Physics Postgraduate Conference

Wednesday 14th August 2024

JA 314

Time	Student	Primary Supervisor
10:00 - 10:15	**Alexander Burden**	**Griffin**
	Optical frequency metrology for future advances in timing in Scotland Stable, accurate, and traceable frequency reference signals are critical for the academic and industrial development of precision timekeeping technologies. An optical frequency comb and an ultrastable laser at the University of Strathclyde enables the provision of test and evaluation services for emerging technologies while also providing accessible and trusted optical frequency references to support next-generation optical clock development. To ensure and maintain trust in produced results, ongoing validation of frequency and phase measurements is important. At the National Physical Laboratory, we will investigate setting thresholds on double-counted beat notes and signal-to-noise ratios to determine and gain confidence in our validation scheme.	
10:15 – 10:30	**Tumadhir Aldakhil**	**Massabuau**
	Effect of Si-doping on the optical properties of α-Ga2O3 Gallium oxide (Ga_2O_3) is a wide bandgap semiconductor with multiple morphologies, including the α phase. The α-Ga_2O_3 phase has the widest bandgap, offering potential for diverse optoelectronic applications, especially when doped with silicon (Si). Silicon doping is known to modify the optical properties of semiconductors. In this study, I investigated the effects of silicon doping on the optical properties of α-Ga_2O_3. However, further research is needed to accurately characterize these effects, as they are currently not fully understood. Through techniques such as photoluminescence spectroscopy, I examined how silicon incorporation affects the emission spectra and defect-related photoluminescence of α-Ga_2O_3.	
10:30 – 10:45	**Kathryn McInroy**	**Daley**
	Utilising Quantum Metrology in Quantum Phase Estimation Algorithms Quantum phase estimation (QPE) is a vital subroutine to the larger space of quantum algorithms we hope to utilise in the advent of useful quantum computing, with applications from prime factoring to quantum chemistry and the aerospace industry. In this work we examine a form of QPE algorithm utilising quantum metrology techniques to reduce the resource requirements in the implementation of this procedure. We present the results of state vector simulations of such a procedure enacted by utilising spin-squeezed states generated through one-axis twisting and identify areas for further improvement.	

10:45 – 11:00	**Paul Catterson**	**Kuhr**
	Improved cooling technique for quantum simulation Quantum simulators provide an innovative platform for investigating complex many-body quantum systems, where classical computation falters due to the exponentially growing Hilbert space. Quantum-gas microscopes, with their ability for single-atom-resolved imaging in optical lattices, excel in this domain. The experimental method of Raman gray molasses cooling through the integration of a coherent sideband technique was implemented with the theoretical limit of 30μK being reached, significantly improving the cooling efficiency. To enhance the experiment's capabilities, a Digital Micromirror Device (DMD) is being incorporated, allowing for the generation of tailored light potentials to explore a wide array of quantum systems.	

Break 11:00-11:45

11:45 - 12:00	**Lewis Penman**	**Massabuau**
	Analysis of Ga_2O_3 polymorphs Gallium Oxide (Ga2O3) is a highly polymorphic wide bandgap semiconductor with reported phases α, β, γ, δ, and κ. β-Ga2O3 has long been the most studied polymorph owing to its thermal stability, however metastable phases such as the α- and κ-phases have become the subject increasing interest due to desirable properties such as a wider bandgap than β-Ga2O3[1]. However they are less understood and require further study to characterise them. Using techniques such as UV-Vis spectrophotometry, photoluminescence, and cathodoluminescence. I have characterised their optical properties, and identified emission sources relating to defects. [1] Pearton et al, Appl. Phys. Rev. 5, 011301 (2018)	
12:00 - 12:15	**Aaron Holmes**	**Hourahine**
	Advanced image analysis of semiconductor structures This study investigates the use of computer vision and machine learning techniques to classify, quantify, and analyse scanning electron microscope (SEM) images of crystalline materials, such as semiconductors. By automating the identification of crystal defects, such as dislocations, these methods aim to overcome the limitations of manual analysis. Analysing the characteristics of detected dislocations could provide valuable insights, both individually in understanding dislocation behaviour and collectively in uncovering features such as grain boundaries. This research aims to develop a better understanding of the causes of these defects and how to avoid them, contributing to the growth of more consistent materials with fewer defects.	

12:15 - 12:30	James Howell	Kuhr
	Quantum simulation with K 40 Quantum simulators are powerful tools for the study of dynamics of many body quantum systems where the exponential scaling of the Hilbert space makes numerical simulation a challenging task. With a K 40 quantum gas microscope we are able to achieve single site resolution. We have been working on our sub Doppler cooling methods including Raman gray molasses and Raman sideband cooling (RSBC) to work towards achieving single atom imaging again. Once this has been achieved the possibility of implementation of controllable light potentials allows study of interesting phenomena such as synthetic horizons.	

Lunch 12:30-14:00

14:00 - 14:15	Maximillian Wells-Pestell	Pritchard
	Optimisation of weighted graphs using neutral atom arrays Recent theoretical work has proposed a method of mapping weighted problems to neutral atom arrays using gadget constructions and local light-shifts. This work presents the first demonstration of such an approach, implementing weighted graph optimisation on a cold atom platform using a novel dual-stage annealing ramp, combining global Rydberg excitation with local light-shifts from a separate tweezer array. We explore both 1D and 2D weighted graph problems, demonstrating the feasibility of this new approach, and suggest an extension of the application of these addressable light-shifts to investigate dynamics under a local quench.	

14:15 – 14:30	**Euan Parry**	**Rossi**
	Characterizing superconducting microresonators for the interface of spin-qubits The two fundamental components of the hybridised quantum computer are the semiconductor qubit (that hosts quantum information) and the multi-purpose superconducting resonator [1]. Applications of the resonator range from the initialisation and readout of the qubit state to acting as quantum memories or information buses. To utilize these applications, strong coupling between the resonator and the desired spin-system must first be achieved. This work investigates the deterioration of a resonator's performance at the low input powers of interest for quantum experiments and in the presence of the magnetic fields required for strong coupling. [1] - Burkard, G. et al. Semiconductor spin qubits. Rev. Mod. Phys. 95, 025003 (2023). https://arxiv.org/abs/2112.08863	
14:30 - 14:45	**Cameron Paterson**	**Oi**
	Satellite Quantum Networks Quantum advantage has the potential to push technology beyond what is classically possible. These technologies, built upon the fundamental aspects of quantum theory with no classical analogue, include the generation of provably secure cryptographic keys, precise clock synchronisation and quantum metrology. Realising these become a problem of distributing high-quality quantum entanglement at scale. Quantum networks are introduced to address the question of distributing entanglement and their fundamental operations are discussed. Satellite quantum networks are introduced as an answer to the problem of distributing entanglement over large distances. The talk finishes by discussing future work regarding the modelling of distillation within quantum satellite networks.	