**Physics Post Graduate Conference**

**Wednesday 16th August 2017**

**McGougan Room**

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| **Time** | **Student** | **Primary Supervisor** |
| **09:30 – 09:45** | **Liam Walker** | **Robb** |
|  | **Title:** Quantum feedback control of levitated nano-particles  **Abstract:** Cooled mechanical resonators have a wide range of potential applications towards future quantum-limited metrology and sensing of small forces (e.g., gravitation), as well as improving our understanding of decoherence in quantum mechanical systems. Various experiments involving cooling trapped microscopic particles are moving towards or have reached the quantum limit. We are developing theoretical models that attempt to describe the dynamics of current experiments which involve measuring and applying feedback damping to diamagnetically levitated nanospheres. Our aim is to understand at what point we reach the fundamental quantum limits of this process and to create a basis for preparing and manipulating quantum states of motion in these experiments.  . |  |
| **09:45 – 10:00** | **Samantha Hume** | **Hunt** |
|  | **Title:** Biomedical Applications of 2D-IR Spectroscopy  **Abstract:** Analysing the biomolecule composition of human blood serum has the ability to offer new diagnosis methods for cancer, thus increasing patient survival rates and quality of life. Two-Dimensional Infrared (2D-IR) spectroscopy is an experimental technique used to investigate molecular dynamics and spectroscopy of proteins on an ultrafast timescale. Typically, proteins are dissolved in 2H2O when using 2D-IR, however for the analysis of serum this is not feasible or practical for clinical applications. Here we present the first experimental 2D-IR study of protein structures and dynamics in H2O, how they compare to dynamics in 2H2O and the first steps in distinguishing between individual proteins for serum analysis. |  |
| **10:00– 10:15** | **Patrck Bevington** | **Griffin** |
|  | **Title:** RF Optical Magnetometry in an Unshielded Environment  **Abstract:** Radio frequency (RF) optical atomic magnetometers (AMAGs) have received considerable interest as a 'quantum technology'. Their fundamental sensitivity of 0.01fT/(Hz^1/2) supersedes rival technologies (SQUIDS), and has applications in biomedical imaging, environmental sensing and explosive detection.  RF AMAGs are commonly operated within magnetic shielding, however this is bulky/heavy and costly. This work is concerned with the development of unshielded RF AMAGs, increasing the number of practical applications of the sensor technology. Presented here is a description of the system and methodologies for compensating environmental and experimental noise. |  |

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| **10:15 – 10:30** | **Jacopo Surace** | **Tagliacozzo** |
|  | **Title**: The role of entanglement in out of equilibrium dynamics  **Abstract:** Entanglement makes quantum systems fascinating, but contributes making them hard to numerical simulate.  The computational cost necessary to perform a numerical simulation of a quantum system indeed increases with the amount of entanglement contained in the state. This has been considered as the major bottleneck for performing the out-of-equilibrium dynamics of quantum systems with classical computers.  Recent developments show that, in analogy to statistical mechanics, it is not necessary to take into account all the correlations for a useful description of the system, and phenomena like thermalisation can be simulated through appropriately designed approximate dynamics whose computational cost is much more contained than the full exact dynamics. We will present our strategy to design such new algorithm, that should lead to an almost exact description of the dynamic of local observables. |  |
| **Coffee Break 10:30-11:00** | | |
| **11:00 – 11:15** | **Abeer Alghamdi** | **Rolinski** |
|  | **Title:** Detecting beta-amyloid aggregation from the time-resolved emission spectra (TRES)  **Abstract:** Aggregation of beta-amyloids is one of key processes responsible for the development of Alzheimer’s disease. Early molecular-level detection of beta-amyloid oligomers may help in early diagnosis and in the development of new intervention therapies. The observed change in beta-amyloid’s single tyrosine intrinsic fluorescence response during aggregation was used, in previous studies, to indicate the extent of aggregation at its earliest stages. Here we present a complementary approach based on time-resolved emission spectra (TRES), which has the advantage of resolving the fluorescent species in the aggregating beta-amyloid state and revealing their dielectric relaxation, the latter carrying information on the local environment. |  |
| **11:15-11:30** | **Carolyn O’Dwyer** | **Griffin** |
|  | **Title:** Atomic Magnetometry in Unshielded Environments  **Abstract:** Precise magnetic field measurements have advantages in many applications, but the current tools we use can be costly, bulky and power-intensive. Optical atomic magnetometry offers solutions to these issues; by using double resonance techniques we aim to build a compact system in an unshielded environment, producing measurements with high precision for a range of applications, with particular efficacy in the geophysical range. I will present the motivations for building unshielded magnetometers, as well as the field control system we have designed to achieve a tolerance of 0.24 nT on a 200 nT field in our test system.  . |  |

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| **11:30-11:45** | **Araceli Venegas-Gomez** | **Daley** |
|  | **Title:** State preparation with optical lattices via adiabatic cooling of bosons  **Abstract:** Experiments with cold atoms in optical lattices offer new opportunities to observe sensitive many-body phenomena like quantum magnetism. The macroscopic control over these systems provides an excellent platform to study the behaviour of such strongly correlated systems directly linked to solid-state physics.  The challenge in on-going experiments remains reaching the low temperatures/entropies necessary for some particularly sensitive interacting states. We study new techniques to prepare states with a very low entropy using adiabatic state preparation, especially investigating the magnetically ordered quantum states that can be engineered using these techniques. We model these techniques for realistic parameters using numerical methods based on tensor networks. |  |
| **11:45-12:00** | **Zendesha Mbalaha** | **Chen** |
|  | **Title:** Gold nanoparticle based nanoprobe for biomedical applications  **Abstract:** The threat posed by cancer to human existence is a global phenomenon. Statistics have shown the increasing cases of cancer and related deaths. Attempts to treat cancer through conventional methods (surgery, chemotherapy and radiation therapy) have been hampered by cancer metastasis, regeneration, drugs resistance and other associated side effects. Early diagnosis of cancer remains one of the viable approaches to fight against cancer. Therefore, the development of new ways to screening, diagnosis and treatment is desirable. Gold nanorods (GNRs) have proven to be good candidates for these purposes due to their unique optical properties and compatibility with biological molecules. The aim of the study is to fabricate small gold nanorods based nanoprobe for detection and photothermal therapy of cancer. This work has synthesized small gold nanorods of various sizes by adding varying amount of seeds solution and silver nitrate into the growth solution and, a small gold nanorods based nanoprobe has been developed for biomedical applications.  Key words: **Gold Nanorods, Nanoprobe, Photothermal.** |  |
| **Lunch 12:00-13:30** | | |
| **13:30 – 13:45** | **Scot Thomas** | **Riis** |
|  | **Title:** RF Voltage Testing of Microfabricated Ion Traps  **Abstract:** Ions in radio-frequency traps offer one of the leading ways to create a quantum computer due to their accuracy and long coherence times. Microfabricated chip-scale traps makes scalability a further advantage. In order to operate these micro-traps require deep potential wells which are created with A.C. voltages with amplitudes of 300-400V and frequencies in the 5-30MHz region. To verify that newly produced traps can withstand high voltages an RF Test Setup has been created to measure the point at which surface flashover occurs. Devices that exceed the 300V test are considered to be suitable for use in ion trapping experiments. |  |

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| **13:45-14:00** | **Gioan Tatsi** | **Jeffers** |
|  | **Title:** Cat State (Non-) Amplification  **Abstract:** Schrödingercat states have been proven to play an important role in quantum computation and in quantum cryptography. For these applications cat states of high amplitude and high fidelity are desirable. This gives rise to the need for cat state amplification.  The quantum world is quite forbidding when it comes to deterministic amplification due to the no cloning theorem. Non-deterministic amplifiers have been proposed as the solution. This talk considers the use of one such amplifying scheme for cat states. |  |
| **14:15 – 14:30** | **Nora Alkudaisi** | **Chen** |
|  | **Title:** Lysozyme encapsulated gold nanoclusters for studying protein aggregation  **Abstract:** Protein aggregation can lead to amyloid fibrils formations that can be found in many diseases such as Alzheimer's. This work explores the potential of employing Lysozyme gold nanoclusters (Lys-AuNCs) to study the protein aggregation. The fluorescence properties of (Lys-AuNCs) as function of pH, and the concentration of additional native lysozyme at pH 12.5 are studied using steady-state and time-resolved fluorescence spectroscopy. It was found that the fluorescence intensity of AuNCs and the lifetime decreases with decrease of the pH possibly due to Stark Effect. At pH 12.5 the fluorescence intensity of gold nanocluster increases up to 27.43% at 5 mg/ml then remain constant due to the formation of protein aggregations. |  |
| **Coffee Break 14:30-15:00** | | |
| **15:00-15:155** | **Matthew Johnson** | **Riis** |
|  | **Title:** Atomic Waveguides for Matter-wave interferometry using Fresnel Zone Plate Holography **Abstract:** Some of the highest performing Gyroscopes today use atomic systems, exploiting their stability and increased sensitivity. The majority require large and immobile apparatus to operate, such as atomic fountains. In the pursuit of miniaturisation, optically generated potentials can be used to confine and guide cold atoms instead. Static potentials for interferometry, atomtronics and fundamental physics can be generated holographically by using a Fresnel zone plate – a binary hologram based on the focusing optic[**1]**. In this talk I will cover the principle of rotation sensing using a Bose-Einstein Condensate and present details on the Fresnel Zone Plate we are developing.  [1] V.A. Henderson, P.F. Griffin, E. Riis and A.S. Arnold, New J. Phys. **18**, 025007 (2016) |  |

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| **15:15-15:30** | **Matthew Brown** | **Kuhr** |
|  | **Title:** Towards quantum degeneracy of fermionic potassium-40 in a quantum gas microscope.  **Abstract:** Quantum gas microscopes offer unique possibilities to probe the properties of quantum systems with single atom resolution. We perform evaporative cooling in a crossed optical dipole trap to realise an ultra-cold ensemble of K40, before loading into an optical lattice. Evaporation efficiency is enhanced through application of magnetic field gradients across the trap, along with an additional optical beam providing strong horizontal confinement near the trap centre. Using absorption imaging, we record the density distribution of the atomic cloud after release from the confining potential. Initial Fermi-Dirac fits to the measured density profiles indicate the evaporated fermions are entering the regime of quantum degeneracy. |  |