SUSSP81 Summer School in Photonic Sensing and Metrology for the United Nations Sustainable Development Goals

PROGRAMME

FOR DAY ATTENDEES

June 2025
University of Stirling

CENTRE FOR DOCTORAL TRAINING IN APPLIED PHOTONICS
Use-Inspired Photonic Sensing and Metrology

OPTICA

SUSSP
SCOTTISH UNIVERSITIES SUMMER SCHOOL IN PHYSICS

University of St Andrews
THE UNIVERSITY of EDINBURGH
University of Dundee
University of Glasgow
HERIOT WATT UNIVERSITY
University of HUDDERSFIELD Inspiring global professionals
NPL National Physical Laboratory
University of Strathclyde Glasgow
UKRI Engineering and Physical Sciences Research Council

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Programme for Day Attendees

General Information

We are pleased to be able to offer a day rate for attendance at SUSSP81, the price of which includes access to all lectures/talks on your chosen day(s), morning and afternoon refreshments, and lunch.

To apply, please complete the form: SUSSP81 day attendance

The cost is £50 per day; with a special student rate of £35 per day.

Payment should be made by electronic bank transfer to:

ACCOUNT NAME: CDT Summer School in Photonics

HELD AT: Santander Business Banking, Bridle Road, Liverpool, Merseyside, L30 4GB

ACCOUNT NUMBER: 28907972

SORT CODE: 09-01-29

Please use reference SUSSP81 and your surname.

If you have any questions, please contact cdtphotonics@hw.ac.uk.

Sunday 8th June

09:00-10:00	**Lecture: Spectroscopic sensing of atmospheric composition** Damien Weidmann, RAL Space Spectroscopy
10:00-11:00	**Lecture: Light driven processes in environmental engineering** Stephanie Loeb, McGill University
11:00-11:30	Morning tea and coffee break
11:30-12:30	**Optica and the role of scientific societies** Yann Amouroux, Optica
12:30-13:50	Lunch
14:00-15:00	**Photonics in Scotland: a great career opportunity** Alison McLeod, Technology Scotland
15:00-16:00	**Publishing workshop** Yann Amouroux, Optica, Martin Lavery, University of Glasgow, Derryck Reid, Heriot-Watt University, Gordon Robb, University of Strathclyde
16:00-16:30	Afternoon tea and coffee break
16:30-17:30	**Publishing workshop** Yann Amouroux, Optica, Martin Lavery, University of Glasgow, Derryck Reid, Heriot-Watt University, Gordon Robb, University of Strathclyde

Monday 9th June

09:00-10:00	**Lecture: Optics and photonics in early cancer detection** Sarah Bohndiek, University of Cambridge
10:00-11:00	**Lecture: Greenhouse gas emission monitoring at facility scale** Damien Weidmann, Damien Weidmann, RAL Space Spectroscopy
11:00-11:30	Morning tea and coffee break
11:30-12:30	**CDT in Applied Photonics alumni journeys and panel discussion** Leonardo Del Bino, Akhetonics, Natalie Flaherty, Thales, and Adam Sroka, Hypercube
12:30-13:00	**Group photo**
13:00-13:50	Lunch
14:00-16:00	**Poster presentations**
16:00-16:30	Afternoon tea and coffee break
16:30-17:30	**Poster presentations**

Tuesday 10th June

09:00-10:00	**Lecture: Striking a molecular chord – an introduction to quantitative absorption spectroscopy** Greg Rieker, University of Colorado Boulder
10:00-11:00	**Lecture: Augmenting the vision of the endoscopist** Sarah Bohndiek, University of Cambridge
11:00-11.30	Morning tea and coffee break
11:30-12.30	**Aria career talk** Sarah Bohndiek, Aria
12:30-13:50	Lunch
14:00-15:00	**Lecture: Greenhouse gas emission monitoring at facility scale** Damien Weidmann, RAL Space Spectroscopy
15:00-16:00	**Lecture: Photonics enabled technologies for water treatment** Stephanie Loeb, McGill University
16:00-16:30	Afternoon tea and coffee break
16:30-17:30	**Lecture: Plant phenotyping facilities** Jian Jin, Purdue University

Friday 13th June

09:00-10:00	**Lecture: Overcoming skin tone associated measurement bias** Sarah Bohndiek, University of Cambridge
10:00-11:00	**Lecture: Leading edge plant sensor innovations and their applications** Jian Jin, Purdue University
11:00-11:30	Morning tea and coffee break
11:30-12:30	**Lecture: Success through adaptability – absorption spectroscopy approaches for environmental applications** Greg Rieker, University of Colorado Boulder
12:30-13:50	Lunch
14:00-15:00	**Lecture: Single bio-particle analysis using optical nanotweezers** Justus Ndukaife, Vanderbilt University
15:00-16:00	**Poster presentations**
16:00-16:30	Afternoon tea and coffee break
16:30-17:30	**Poster presentations**

Saturday 14th June

09:00-10:00	**Lecture: Nanoplastics characterization with optical nanotweezers** Justus Ndukaife, Vanderbilt University
10:00-11:00	**Lecture: Have 100,000 lasers, will travel – how frequency comb lasers are helping to understand and reduce harmful emissions** Greg Rieker, University of Colorado Boulder
11:00-11:30	Morning tea and coffee break
11:30-12:30	**Building a culture of inclusion in engineering: my career journey as an ED&I enthusiast** Farnaz Mohsenpour, Heriot-Watt University
12:30-13:50	Lunch
14:00-15:00	**Lecture: Future of digital agriculture** Jian Jin, Purdue University
15:00-16:00	TBC
16:00-16:30	Afternoon tea and coffee break
16:30-17:30	**Prize giving and closing session** Bill MacPherson, CDT in Applied Photonics

Technical speakers

Sarah Bohndiek

University of Cambridge/ARIA

Tackling healthcare inequities in early cancer detection

Multispectral imaging represents a new frontier in medical physics that enhances colour vision and enables measurement of local concentrations of key biomarkers. For example, the distinct spectral properties of oxy- and deoxy-haemoglobin can be exploited to infer local blood concentration and oxygenation. The dynamic cellular ecosystem of a growing tumour mass requires a vascular network to obtain oxygen and nutrients, leading to marked changes in vascular structures during the early evolution of cancer that can be exploited for disease detection.

In the first lecture, I will introduce the challenges encountered in improving early cancer detection (linked to SDG3), through the lens of a physicist developing hardware solutions. I will then discuss the potential for photonic sensing and metrology to improve access to cancer care and introduce multispectral imaging as an exciting technology solution in that context. In the second and third lectures, I will introduce two key case studies from my team that demonstrate how to move new technologies along the clinical translational pathway for equitable patient benefit. I will first highlight opportunities to tackle challenges associated with clinical expertise in spotting the earliest signs of cancer in the gastrointestinal tract. I will then highlight the need to overcome biases associated with skin pigmentation in optical devices and approaches to tackle this in cancer diagnostics and more generally.

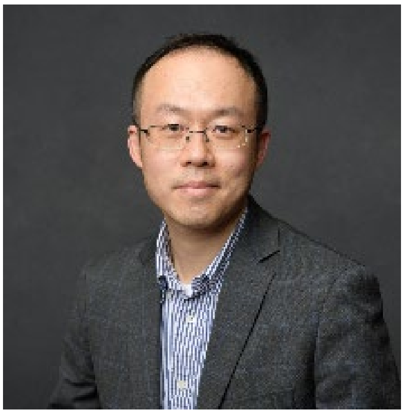
Biography

Sarah Bohndiek is a Professor of Biomedical Physics at the University of Cambridge and has built her team with a focus on pushing the boundaries of optical imaging technology to address the major unmet clinical need for earlier cancer detection. Her team work closely with clinicians enabling first-in-human clinical trials of new technologies emerging from their team. Sarah was elected Fellow of the international optics and photonics society SPIE in 2020 and starting in 2025 will be a co-Director of the OASIS Research and Partnerships Hub, bringing optical and acoustic technologies into the clinic for diagnostic and surgical interventions.

Pivoting from her background in healthcare, Sarah is currently on secondment as a Programme Director with the UK's Advanced Research + Invention Agency, where she co-leads an Opportunity Space on "Scoping our Planet", harnessing the power of photonics for climate monitoring, and is running a programme on creating an early warning system for forecasting climate tipping points.

Jian Jin

Purdue University



Advanced plant phenotyping technologies in digital agriculture

Plant phenotyping technologies have been developing rapidly over the last 2 decades. Plant sensors are becoming more accurate, faster, and easier to use. However, there are still bottleneck issues, including the changing environmental conditions, the plant's diurnal activities, and the complicated G(Genotype) x T(Treatment) x E(Environment) interactions. These issues keep plant phenotyping difficult and limit further application of the sensor technologies in precision agriculture. The plant sensor developers have been working innovatively to develop the next generation sensor technologies to address these issues. In this summer, Dr. Jin will firstly introduce the plant phenotyping facilities and explain why they were built and how they've been successfully used in detecting diseases, nutrients deficiencies, and chemical damages. He will then introduce the most recent plant sensor technologies, such as the 2021 Davidson Prize winner, LeafSpec, a handheld microscope for disease detection, a smartphone-based leaf scanner, and AI technologies for detecting nutrient deficiency and diseases at an earlier time point.

Biography

Dr. Jian Jin is an associate professor from the Department of Agricultural and Biological Engineering at Purdue University. Dr. Jin received his Ph.D. in Agricultural Engineering from Iowa State University in 2009. He earned his M.S. degree in Computer Engineering from Denmark Technical University in 2005 and his B.S. degree in Computer Science from Zhejiang University in 2003. Prior to joining Purdue, Dr. Jin conducted research at DuPont Pioneer (now Corteva). Dr. Jin's major research interest at Purdue is to develop the next generation plant sensor technologies. Dr. Jin is the president and founder of LeafSpec LLC.

Stephanie Loeb
McGill University

Photonics-enabled technologies for water treatment and contaminant detection

Light is both a ubiquitous energy source in the form of solar radiation, and able to transmit at the fastest known speeds. These advantageous properties lead to numerous potential applications for optics, photonics and photocatalytic materials in environmental engineering. Harnessing solar energy for water treatment is a highly desirable approach to provide safe water in resource limited locations. Current materials tend to have relatively wide bandgaps which are not ideal for solar applications. Nanomaterials exhibiting surface plasmon resonance (SPR) can act as light antennae due to their large absorption cross-sections, creating an opportunity to couple small SPR nanoparticles with photocatalytic semi-conductors to enhance photocatalysis. Likewise, due to their vibrant colours and sensitivity to the local environment, SPR materials have potential applications as colourimetric sensors for the detection of environmental contaminants. SPR, or other optical fluorescent based, sensors are advantageous as they may require no consumable reagents, have a negligible per sample cost, and provide near instantaneous results. A leading-edge approach to contaminant detection in environmental samples, rapid small-scale sensors could improve the ability of researchers to monitor pollutant loading while providing higher quality data with greater spatial and temporal resolution.

Biography

Professor Loeb is currently a Professor in Civil Engineering at McGill University, receiving her PhD in Chemical and Environmental Engineering from Yale University. Her research efforts span the intersection of materials science and environmental engineering, with particular focus on the removal of chemical and biological contaminants in water using sunlight, engineered light sources, and light-activated nanomaterials. Her recent research has aimed to characterize how sunlight inactivates challenging viruses in the environment. She is also interested in the fabrication and design of novel light-activated nanomaterials for sustainable water disinfection and developing improved methods for detecting and quantifying pathogens in the environment.

Justus Ndukaife

Vanderbilt University

Next generation optical nanotweezers for health and environment

The 2018 Physics Nobel Prize recognized optical tweezers for their transformative applications in understanding biological systems. Over the years, optical tweezers have enabled non-invasive trapping, manipulation, and study of biological systems. However, due to the diffraction limit of light, traditional optical tweezers struggle to stably trap nanoscale objects such as nanosized extracellular vesicles and nanoplastics. Recent advancements have led to the development of optical nanotweezers, leveraging diverse physical phenomena, including plasmon resonance, Mie resonance, and optically induced electrohydrodynamics, to overcome this limitation. In these lectures, I will provide an overview of the latest innovations in optical nanotweezer technology and their applications in nanoscale extracellular vesicles, single-molecule studies, and nanoplastics characterization. I will introduce next-generation optical nanotweezers with dramatically enhanced throughput, capable of trapping thousands of individual nanoscale objects within seconds. These advanced optical nanotweezer systems not only enable stable trapping but also facilitate precise characterization of size, shape, and composition of the trapped specimens. The multifunctional, non-invasive nature of these new nanotweezer platforms is expected to unlock new frontiers in understanding extracellular vesicle heterogeneity and drive translational applications in areas such as novel therapeutics, liquid biopsy, and environmental monitoring.

Biography

Prof. Justus Ndukaife is a distinguished researcher, educator, and innovator in Optics and Nanophotonics, with a particular focus on optical nanotweezers. He earned his Ph.D. in Electrical and Computer Engineering from Purdue University, USA. His research explores advanced nanophotonics technologies, including plasmonics, dielectric nanoantennas, and metasurfaces, to develop cutting-edge solutions for single extracellular vesicle analysis, environmental sensing, and enhancing on-chip quantum light sources. Prof. Ndukaife has published impactful research in leading journals such as Nature Nanotechnology, Physical Review Letters, Nature Communications, and ACS Nano. He also holds seven U.S. patents, reflecting his commitment to innovation in nanotechnology. His outstanding contributions have earned him numerous prestigious awards, including the NIH MIRA R35 Outstanding Investigator Award, Office of Naval Research Young Investigator Program (YIP) Award, NSF CAREER Award, Optica Challenge Prize, and the Ivan P. Kaminow Outstanding Early Career Professional Prize, among others.

Greg Rieker

University of Colorado Boulder

Energy and environmental system monitoring via laser-based absorption spectroscopy

Lasers emit pure optical frequencies that enable measurements of light-matter interaction at high accuracy, precision, and stability. In particular, infrared laser absorption by molecular species in the atmosphere, energy, and bio-energy systems can quantitatively determine the state of the system under study. This is useful for a broad range of research and interventions in these systems by enabling the detection, quantification, and localization of molecular species over time. My lecture series will introduce quantitative absorption spectroscopy and discuss its application across a variety of energy and environmental applications. I will conclude with emerging techniques in absorption spectroscopy, including the use of Nobel prize winning frequency comb lasers to study and actively reduce greenhouse gas emissions from energy infrastructure.

Biography

Greg Rieker is a Professor and Vogel Family Faculty Fellow in Mechanical Engineering at the University of Colorado Boulder. He leads the Precision Laser Diagnostics Laboratory, which aims to understand and improve energy, industrial, and atmospheric systems through laser-based sensing. In particular, the laboratory has spent a decade adapting Nobel prize winning frequency comb laser technology into robust sensors to address emerging challenges, including detecting methane emissions across hundreds of square miles of oil and gas infrastructure, designing hypersonic propulsion systems, and exploring exoplanet atmospheres. Greg earned a BS from the Missouri University of Science and Technology, and MS and PhD degrees from Stanford University. He has affiliations with the National Renewable Energy Laboratory and the National Institute of Standards and Technology. Greg received the NSF CAREER award, the Peter Werle and Hiroshi Tsuji Early Career Scientist Awards, and the Colorado Governor's Award for High-impact Research. He is a senior member of the National Academy of Inventors, and co-founder and CTO of LongPath Technologies, Inc.

Damien Weidmann

Rutherford Appleton Lab

Photonics is in the air: spectroscopic sensing of the atmosphere

Global change, and its implications, are driven by changes in atmospheric composition. Being the dumping of greenhouse gases into the atmosphere contributing to warming, or release of polluting chemicals degrading air quality, knowing what is injected into the atmosphere and what it becomes is imperative to understand the impact and the fate of a changing atmosphere. And possibly to mitigate and adapt. High resolution spectroscopy describes the interaction of light with molecules in diluted medium, such as the atmosphere. This is the tool of choice for accurate detection, identification, and quantification of atmospheric constituents. As light is involved, photonics plays a critical role in the development of high-performance spectroscopic sensors enabling high quality, ubiquitous monitoring of the atmosphere. These sensors are the sources generating data flows into digital systems that, in turns, produce knowledge and actionable outputs. Over the lectures we will establish the need for, and fundamental principles behind, accurate spectroscopic sensing of the atmosphere. Through two practical examples, the transformative value of photonics-based spectroscopic sensing will be highlighted and presented, as well as where they fit within the overall architecture of an atmospheric measurement system.

Biography

Damien Weidmann heads the Spectroscopy programme of the Space Science and Technology Department of the STFC Rutherford Appleton Laboratory (aka RAL Space). He has been conducting research and development for more than 30 years in molecular spectroscopy and atmospheric sensing, in France, the USA and the UK. He has a particular interest in the development and application of novel high resolution sensing concepts enabled by spectroscopy, covering technologies, algorithms, systems, and mission concepts. DW is also co-founder and chief scientific officer of MIRICO Ltd, a company exploiting high-precision gas sensing for terrestrial applications.