**Physics Post Graduate Conference**

**Wednesday 21st August 2019**

**McGougan Room**

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| **Time** | **Student** | **Primary Supervisor** |
| **09:30-09:45** | **Eliana Battistella** | **McConnell** |
|  | **Title:** Developing a light sheet system for mesoscale imaging  **Abstract:** Optical mesoscopy allows the investigation of large and thick samples with sub-cellular resolution, essential in a wide range of studies. However, it has some limitations that can be overcome by using light sheet fluorescence microscopy. This technique presents numerous advantages such as improved imaging speed, optical sectioning ability, and reduction of photo damage. In this work we aim to combine mesoscale imaging, possible thanks to the Mesolens, and a light sheet system covering a millimetre-wide field of view with micrometric axial resolution. I will present an optical configuration that allows the generation of a static light sheet with longer Rayleigh range than a conventional Gaussian beam. |  |
| **09:45 – 10:00** | **Douglas Cameron** | **Martin** |
|  | **Title:** Polarity Banded Gallium Nitride  **Abstract:** Semiconductor devices such as LEDs, solar cells, transistors and laser diodes are vital to modern everyday life. Although commercially successful they are still hampered by many issues, many of which can be combated through the growth of crystalline microstructure. Here we discuss polarity banded structures as a potential route to efficient multicolour lighting. We explore the properties of such crystal structures using electron microscopy techniques including cathodoluminescence and electron backscattered diffraction.  . |  |
| **10:00 – 10:15** | **Ryan Corbyn** | **Patton** |
|  | **Title:** Toward biologically generated field mapping using nanodiamond sensors  **Abstract:** Nanodiamonds have been presented as a strong candidate for performing high spatial resolution imaging and sensing within biological samples. Structural defects within the diamond lattice can fluoresce under laser excitation, by exploiting this property we have a fluorophore that is highly photostable. The aim of this project is to be able to utilise nitrogen – vacancy centres in nanodiamond crystals within living cells to provide sub-micron mapping of biologically generated fields. Presented here is the progress that has been made in developing an experimental procedure for measuring magnetic fields using nanodiamond probes. |  |

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| **10:15– 10:30** | **Shannan Foylan** | **McConnell** |
|  | **Title**: MesoTIRF: Optical development for mesoscopic live cell imaging  **Abstract:** In fluorescence microscopy, high resolution detail is forfeited for a large field of view (FOV). The Mesolens is a novel objective lens with a lateral FOV of 36 mm2, a lateral resolution of 0.7 µm and an axial resolution of 7 µm. To extend the axial resolution further, an illuminator based on the established Total Internal Reflection Fluorescence (TIRF) microscopy is being designed for the Mesolens. As TIRF provides a 100 nm axial resolution, MesoTIRF would allow for clearly resolving the dynamics at the cell membrane over populations of bacterial cells, therefore having useful application in novel antibiotic screening. |  |
| **Coffee Break 10:30-11:00** | | |
| **11:00 – 11:15** | **Petros Hadjichristodoulou** | **Patton** |
|  | **Title:** Multiscale Neural Imaging – from Synapse to Whole Organism  **Abstract:** We wish to image whole organisms at cellular resolution in order to link observations of the whole organism with processes occurring at sub-cellular level. Additionally, imaging nanodiamonds in living organisms and identifying an individual organism from its nanodiamond pattern are going to be investigated. To achieve this we are designing and constructing a SPIM microscope. We have found an optical solution, combined with a suitable selection of hardware that will allow us to image a FOV of 2mm at a resolution of 3μm. Axial and lateral beam scanning in combination with beam selection, are achieved by an SLM in the illumination path, while aberration correction is provided by a deformable mirror in the detection path, resulting in an adaptive SPIM design. |  |
| **11:15 – 11:30** | **Hajar Mousavi** | **Chen** |
|  | **Title:** Potential application of Gold nanoclusters toward detection of Beta Amyloid Monomers/oligomers as a Biomarker of Alzheimer’s disease  **Abstract:** Nowadays countless people suffer from neurodegenerative disease like Alzheimer’s. It is believed that the main reason behind this group of disorders is protein misfolding which results in creation of toxic oligomers and finally turn into highly ordered beta-sheet fibrils which is called beta amyloid in case of AD. Several strategies have been already proposed toward Amyloid beta detection including immunoassay, electrochemical detection, capillary electrophoresis, resonance light scattering, and so on. However, a promising approach remains unsolved. Some detection methods are expensive, time consuming and not enough selective and sensitive. Fluorescent oriented method is one of the reliable solutions which has a great potential toward Aβ detection. In this regard, wide ranges of nanostructures have been used as fluorophore for bioimaging. Hereby, we looked at some recent research in this area and then focus on fluorescent gold nanoclusters as AD sensor with advantage of long life time, large stock shift, Discrete Electronic Structure and biocompatibility. |  |

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| **11:30-11:45** | **Magdalena Lesniewska** | **Henrich** |
|  | **Title:** Microfluidic flow of colloid liquid crystal materials  **Abstract:** Liquid crystals exhibit intermediate phases where they flow like liquids, yet possess some physical properties characteristic of crystals. Colloids, i.e. nanosized particles, behave much differently when placed in an Newtonian fluid because of the surface interactions between the particles and the liquid crystal, which results in elastic stresses and topological defects. By changing volume fraction, pressure gradients, and anchoring effects intriguing effects are observed, such as: creation of percolating networks, colloid separation, reorientation of Saturn ring defects, or negative mobility. |  |
| **11:45-12:00** | **Ruairidh McArthur** | **Jaroszynski** |
|  | **Title: Theoretical study of laser based axion experiments**  **Abstract:**  Beyond the standard model (SM) axion like particles (axions) are theoretically studied from a laboratory point of view. The Klein Gordon (KG) and inhomogeneous Maxwell's equation with an axion coupling to the electromagnetic fields was derived from the Euler Lagrange equations and used to study the relationship between the governing parameters of the source signals to those of the created axion's. A three wave mixing method, similar to a Raman style amplification in plasma physics was used to boost the signal of the axion, increasing chances of detection as well as a method used to induce its decay into two light signals whose evolution was characterised. |  |
| **Lunch 12:00-13:30** | | |
| **13:30-13:45** | **Mollie McFarlane** | **McConnell** |
|  | **Title:** Applications of High Brightness 280nm LEDs in Biomedical Optical Imaging  **Abstract:** Recent advances in LED technology have produced high brightness deep-ultraviolet LEDs emitting at 280nm (1). These LEDs have potential applications in fluorescence microscopy including excitation of quantum dots - semiconductor nanoparticles which have many advantages over traditional fluorophores (2). To first characterise the optical properties of the LED, its emission spectrum was measured using a spectrometer, its optical stability using a photodiode power sensor and its emission pattern using a custom-built microscope. Results obtained from this investigation will assist in the development of the LED into a fluorescence microscope excitation source, which can then be used to image quantum dot labelled cells. |  |

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| **13:45 – 14:00** | **Jordan Murray** | **McConnell** |
|  | **Title:** Optical Mesoscopy of *Streptomyces*  **Abstract:** *Streptomyces* is a genus of soil-dwelling Gram-positive bacteria with a complex life-cycle and morphology. As a prolific producer of secondary metabolites, they produce over two-thirds of clinically relevant antibiotics in use today. *Streptomyces* are able to chemically attack and displace competing organisms, including other non-kin streptomycetes. However, the methods by which they are able recognise kin and non-kin genotypes has not been elucidated. We aim to determine these mechanisms using optical microscopy, in particular with the Mesolens which is able to image multiple *Streptomyces* colonies in one image. Here, we present our method of applying optical mesoscopy to *Streptomyces.* |  |
| **14:00-14:15** | **Alastair Nutter** | **Hidding** |
|  | **Title:** Femtosecond-micrometer spatiotemporal plasma based diagnostic  **Abstract:** Plasma afterglow metrology has the potential to become a novel diagnostic tool which allows for passive monitoring of experimental plasmas. Previous work at the FACET facility has yielded results indicating the viability of such a tool for the spatiotemporal alignment of electron and laser beams. Recent experimental results from the Daresbury Laboratory CLARA facility are presented, which demonstrate the successful implementation of plasma afterglow utilising a gas jet. Further discussion will address upcoming experiments which seek to examine this diagnostic for application in more advanced plasma acceleration schemes. |  |
| **14:15 – 14:30** | **Sofia Pistoni** | **Patton** |
|  | **Title:** Super-resolution imaging of biological organisms: seeing below the classical limits.  **Abstract:** Stimulated emission depletion microscopy is one of the techniques that constitutes super-resolution microscopy. These techniques allow the acquisition of high resolution images.  A confocal microscope can be converted into a stimulated emission depletion by incorporating a depletion beam. A Spatial Light Modulator (SLM) can be used to phase modulate the depletion beam, but needs to be calibrated before use. Interferometric techniques are an efficient way to perform the calibration.  The interferometric set-up and the first steps towards the calibration will be discussed. |  |
| **Coffee Break 14:30-15:00** | | |

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| **15:00-15:15** | **Natakorn Sapermsap** | **Chen** |
|  | **Title:** Rapid time-resolved fluorescence detection in flowing cells  **Abstract:** The lack of sensitive and affordable tools for rapid and reliable diagnosis remains an important obstacle to reducing cancer mortality. Frequently a biopsy is performed. However, even where liquid biopsy is appropriate current methods involve lengthy multiple processes and costly reagents. Their outcomes depend on the experience of assessors and interpretation is often subjective. This project aims to develop a rapid time-resolved fluorescence detecting system to facilitate tumour cell differentiation via flow cytometry using novel mRNA nanoprobes, thus providing a rapid, sensitive, reliable and high throughput solution for cancer diagnosis. |  |
| **15:15-15:30** | **Bohdan Jacek Starosta** | **Hourahine** |
|  | **Title:** Extended defect detection and analysis on ECC images  **Abstract:** Electron channelling contrast imaging (ECCI) is a non-destructive SEM imaging technique used for identifying defects in crystalline materials, which appear on the resulting images as spots with a distinctive black-white contrast. Analysis of these spots can potentially reveal a lot of information about the dislocation network beneath the surface of the sample material, however the laborious nature of characterising individual defects on images that may contain up to several thousand of them presents a barrier to conducting larger scale statistical analyses across many images and samples. This presentation will briefly discuss the nature of this problem, current attempts to tackle it using image processing algorithms, software developed as a result, and finally, future plans to utilise machine learning based image analysis to generate data for, and study the statistical distribution of extended defects in GaN films. |  |
| **15:30-15:45** | **Kieran James Wilson** | **Ronald** |
|  | **Title:**  Large helicon plasma source for investigation of parametric microwave coupling in magnetised plasma  **Abstract:** A helicon plasma source is under construction to investigate parametric microwave interaction in plasma. The 1m diameter by 2m stainless steel vessel will be surrounded by DC electromagnets producing axial fields of ~0.09T. The aim is to investigate parametric scattering, cyclotron/upper hybrid heating and current drive, both directly and through beat wave interactions in dense plasma. A range of diagnostics including Langmuir probes, microwave interferometers and energy analysers will be used to characterise the helicon and the impact of the EM waves on the plasma. Progress on modelling a helicon using COMSOL Multiphysics’ finite element solver shall be presented. |  |