Physics Department Colloquia Speakers 2022/23

Prof Ruth Oulton (University of Bristol)

Nanolightbulbs: a bright future for quantum technology

Monday 28 December 2022

Prof Paul Williams (University of Reading)

Forecasting atmospheric turbulence from hours to decades ahead

Friday 4 November 2022

Turbulence was called “the most important unsolved problem of classical physics” by Richard Feynman. It has also been called “the last major weather-related safety challenge facing large commercial aircraft” by Delta Air Lines. Operational turbulence forecasts for the aviation sector have historically had limited skill, to the extent that many pilots simply ignored them. In this colloquium, I will explain how we developed an improved atmospheric turbulence forecasting algorithm, which is based on a new physical mechanism for turbulence generation. The algorithm is now used operationally to forecast turbulence for the aviation sector up to 18 hours ahead. It has helped make billions of passenger journeys smoother, safer, and greener. I will also explain how climate change is steadily increasing the amount of wind shear in the atmosphere. This effect is projected to lead to hundreds of per cent more turbulence in the coming decades, causing bumpier flights on some of the world’s busiest flight routes.

Prof Euan Hendry (University of Exeter)

Single pixel THz imaging using near field photomodulation

Friday 2 December 2022

Many materials respond in interesting ways to terahertz frequency radiation, and due its non-ionizing photon energies there is great interest and potential in imaging in the THz region. However, working in this region of the EM spectrum is notoriously difficult, with limited options for sources and focal lane detectors. Moreover, with the long (~mm) wavelengths, the diffraction limit places very restrictive limits on resolution.

In this talk, I will describe a relatively new approach to THz imaging that uses optically modulated, spatially patterned THz beams, created via a photomodulator. Using this approach, we can leverage the power of single pixel imaging techniques such as Hadmard imaging, with excellent signal to noise and high resolution (down to 8um), breaking the THz diffraction limit by almost two

orders of magnitude. I will present our most recent work in this area, which targets specific applications ranging from cancer detection to security screening.

Prof Tannie Liverpool (University of Bristol)

Mathematics, Physics, Biology and the 2nd law of Thermodynamics (or the Statistical Mechanics of Wound Healing)

Friday 16 December 2022

I will discuss some recent work looking quantitatively at the process of wound healing using ideas from thermodynamics and statistical mechanics. Wound healing is a highly conserved process required for survival of an animal after tissue damage. The wound repair process is not only of great interest in its own right but is also a laboratory to study complex tissue dynamics and regeneration.

Many wounds involve damage to an epithelial (barrier) tissue (like skin) that separates different regions of the body of a living organism. I will describe some recent work on studying wound healing in two dimensional epithelial tissues of a fruit fly pupal wing. This epithelium was chosen because it is transparent and accessible to sophisticated imaging techniques. We use live confocal time-lapse microscopy to follow the behaviour of cells in a tissue before and after wounding.

I will focus on three cell-behaviours that are generally accepted to contribute to wound re-epithelialisation: cell shape deformation, cell division, and cell migration.

I will describe how we are beginning to use a combination of theory and experiment to disentangle some of the organising principles behind the complex orchestrated dynamics that lead to wound healing.

Dr Habib Rostami (University of Bath)

Straintronics and Phononics in 2D Quantum Materials

Friday 24 March 2023

Dr Claire Cisowski (University of Glasgow)

Optical skyrmions: novel topological fields of light

Friday 31 March 2023

Skyrmions are topologically protected field configurations that have been observed in condensed matter systems, chiral magnetic systems and nematic liquid crystals, and most recently in optics. Since their initial conception in 2018, optical skyrmions have attracted considerable attention due to their highly reconfigurable generation. Unlike their magnetic counterparts, optical skyrmions are free from energy constraints and therefore allow the investigation of topological stability in its purest form. In this talk, I will provide a definition of optical skyrmions

based on rational maps, I will show how we generate such beams in the laboratory and I will demonstrate how we can characterize them using topological considerations.

Dr Sophie Nedelec (University of Exeter)

Coral reef soundscapes and boat noises

Friday 26 May 2023

Anthropogenic noise is a pollutant of international concern, with mounting evidence of impacts on animal behaviour and physiology that are pervasive across taxa, ecosystems and the world. Recent work from Dr Nedelec and her team shows that underwater noise affects all stages of the life cycles of fishes that inhabit fragile coral reef habitats. Stressed and badly behaved fishes are pushed to their limits, with impacts on survival.

But the tide could turn on noise pollution. Dr Nedelec's team experimentally tested the hypothesis that protecting vulnerable habitats from noise pollution can improve animal reproductive success. Using a season-long field manipulation with an established model system on the Great Barrier Reef, the spiny chromis, they demonstrated that limiting motorboat activity on reefs leads to the survival of more fish offspring compared to reefs experiencing busy motorboat traffic. A complementary laboratory experiment isolated the importance of noise and, in combination with the field study, showed that the enhanced reproductive success on protected reefs is likely due to improvements in parental care and offspring growth. Noise mitigation and abatement offer simple wins in protecting coral reefs from human impacts and present a valuable opportunity for enhancing ecosystem resilience.

Prof Nathan Lepora (University of Bristol)

How will AI transform robotics?

Friday 9 June 2023

Over the last decade, AI has made huge advances in interpreting complex information learnt from lots of data. First, this transformed image processing, e.g. recognizing photos, then it transformed speech/language processing, e.g. Siri/Alexa, and more recently it has transformed text generation, e.g. ChatGPT. However, to affect the real world directly, the AI needs to be embodied in robots. In this talk, I describe how this may be the next major advance in AI and how it could transform future robotics.

Dr Gareth Alexander (University of Warwick)

Active Liquid Crystals and Chiral Mechanics

Friday 16 June 2023

Active liquid crystals are materials with liquid crystalline order – the stuff that's in our flat screen displays – but that are driven out of equilibrium by energy uptake at the microscopic level. In recent years it has become established that active liquid crystals provide a framework for

modelling a range of biological materials, including individual cells and entire tissues, giving insights into motility, cell apoptosis, and morphogenesis. The majority of these advances have come from analysis of the simplest liquid crystal phase, the nematic, and systems that are effectively two-dimensional. However, there are a great variety of different liquid crystalline phases, including in biological materials both in vitro and in vivo. After summarising the theoretical description of active liquid crystals using non-equilibrium statistical physics, I will describe our recent work on three-dimensional materials with focus on spatially modulated states, including cholesteric and columnar phases. These phases exhibit distinctly new phenomenology associated with active chiral, or 'odd', mechanics, including the formation of controllable vortex lattices and oscillations in a purely overdamped Stokesian fluid.

Prof Philip Moriarty (University of Nottingham)

How quickly does an encaged electron tunnel free?

Friday 23 June 2023

Remarkable advances in synthetic chemistry mean that fullerenes can now be partially 'unzipped', an atom or molecule placed inside, and the carbon framework subsequently zipped up again to restore the original cage architecture [1]. The resulting endofullerene represents both an exotic state of matter (essentially a gas phase-solid state hybrid) and a unique platform for the controlled study of intra- and intermolecular charge transfer. I will discuss unpublished results from our recent beamtime experiments at the Diamond Light Source (Beamline I09) in which we have used the core-hole clock technique[2], coupled with normal incidence X-ray standing wave (NIXSW) analysis [3], to time how long it takes for an electron excited to the 4s state of an argon atom in Ar@C60 to tunnel free. Time permitting, application of the core-hole clock technique to an encapsulated molecule – namely, nitrogen in N2@C60 – will also be covered, highlighting the key role of vibrational excitation.