Physics Post Graduate Conference

Wednesday 18th August 2021

Room 2

Zoom link : https://strath.zoom.us/j/83250652415 (passcode : 023002)

Time	Student	Primary Supervisor
10:00 - 10:15	**Dillon Downie**	**Laurand**
	Colour Converting Self Assembled Microspheres based on Colloidal Quantum Dots and Lanthanide Doped Nanoparticles Quantum Dots, Microspheres and Lanthanide doped nanoparticles have shown great promise in optoelectronics with the capacity for optical fine-tuning, however there are still significant hurdles to overcome in their development for the wholesale adoption into everyday technology. A property of particular interest is colour conversion which coupled with surface functionalisation and the absorption of near-Infrared light could provide a non-intrusive method for both biosensing and targeted drug delivery. With biomedical applications in mind, the pursuit of a cheap, non-toxic material with great performance to be desired, and while the literature has often characterised the EQE or PLQY in laboratory conditions it is paramount to expand on this when the nanocrystals' ability to fluoresce is significantly affected by a host of environmental factors such as pH and temperature. The methodology of synthesis is a crucial aspect for the overall viability of a chosen material, and as such the self-assembly of microspheres provides a simple yet effective route in fabricating nanocrystals with control over the size dispersion and surface quality. Building on this, CdSeS/ZnS and non-toxic InP/ZnS self-assembled microspheres were fabricated for performance characterisation and in the pursuit of improving methods for water soluble nanocrystals.	
10:15 – 10:30	**Ewan Bacon**	**McKenna**
	Study of Higher Order Mode Generation from a Relativistically Oscillating Aperture This presentation is concerned with the understanding of the underlying physics of a novel higher order mode (HOM) generation mechanism through simulations, which will then lead to the ability to optimise the yield of the generated HOM and tailor its characteristics for a given application. Also of concern is the experimental considerations for investigating this mechanism as there is an experimental campaign planned for 2022 using the Gemini laser system at Rutherford Appleton Labs (RAL).	

10:30 – 10:45	**Kieran Hiller**	**Trager-Cowan**
	Imaging Techniques for Quantitative Defect Analysis in EBSD Electron backscatter diffraction (EBSD) is a scanning electron microscopy technique with which to investigate the crystallographic properties of a material. When investigating the crystallography of line defects such as dislocations, it is important that the EBSD data is complemented with images of the sample surface, where dislocations may be visible. This research has adopted image processing techniques applied to the EBSD dataset in order to obtain these images and push current resolution boundaries. This has allowed for individual dislocations to be resolved in GaN and AlN samples, and subsequently characterised using the crystallographic information available from the same dataset.	
10:45 – 11:00	**Bethan Charlton**	**Laurand**
	Colloidal Quantum Dot Microassemblies for Chipscale Sensors Colloidal quantum dots (CQDs) have great optical properties and can be assembled into spherical microstructures that are optically active whispering gallery mode resonators. With suitable functionalisation, these microlasers could be used to detect harmful proteins or environmental pollutants through changes in the emission spectra. This class of self-assembled laser is novel thus the stability of these structures in different conditions will be tested, then functionalisation procedures will be developed to produce working laser biosensors. Manipulation and printing of a single microlaser will also be trialled in the future to move towards integration into a chipscale sensing device.	
Break 11:00-11:30		
11:30 - 11:45	**David Nicol**	**Massabuau**
	Understanding the Mechanisms of α-Ga_2O_3 In recent years, gallium oxide (Ga_2O_3) has emerged as a material of interest due to its large bandgap and high breakdown electric field making it suitable for applications such as ultraviolet photodetectors and high power electronics [1].The material exists in several different polymorphs [2], however α-Ga_2O_3 offers a promising avenue for research due to (i) having the largest bandgap (ii) bandgap can be tuned via alloying. A deep understanding of the mechanisms which lead to carrier transfer is essential for the development of efficient electronic devices, and we will try achieve this through optical, electrical, and structural characterisation. [1] Higashiwaki et al, *Physics status solidi (a)* ***211***(2014) [2] Roy et al, *Journal of American Chemical society* **32**(1952) [3] Wheeker et al, *Chemistry of Materials* **32**(2020)	

11:45 - 12:00	**Thomas Dickinson**	**Caspani**
	Entangled two photon absorption Entangled two photon absorption (ETPA) has been theorised to provide an advantage over classical two photon absorption in the low photon regime. We attempt to observe this phenomenon in order to determine the viability of this process in use with imaging biological tissue. Here I present early results from this investigation and an overview of our experimental design with particular emphasis on calculating the phase matching for the down conversion process and the importance this will play in an efficient evaluation.	
12:00 - 12:15	**Alex Dickson**	**Hidding**
	Laser Plasma Accelerator Ecosystem Particle accelerators have been utilised as machines of discovery and for the advancement of humankind. However, state of the art RF accelerators possess limits to their capabilities and scope. Laser Wakefield Acceleration and Plasma Wakefield Acceleration are examples of plasma based advanced accelerator concepts being developed that can increase the accelerating gradient by orders of magnitude. These two techniques have recently been combined in a Hybrid Acceleration scheme which opens up pathways to advanced injection techniques such as plasma photocathode injection. The produced electron bunches are effectively stabilised and exhibit brightness values that surpass current generation plasma and linear accelerators alike.	
12:15-12:30	**Steven Cohen**	**Strain**
	PIC Solutions: Interposed Chip Design for Silicon Electronics This presentation demonstrates the integration of photonics and silicon electronics, packaged in a chip format that can be included within the current industrial manufacturing infrastructure. The data carbon footprint continues to grow exponentially, while at the same time the hitherto exponentially increasing efficiency of electronic chips begins to plateau. The energy required for logic functions approaches a minimum, so the capacitive charging of the electronic interconnects represents a bottleneck against further reductions. This can be overcome by a shift from electronics to faster, more efficient optical interconnects. This new architecture is presented, and the feasibility of its implementation discussed.	
	Lunch 12:30-13:30	

13:30-13:45	**Kristopher Barr**	**Lagoudakis**
	Spin State Tailoring of Isolated Quantum Dot Systems The ability to coherently control individual quantum systems has great potential for applications in fields such as quantum information processing and quantum communications. Quantum dots, the solid state qubit, is but one system with which we look to demonstrate the advantages of coherent control. This talk will cover basic aspects such as the concept of coherent control, how infrastructure is built to optically address transitions and explain the effects of magnetic field geometries on the level structure of charged quantum dots.	
13:45 – 14:00	**Svetsolav Stoyanov**	**Mathieson**
	Optoelectronic Neural Implants for Degenerative Neural Conditions Neurodegenerative disease is becoming an increasingly relevant phenomenon in society and is predicted to surpass cancer mortality rates by 2040.[1] This outlines a new challenge for the medical sciences and society in general. To understand such conditions better, we have to understand how the brain works, and one of the best way to achieve this is to study neural circuits in the animal model. Optogenetics is technique of studying the animal brain by using light for neuromodulation. This project focuses on developing a wireless optogenetics neural interface capable of stimulation and recording to be used in the mouse model. [1] Gammon, K. Neurodegenerative disease: Brain windfall. Nature **515**, 299–300 (2014). https://doi.org/10.1038/nj7526-299a	
14:00 - 14:15	**Conor Davidson**	**Sheng**
	Theory and simulations studies of the Weibel instability in plasmas The Weibel instability was explored in plasmas by deriving dispersion relations via a linearisation method and comparing to particle-in-cell (PIC) simulations. The dispersion relation for counterstreaming electron beams with a third population of electrons at rest with the ion background was newly derived and great agreement with PIC simulations was found. The dispersion relation for a lepton (electron-positron) jet incident on to a cold electron-proton plasma also showed agreement with PIC simulations. Following from this, the maximum growth rate of the Weibel instability showed a nonmonotonic relation with lepton jet velocity.	

14:15 - 14:30	**Jack Easton**	
	Input/output coupling systems of Gyro-TWAs for DNP-NMR applications A broadband gyro-TWA operating at 395 GHz can be used for DNP-NMR at 600MHz. Very short pulses of THz radiation within a strong magnetic field, made possible by the large bandwidth of the gyro-TWA, increases the sensitivity of NMR spectroscopy systems. This speeds up the process of developing drugs without negatively impacting safety or efficacy. Quasi-optical components become more attractive at higher frequencies due to the machining difficulties and high ohmic losses of low-mode waveguides. The aim of this PhD is to investigate the design and manufacturing of input/output couplers for sub-mm broadband gyro-TWAs. Any output coupler will need a low reflection to avoid self-oscillations, while input couplers require high transmission.	
	Break 14:30 - 15:00	
15:00 - 15:15	**Stefan Nicolson**	**Ivaturi/Martin**
	Cathodoluminescence for Understanding Perovskite Solar Cells Cathodoluminescence as a technique is being used more readily in the study of Perovskites as an upcoming highly-efficient solar cell absorber material. However, it's use can sometimes be limited due to the sensitivity of the material and the signal to noise ratio of the equipment. Within Perovskites, it is important to use techniques such at Cathodoluminescence to understand the inefficiencies within the Absorber material, and how this impacts on the cell as a whole. My talk will cover the concept of Perovskites and Cathodoluminescence, and how this is being used to understand the effect of dopants on improving the films.	
15:15 - 15:30	**Zongyi Xia**	**Strain**
	Quantum-level Imaging and Communications with High-speed, High Density Micro-LED-based Structured Illumination In this Presentation, backgroup and drawbacks of current Spatial Light Modulators will be introduced. A tatally new designed high frame-rate (MHz) Spatial light modulator concept will be introduced. Related technologies including MicroLED and transfer-printing are talked and these technologies are used in this project to reduce dispersion. Current progression and data in the first year are presented. Futher work of next stage is introduced briefly.	
15:30 - 15.45	**Abubakr Qaasim**	**Rossi**
	Quantum Memory: Coupling defects in SiC to a Superconducting Resonator Quantum computing requires long-term memory storages. A spin-active defect in SiC coupled to a superconducting resonator is a candidate for such a quantum memory for superconducting quantum circuits. Defects in SiC are created by bombarding SiC with carbon atoms which create silicon or carbon vacancies. These defects are spin active and the divacancies which will be used have a spin triplet character. Applying a static magnetic field produces a two-level system where quantum information is stored and transferred from the superconducting resonator. This presentation will reveal results of the resonators that will be used, which shows a resonance at 3GHz.	

15:45 - 16.00	**Adam Hewitt**	**Hidding**
	High Intensity Laser-Plasma Interactions Plasma accelerators are a novel type of particle accelerator, enabling ultra-high acceleration gradients. These PWAs would enable relativistic particles to be far more readily available than they are currently. Ionization of gas into plasma is a crucial step and a large hurdle for PWAs, as the generated channel can affect the dynamics of the accelerator greatly. Presented here are results of simulations employing an intense laser pulse to ionize the plasma, with the aim of enabling future PWA experiments at FACET-II. The results show that plasma effects, namely refraction, are a major hindrance and solutions to overcome these effects are needed.	