IAC Meeting 2017

Photonics Theme

Theme Co-Leaders:

Prof Robert R. Thomson

School of Engineering and Physical Sciences; Photonics & Quantum Sciences, Heriot Watt University

Dr Jennifer E. Hastie

Institute of Photonics, Department of Physics, University of Strathclyde

Photonics

Photonics is a key theme in SUPA, with ~85 core photonics academics working in Scottish physics departments:

- Dundee > 6
- Glasgow > 5
- Heriot Watt > 30
- St Andrews > 15
- Strathclyde > 30

Scottish photonics industry

Fraunhofer UK

Fraunhofer Centre for Applied Photonics (CAP) – SUPA Associate Member

Cascade Technologies

Coherent

Chromacity

Gilden Photonics

Helia Photonics

KAIAM

M Squared

optocap

optoscribe
www.optoscribe.com

Photonic Solutions

PowerPhotonic

Thales

Major projects/initiatives

Multi-institution collaborations and networks

Training networks

EPSRC Centres for Doctoral Training

Applied Photonics
Heriot Watt University (lead), Universities of **Dundee**, **Glasgow**, **St Andrews**, and **Strathclyde**
23 industrial partners, including Fraunhofer CAP

Integrative Sensing and Measurement
University of Glasgow (lead) and the **University of Edinburgh**
Industrial, research and international partners

Optical Medical Imaging
University of Edinburgh (lead) and the **University of Strathclyde**

Medical Devices & Health Technologies
University of Strathclyde

Diamond Science & Technology
University of Warwick (lead), **University of Strathclyde** and 6 other UK universities
30 industry partners including **Fraunhofer CAP**

Horizon 2020 Marie Skłodowska-Curie Innovative Training Network

Collective effects and optomechanics in ultra-cold matter (ColOpt)
University of Strathclyde (co-ordinator), **University of Glasgow** and 7 other academic partners
€3.9M, Jan 2017

SUPA SU2P and IMPP

SU2P

Partners: Universities of **Strathclyde, St Andrews, Heriot Watt, Glasgow** and **Edinburgh**

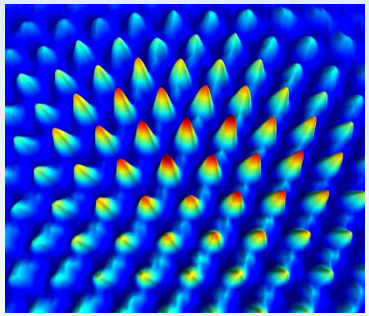
Partner: **Stanford University**

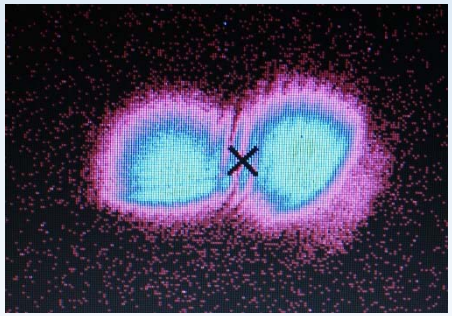
International Max Planck Partnership

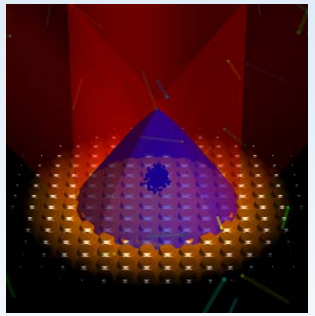
Measurement and Observation at the Quantum Limit

Partners: Universities of **Glasgow**, **Strathclyde**, **St Andrews**, **Heriot Watt** and **Edinburgh**

Partner MPIs: Gravitational Physics (Hannover), Science of Light (Erlangen), Quantum Optics (Garching), Chemical Physics of Solids (Dresden), and Solid State Research (Stuttgart)







EPSRC Quantum Tech. Hubs

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

- £270M investment to fund a national network of Quantum Technology Hubs
- Launched December 2014
- 17 universities
- 132 companies at time of launch

UK National Quantum Technology Hub Sensors and Metrology

QUANTIC

NQIT Networked Quantum Information Technologies

QUANTUM COMMUNICATIONS HUB

Universities: Birmingham (lead), **Glasgow**, Nottingham, Southampton, **Strathclyde**, Sussex

Aims: develop a range of quantum sensor and measurement technologies that are ripe for commercialisation by UK business.

Applications include: defence, geophysics, medical diagnostics, construction, naval navigation, health monitoring, GPS, network timing, and gravity imaging.

EPSRC investment: £35M

EPSRC Quantum Tech. Hubs

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UK National Quantum Technology Hub Sensors and Metrology

QUANTIC

NQIT Networked Quantum Information Technologies

QUANTUM COMMUNICATIONS HUB

Universities: **Glasgow** (lead), Bristol, **Edinburgh**, **Heriot-Watt**, Oxford, **Strathclyde**

Aims: develop new ultra-high sensitivity cameras with capabilities far beyond current state-of the art.

Applications include: visualising gas leaks, seeing through smoke, around corners and under skin, single-photon cameras, single-pixel cameras, gravity field imaging, extreme time-resolution imaging.

EPSRC investment: £23M

EPSRC Quantum Tech. Hubs

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

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UK National Quantum Technology Hub Sensors and Metrology

QUANTIC

NQIT Networked Quantum Information Technologies

QUANTUM COMMUNICATIONS HUB

Universities: Oxford (lead), Leeds, **Strathclyde**, Sussex, Bath, Southampton, Cambridge, **Edinburgh**, Warwick

Aims: develop networked quantum information technologies to surpass current supercomputers. Flagship project is the Q20:20 quantum engine.

Applications include: drug development, analysing 'Big Data', ultra-fast generation of quantum random numbers, secure communication, distributed sensing.

EPSRC investment: £38M

EPSRC Quantum Tech. Hubs

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

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- Launched December 2014
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- 132 companies at time of launch

UK National Quantum Technology Hub Sensors and Metrology

QUANTIC

NQIT Networked Quantum Information Technologies

QUANTUM COMMUNICATIONS HUB

Universities: York (lead), Bristol, Cambridge, **Heriot-Watt**, Leeds, Royal Holloway, Sheffield, **Strathclyde**

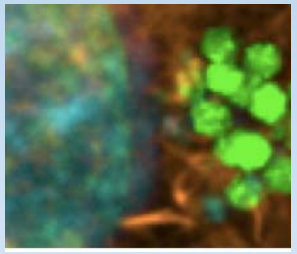
Aims: development of quantum key distribution; working towards market-ready technologies; smaller, lower-cost devices to be integrated into existing systems and infrastructure; chip-scale integration.

Applications include: encryption of communications, passwords, ID; financial transactions; mobile banking.

EPSRC investment: £24M

EPSRC large projects

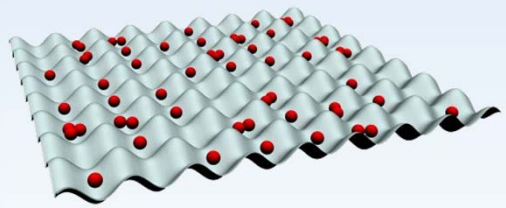
PROTEUS



Interdisciplinary Research Collaboration (IRC)

- Consortium Universities: **Edinburgh**, **Heriot-Watt** and Bath
- Aim: develop a revolutionary technology that will provide quick, in situ, in vivo diagnoses and management of lung diseases in the clinical environment.
- 2013 - 2019
- **EPSRC investment: £11.3M**

DesOEQ



Programme Grant

- Universities: **Strathclyde**, Cambridge, Oxford
- Aim: explore, understand, and design out-of-equilibrium quantum dynamics that are relevant for future communication and quantum technologies, using quantum simulators.
- 2017 - 2022
- **EPSRC investment: £5.8M**

Photonics Grants

Including cross-disciplinary funding, since May 2016

Photonics grants – RCUK

Heriot Watt University

- Black Hole Superradiance in Rotating Fluids (SURF)
  EPSRC £334k, Dec 2016 – Daniele Faccio
- Multi-modal Manufacturing of Medical Devices (4MD)
  EPSRC £1.3M, Apr 2017 – Duncan Hand
- Compact visible frequency combs: the missing link in a vision of pervasive quantum timekeeping
  EPSRC £543k, Dec 2016 – Derryck Reid
- HIRES Phase A study 2016+
  STFC £103k, Jul 2016 – Derryck Reid
- Imaging the stars from within: Super-resolution contrast ultrasound imaging
  STFC £210k, Sep 2016 – Vassilis Sboros
- Tunable Plasmonics for Ultrafast Switching at Telecom Wavelengths
  EPSRC £101k, Mar 2017 – Marcello Ferrera
- Frequency-comb enabled metrology for manufacturing
  EPSRC £539k, Mar 2016 – Derryck Reid
- Two-dimensional photonics fabrication facility
  EPSRC £582k, Jul 2017 – Brian Gerardot
- Precision Astronomical Spectrographs using Single-Mode Photonic Technologies
  STFC £490k, Apr 2017 – Robert Thomson

Photonics grants – RCUK

University of Strathclyde

- Fibre-laser pumped diamond Raman lasers for LIDAR and clear plastics welding
  EPSRC £730k, Oct 2016 – Alan Kemp
- CW operation of 94GHz Gyro-TWA for telecommunications applications
  STFC £365k, Feb 2017 – Wenlong He
- Parallel Heterogeneous Integration of III-V Devices on Silicon Photonic Chips
  EPSRC £323k, Mar 2017 – Michael Strain
- Theoretical and numerical investigation of collective effects in extreme laser-plasma interaction
  EPSRC £269k, Jan 2017 – Remi Capdessus
- QuDOS II: Quantum technologies using Diffractive Optical Structures (Phase II)
  EPSRC £153k, Mar 2017 – Paul Griffin
- REMOTE – RuggEd Micro-ECDL technology for cOld aTom application in space
  EPSRC £26k, Mar 2017 – Erling Riis
- Light-controlled manufacturing of semiconductor structures: a platform for next generation processing of photonics devices
  EPSRC Platform £1.3M, Apr 2017 – Martin Dawson (PI: Peter Skabara, Chemistry)
- Designing out-of-equilibrium many-body quantum systems
  EPSRC Programme £5.8M, Feb 2017 – Andrew Daley
- Laser-driven radiation beamlines at SCAPA
  EPSRC £1.6M, Feb 2017 – Paul McKenna

Photonics grants – RCUK

University of St Andrews

- Effective and affordable detection of small UAVs using millimetre wave coherent Doppler radar.
  STFC £218k, Jul 2016 – Duncan Robertson
- Single-molecule studies of light-emitting polymers: observing and manipulating polymer conformation in solution
  EPSRC £398k, Feb 2016 – Carlos Penedo

University of Glasgow

- Shaping light for volumetric microscope imaging in the heart
  EPSRC £100k, Nov 2016 – Jonathan Taylor
- GasSight
  EPSRC £115k, Mar 2017 – Graham Gibson

University of Edinburgh

- Quantum Entanglement Tomography for enhanced medical imaging
  EPSRC £360k, Mar 2017 – Daniel Watts

Photonics grants – European

Heriot-Watt University

- *High Energy Optical Soliton Dynamics for Efficient Sub-Femtosecond and Vacuum-Ultraviolet Pulse Generation*
  ERC Starting Grant €1.7M, Jul 2016 – John Travers
- *Two-dimensional quantum photonics*
  ERC Consolidator Grant €2M, Jan 2018 – Brian Gerardot

University of Strathclyde

- *Monolithic Diamond Raman Laser (MonoDial)*
  ERC Proof of Concept €150k, Nov 2016 – Alan Kemp
- *Collective effects and optomechanics in ultra-cold matter (ColOpt)*
  Horizon 2020 MCSA ETN £802k, Jan 2017 – Thorsten Ackemann
- *All-optical diffractive element approach to compact, simple, rapid BEC creation in space*
  European Space Agency, Jan 2017 – Paul Griffin

Photonics IUK projects

- *COCLES – Compact optical clock light engines*
  M Squared Lasers Ltd, Fraunhofer UK Research Ltd, **University of Strathclyde**
  IUK £207k, Aug 2016 – Jul 2017
- *Airy light sheet microscopy for neurological imaging*
  M Squared Lasers Ltd and **University of St Andrews**
  IUK £118k, Feb 2016 – Apr 2017
- *FlexiLEDs with printed graphene based thermal management*
  University of Strathclyde, Nano Products Ltd, Nottingham Trent University, Plessey Semiconductors Ltd, Thomas Swan & Co. Ltd
  IUK £85k, May 2016 – Apr 2017
- *GasSight: quantum technologies for gas imaging*
  M Squared Lasers Ltd and **University of Glasgow**
  IUK £222k, Mar 2017 – Feb 2018
- *QuDOS II: Quantum technologies using diffractive optical structures (Phase II)*
  M Squared Lasers Ltd and **University of Strathclyde**
  IUK £294k, Mar 2017 – Feb 2018

Research Output

With selected highlights

Research output

SUPA Photonics impact since the last IAC

> 158 papers in top-ranking multidisciplinary and field specific journals, including:

High impact interdisciplinary journals

- Science Advances: 3
- Nature Communications: 14

High impact physics journals

- Physical Review Letters: 24
- Physical Review A: 23
- Applied Physics Letters: 20

High impact field-specific journals

- Nature Photonics: 2
- Laser & Photonics Reviews: 7
- ACS Photonics: 6
- Optica: 5
- Advanced Optical Materials: 2
- Nanophotonics: 1
- Journal of Biophotonics: 2
- IEEE J. of Sel. Top. in Quantum Electron.: 2
- Biomedical Optics Express: 5
- Optics Express: 32
- Optics Letters: 12

Research highlights

University of Glasgow (Physics)

Strong activities in ***fundamental optics*** (e.g. Padgett, Barnett, Courtial, Franke-Arnold) and ***optical instrumentation*** (e.g. Harvey & Taylor)

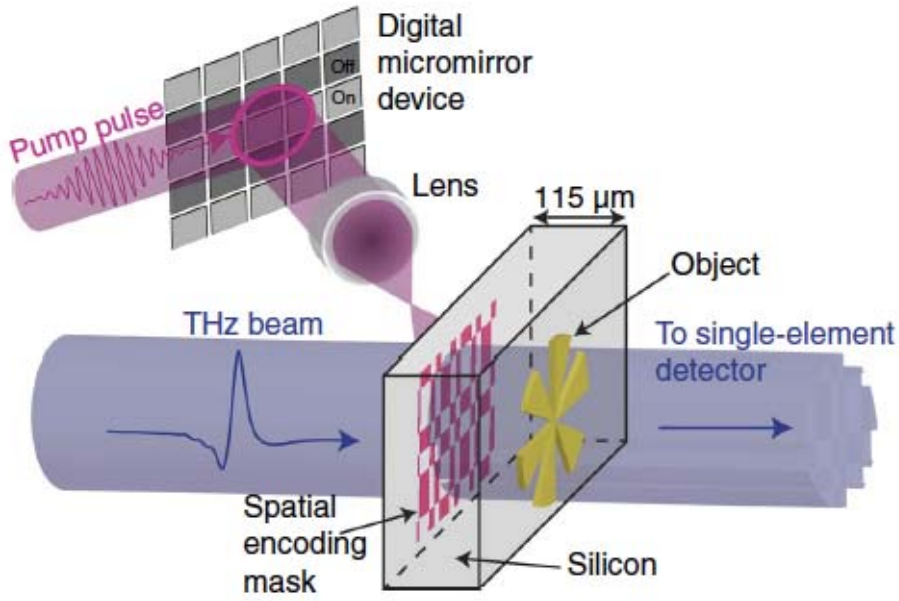
Science Advances AAAS

RESEARCH ARTICLE

APPLIED OPTICS

Noninvasive, near-field terahertz imaging of hidden objects using a single-pixel detector

Rayko Ivanov Stantchev,[1]* Baoqing Sun,[2] Sam M. Hornett,[1] Peter A. Hobson,[1,3] Graham M. Gibson,[2] Miles J. Padgett,[2] Euan Hendry[1]



Research highlights

Heriot Watt University

Strong activities ***quantum and ultrafast science*** (e.g. Reid, Faccio, Kar, Buller, Travers) ***laser manufacturing*** (e.g. Hand & Esser)

nature COMMUNICATIONS

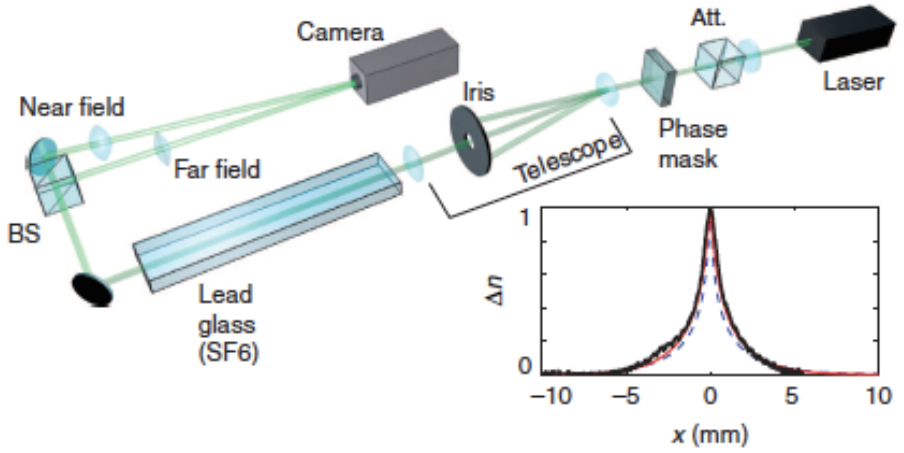
ARTICLE

Received 27 Feb 2016 | Accepted 7 Oct 2016 | Published 14 Nov 2016

DOI: 10.1038/ncomms13492 OPEN

Optical analogues of the Newton–Schrödinger equation and boson star evolution

Thomas Roger[1], Calum Maitland[1], Kali Wilson[1], Niclas Westerberg[1], David Vocke[1], Ewan M. Wright[1,2] & Daniele Faccio[1]



DOI: 10.1038/ncomms13492

Research highlights

University of St Andrews

Strong activities in ***biophotonics, semiconductor optoelectronics, quantum optics, nano-photonics***

(e.g. Dholakia, Samuel, Turnbull, Brown, Di Falco, Gather & Koenig)

Letter Vol. 4, No. 3 / March 2017 / Optica 330

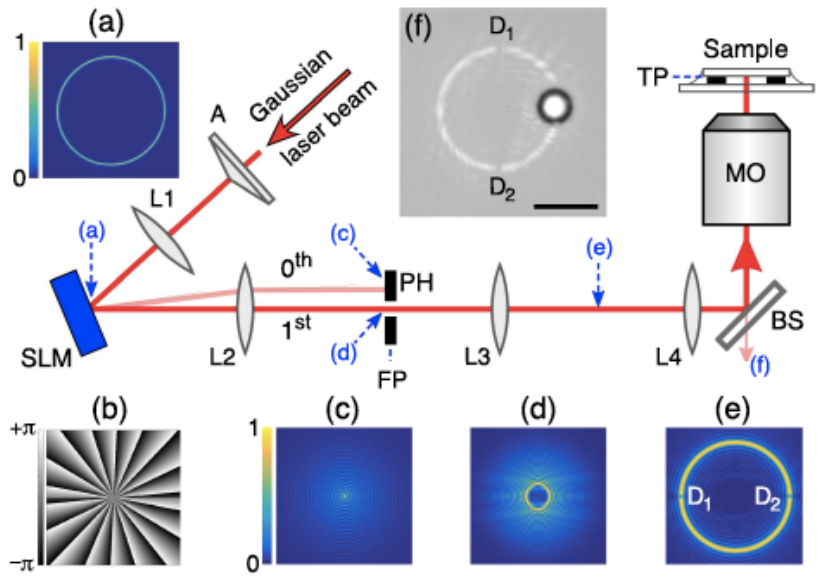
optica

Is it possible to create a perfect fractional vortex beam?

GEORGIY TKACHENKO, MINGZHOU CHEN, KISHAN DHOLAKIA, AND MICHAEL MAZILU*

SUPA, School of Physics and Astronomy, University of St. Andrews, KY16 9SS, UK
**Corresponding author: michael.mazilu@st-andrews.ac.uk*

Received 26 October 2016; revised 6 February 2017; accepted 7 February 2017 (Doc. ID 279578); published 3 March 2017



Research highlights

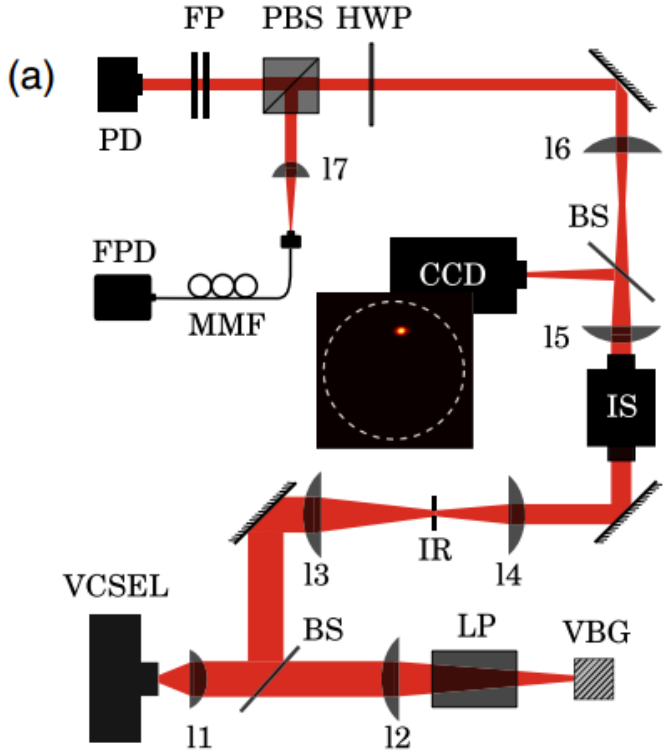
University of Strathclyde

Strong activities in ***quantum optics,*** (e.g. Riis, Kuhr, Daley, Haller, Arnold, Griffin), ***nonlinear photonics*** (e.g. Oppo, Ackemann, Yao), ***quantum theory of light*** (e.g. Jeffers), ***optoelectronic devices*** (e.g. Dawson, Strain), ***advanced lasers*** (e.g. Kemp), and ***neurophotonics*** (Mathieson).

PRL 118, 044102 (2017) PHYSICAL REVIEW LETTERS week ending 27 JANUARY 2017

Observation of Mode-Locked Spatial Laser Solitons

F. Gustave,[1] N. Radwell,[2] C. McIntyre,[3] J. P. Toomey,[4] D. M. Kane,[4] S. Barland,[1]
W. J. Firth,[3] G.-L. Oppo,[3] and T. Ackemann[3,*]
[1]*Université Côte d'Azur, CNRS, 06560 Valbonne, France*
[2]*SUPA and Department of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, United Kingdom*
[3]*SUPA and Department of Physics, University of Strathclyde, Glasgow G4 ONG, Scotland, United Kingdom*
[4]*MQ Photonics Research Centre, Department of Physics & Astronomy, Macquarie University, Sydney 2109, Australia*
(Received 27 May 2016; published 27 January 2017)



Awards and recognition

SUPA researchers in photonics and photonics related areas

Awards and recognition

- **Wilson Sibbett (St Andrews)** was made an **Honorary Fellow of the Institute of Physics**.
- **Sheila Rowan (Glasgow)** was awarded the **IOP Hoyle Medal and Prize** for "*having devised and implemented a range of refinements in precision laser interferometers, pioneering aspects of the technology of gravitational wave observatories*"
- **Sheila Rowan** was appointed **Scottish Chief Scientific Advisor**
- **Martin Dawson (Strathclyde)** was awarded the **2016 IEEE Photonics Society Aron Kressel Award**, for "*broad and sustained contributions to semiconductor opto-electronic engineering, including optically-pumped semiconductor lasers, diamond photonics and gallium nitride microdevices*".
- **Martin Dawson** was awarded the **Gabor Medal from the IOP** for his vision and leadership in applied photonics, including pioneering contributions to optically pumped semiconductor lasers, diamond photonics and gallium nitride optical microsystems, and for fostering the international development and commercialisation of these technologies.

Awards and recognition

- **Malte Gather (St Andrews)** was awarded the **IOP Paterson Medal and Prize** for "*inventing a way of generating laser light within live cells and pioneering the application of this concept for the life sciences, and for his work on organic LEDs, which find applications in the display industry and in biophotonics*."
- **Daniele Faccio (Heriot Watt)** and **Derryck Reid (Heriot Watt)** were both made **Fellows of the RSE**.
- **Daniele Faccio** was awarded the **RSE Senior Public Engagement Prize**.
- **Gian-Luca Oppo (Strathclyde)** was appointed to the **PRL Editorial Board**.
- Honorary mention: **Tom Baer (Stanford)** was made a **Corresponding Fellow of the RSE** in recognition of his work with Scottish Universities in the area of photonics innovation under the SU2P programme.