Physics Post Graduate Conference

Wednesday 18th August 2021

Room 1

Zoom link : https://strath.zoom.us/j/81909404099 (passcode : 767742)

Time	Student	Primary Supervisor
10:00 - 10:15	**Cait McCarry**	**McKee**
	A quantitative interpretation of satellite derived ocean colour RGB imagery Satellite derived ocean colour imagery is a tool widely used to monitor global oceans, providing datasets with extensive spatial and temporal coverage. However, one limitation is the lack of standardization in enhanced RGB image processing, making it difficult to identify features on temporal scales. In this talk, I outline a method of eRGB standardisation for ocean colour that is globally applicable. In addition, I quantitatively explore the colours produced from varying combinations of constituent concentrations (chlorophyll, dissolved organic matter and suspended sediment). Finally, I discuss the potential use of ocean colour imagery to identify the red pigmented zooplankton Calanus finmarchicus.	
10:15 – 10:30	**Binod Limbu**	**Riis**
	Frequency Stabilisation of Diode Lasers for Trapped Ion Trapped ions are often used for research in quantum information, quantum simulation and quantum metrology. A requirement is that the ions are Doppler cooled before applying any quantum control routines. Frequency stability of the cooling laser is necessary to maintain an efficient ion cooling rate and a constant fluorescence signal. Frequency modulation spectroscopy on the absorption spectrum yields first derivative of the absorption signal, which serves as the discriminant for stabilising the laser frequency. A wavemeter monitoring the laser frequency showed stabilisation was maintained for more than 90 hours, which is a vast improvement over the previous system.	

10:30 – 10:45	**Roberto Gonzalez Pousa**	**Oi**
	Security analysis and key rate enhancement for quantum key distribution with imperfect single-photon sources. Quantum key distribution (QKD) uses the laws of quantum physics, e.g. no-cloning theorem, to provide a quantum-safe encryption scheme for distributing a secret key between two parties. The BB84 is a solid quantum cryptography protocol, although it cannot experimentally tolerate all eavesdropper's attacks due to using weak coherent pulses. The security proofs in QKD has developed towards more realistic scenarios. However, the multi-photon pulses still remain an issue, even after the decoy state method, together with the channel loss. Could have a positive impact on key generation novel protocols beyond decoy state using imperfect single-photon sources? and applied in free-space?	
10:45 – 11:00	**Megan Clapperton**	**McConnell**
	Rapid Assessment of bacterial tonsillitis using mesoscopy Recurring paediatric tonsilitis is one of the most common problems presented to GPs in the UK, with an annual reported incidence of 37 per 1000 population [1]. This has detrimental effects on children's quality of life. Often, antibiotic treatment of the infection does not suffice and if a patient has seven or more cases of tonsillitis per year the complete removal of the tonsils is recommended [2]. Previous preliminary studies show the presence of biofilms in the tonsil crypts [3]. We report the first demonstration of mesoscopic imaging of bacterial infection of the human palatine tonsil using the Mesolens. [1] Douglas, C.M., Lang, K., Whitmer, W.M., Wilson, J.A. and Mackenzie, K., 2017. The effect of tonsillectomy on the morbidity from recurrent tonsillitis. Clinical Otolaryngology, 42(6), pp.1206-1210. [2] .SIGN. Management of sore throat and indication of tonsillectomy. SIGN 117. 2010; http://www.sign.ac.uk/guidelines/fulltext/117/. [3] Chole, R.A. and Faddis, B.T., 2003. Anatomical evidence of microbial biofilms in tonsillar tissues: a possible mechanism to explain chronicity. Archives of Otolaryngology–Head & Neck Surgery, 129(6), pp.634-636.	
	Break 11:00-11:30	
11:30 - 11:45	**Elliot Diamond-Hitchcock**	**Pritchard**
	Scalable Qubit Arrays for Quantum Computing and Optimisation The Scalable Qubit Arrays for Quantum Computing and Optimisation (SQuaRe) experiment aims to create a >100 qubit array using neutral Cs-133 atoms. This talk discusses some of the progress made in building a neutral atom quantum computer, with a focus on Raman sideband cooling and blue-detuned optical dipole traps.	

11:45 - 12:00	**Emmanouill Alexakis**	**Cameron**
	Rayleigh Optical Activity: A New Spectroscopic Tool for Chiral Samples. It was predicted about 50 years ago that chiral molecules should elastically scatter left- and right-handed circular polarisation of light at different rates, but this so-called Rayleigh optical activity (RayOA) has not yet been observed in the lab. In this work we aim to expand the existing theory of RayOA to describe such scattering from neat liquids and solutions and to try and build a dedicated RayOA spectrometer to detect it for the first time. Thus, we aspire to obtain important stereochemistry information to robustly assign the molecular absolute configuration.	
12:00 - 12:15	**Christopher Parsonage**	**Kuhr**
	Dynamics of correlated many-body quantum systems To study strongly correlated quantum systems with a single-atom resolution dual-species quantum gas microscope. We have a reproducible Mott insulator in the lab which lays the groundwork for performing experiments on many-body systems. By using a piezo on our retroreflecting mirror for the optical lattice, we can investigate driven systems through changing the effective tunnelling. As a starting point, the superfluid to Mott insulator transition will be driven in one dimension and the effect on correlated particle-hole pairs will be observed. In the future, artificial gauge potentials and previously unavailable Hamiltonians will be investigated.	
12:15-12:30	**Rebecca Craig**	**Patton**
	Characterisation of a low-cost ODMR system The ability to perform optically detected magnetic resonance (ODMR) cheaply and efficiently would allow researchers to easily check the quality of nanodiamond samples they would like to use for imaging. We have determined a system that allows imaging of nanodiamonds using a LED as excitation, we have compared this to laser excitation. We will also show characterisation of objectives and the stability of the system. Presented is a system that we intend to progress to full ODMR by introducing microwave frequencies in the near future.	
	Lunch 12:30-13:30	
13:30-13:45	**Sean Dyer**	**Riis**
	Micro-fabricated Chip-scale Devices Vapour cells are at the heart of atomic sensors, to transition from the laboratory to microfabricated devices we require that these vapour cells can be mass produced with consistent geometries cell to cell. A potential route to this is utilising micro-electromechanical systems (MEMS) based vapour cells. However, the silicon machining techniques struggle when etching more than several millimetres and as a result they have significantly less absorption compared to that of a conventional glass-blown cell. We can work around these limitations by laterally probing the cell by utilising a wet etching technique to produce cell walls at 54.7°	

13:45 – 14:00	**Simon Kothe**	**Kirton**
	Simulation of Open Spin Systems with Matrix Product States and Neural Network Quantum States Due to the exponential growth of the Hilbert space of many-body quantum systems, exact numerical simulations become intractable. This is exacerbated by interactions with outside world. Matrix Product States and Neural Network Quantum states offer approximate techniques to tackle this problem. We introduced and explain these methods and show preliminary results for the open transverse field Ising model. We discuss limitations of these techniques and explore how they may be extended to simulate systems where dissipative phase transitions may be observed.	
14:00 - 14:15	**Boyko Nikolov**	**Pritchard**
	Scalable Qubit Arrays for Quantum Computing & Optimisation There are many ways to skin Schrödinger's cat when it comes to developing quantum computers. This talk will focus on the neutral atom approach to quantum computation which is the subject of the author's PhD project. This group project, supervised by Dr Jonathan Pritchard, combines the efforts of two postdoctoral researchers and two PhD students with the aim of experimentally realising the UK's first quantum computer of this type. The talk highlights the individual contributions made by the author related to building and optimising magneto-optical traps and pre-cooling the Cs atoms used in the experiments to sub-Doppler temperatures. The author's contribution to the group effort that led to successfully loading and imaging an array of 256 atoms trapped in individual dipole traps formed by a spatial light modulator (SLM) is also discussed.	
14:15 - 14:30	**Graeme Campbell**	**Oppo**
	Investigation of nonlocally coupled Lugiato-Lefever equations We present a theoretical investigation aimed to characterise single dark soliton steady states of nonlocally coupled, normally dispersive, Lugiato-Lefever equations(LLE). This model describes the longitudinal dynamics of counter propagating laser fields in a microresonator. It was found that the dark soliton stationary solutions of the normally dispersive nonlocally coupled LLEs are identical to an analogues single LLE at the Maxwell point. This comparison is made by defining an effective detuning which remains constant in the presence of a steady state soliton.	
Break 14:30 - 15:00		

15:00 - 15:15	**Paul Schroff**	**Kuhr**
	Holographically generated light potentials In our quantum-gas microscope experiment, we trap ultracold K40 atoms in an optical lattice. We aim to use arbitrary light potentials to remove the harmonic confinement in our optical lattice and to realise new lattice geometries (e.g., Lieb lattice). This work deals with generating arbitrary light potentials using a liquid crystal on silicon (LCOS) spatial light modulator (SLM). Methods to calculate phase patterns which result in the desired light potential computationally are presented. Further, experimental methods to improve the quality of the experimental light potential are described.	
15:15 - 15:30	**Tomas Koslej**	**Daley**
	Stochastic Generation of Laser Phase Noise Neutral atoms in long-lived Rydberg states present a promising medium for scalable quantum simulation and computation, allowing for strong, tunable atomic interactions. Further progress in this field will require the implementation of novel laser pulse shaping for which a rigorous understanding of potential noise sources is imperative. Laser phase noise is one major source of decoherence in Rydberg systems, and it is the aim of this talk to detail how such noise can be simulated numerically. First, stochastic differential equations are introduced to describe systems with random fluctuations mathematically. Following this the talk details the generation of unique Gaussian noise arrays based on sample phase fluctuation spectra, as well as their effect on coherent dynamics.	
15:30 - 15.45	**Paulius Jonusas**	**Griffin**
	Laser Locking Technique Comparison Narrow-Linewidth, Single-Frequency Stabilized Lasers are widely used in Atomic Physics experiments. Commonly it is not entirely clear why one technique is chosen over the other. Missing key details such as clear comparisons between frequency stability, linewidth and equipment used, make it hard to determine which locking technique should be chosen for the appropriate experiment. We aim to rigorously test 6 different laser locking techniques with initial testing being carried out minimizing performance impacting elements. Once data recording is done for the baseline performance, each setup will be induced with well controlled Thermal, Mechanical vibrations and Magnetic field disruptions. The final aim is to clearly display the different techniques and their setups in easy-to-read tables and graphs for an easy-to-understand performance and complexity comparison.	