Oxford and a Tutorial Fellow at Keble College. He is a theoretical physicist with a background in Quantum Optics and the physics of ultracold ensembles of gaseous atoms. His research interest is in developing applications of first generation quantum devices and in the physics and functionality of strongly correlated quantum matter far away from thermal equilibrium.

Advanced Manufacturing

Bill O'Neill - Cambridge University

Carbon nanofibres: synthesis, processing and applications.

Carbon nanotubes (CNTs) have physical and mechanical properties that are superior to many known materials. They offer high strength, stiffness, electrical and thermal conductivity, thus making them extremely attractive for many future industrial applications. However, most research and development on bulk CNT materials production and applications has taken place on a small scale due to limitations in material production technologies and cost. As a result, integration of CNT structures into commercial products has not been widespread. I will present the latest developments in the synthesis and processing of carbon nanotube fibres, and discuss their application potential in electrical systems.

Prof Bill O'Neill, is the Director of the Centre of Industrial Photonics, a Fellow of Downing College, Cambridge, and Director of the EPSRC Centre for Doctoral Training in Ultra Precision. His research interests focus on laser matter interactions, materials processing and the creation of next generation manufacturing capabilities.

Advanced Manufacturing

Chris Sutcliffe - Liverpool University

Metal Additive Manufacturing a Future Production Mass Manufacturing Solution?

Metal Additive manufacturing is still in its infancy as manufacturing technologies go this proposal will investigate the current state of the art in laser based additive manufacturing suggesting future avenues for interesting research and leading onto identify new markets for adoption of the technology.

Professor Sutcliffe, works in additive manufacturing (AM) particularly laser melting and inkjet printing developing new processes and products. His work is patented, licensed and published worldwide and has resulted in the development of implants and manufacturing equipment. He holds a tenured academic position at the University of Liverpool and is Research Director at Renishaw AMPD and Director and co-founder of Fusion Implants. He has, or is, involved in 19 grants has successfully supervised 15 PhD students and has 19 active patents.

Defence and Security

Peter Asenbaum - Stanford University

Atoms as a non-local probe for gravity

Freely falling atoms are ideal test masses to study gravitational interactions. Light pulse interferometry allows one to study the motion of the atoms in respect to the laser beams, which act as rulers for the atomic position. Recent advances in interferometer times and large momentum transfer are crucial for applications such as gravity imaging as well as high precision tests of fundamental physics, e.g. the equivalence principle or quantum states in curved spacetime.

Dr. Peter Asenbaum received his PhD in Physics from the University of Vienna in 2014. The same year he joined the group of Mark Kasevich at Stanford University to work on high precision atom interferometry.

Defence and Security

Mike Holynski - Birmingham University

Cold atom gravity gradiometry

The UK National Quantum Technology Hub in Sensors and Metrology is creating a range of sensors based on cold atoms. A particular focus is on the creation of gravity gradiometry sensors for applications such as the location of underground assets, such as pipes or tunnels, and gravity mapping for resilient navigation. In order for cold atom gradiometry to bring benefit to such applications, a significant effort is needed in increasing the technology readiness of both the underpinning hardware and the sensors themselves, with a recent push being towards demonstrations in the field.

Michael Holynski is the lead of the atom interferometry team at the University of Birmingham. The team works on a range of cold atom based gravity and gravity gradient sensing, with a particular focus on the development of field ready prototypes and enabling capability within industry. One such project is the DSTL Gravity Imager, a gravity gradiometry array which targets defence orientated applications. In addition to development of the sensor hardware, the team develops new techniques in gravity inversion in order extract better information from gravity maps.