Quantum Roundabout 2018

Nottingham, 11th-13th July 2018

	Tue 10	Weds 11	Thur 12	Fri 13	Fri 14
08:50 - 09:00		Opening			
09:00 - 10:00		J. Oppenheim	N. Datta	M. Paris	
10:00 - 10:30		C. Lombard L.	S. Tserkis	T. Bromley	
10:30 - 11:00		Coffee Break	Coffee Break	Coffee Break	
11:00 - 11:30		C. M. Scandolo	Y. Lim	F. Albarelli	
11:30 - 12:00		E. Bäumer	Y. Xiang	J. Rubio. J.	
12:00 - 12:30	ARRIVALS	M. Weilenmann	A. Riccardi	L. Innocenti	DEPARTURES
12:30 - 14:00		Lunch	Lunch	Lunch	
14:00 - 15:00		J. Oppenheim	N. Datta	M. Paris	
15:00 - 15:30		G. M. Andolina	J. Watson	M. Vasmer	
15:30 - 16:00		D. Farina	M. Rossi	E. Polino	
16:00 - 16:30		Tea Break	Tea Break	Tea Break	
16:30 - 17:00		S. Milz	P. Brown	G. Chesi	
17:00 - 17:30		A. Skelt		D. Branford	
17:30 - 18:30		Free time	Social event and conference dinner	S. Qvarfort	
18:30 - 22:00		Poster Session		Closing	

Welcome to Quantum Roundabout 2018!

Organising committee

- **Benjamin Morris**, University of Nottingham
- **Carmine Napoli**, University of Nottingham
- **Giorgio Nocerino**, University of Nottingham
- **Buqing Xu**, University of Nottingham

with support from **Gerardo Adesso**, **Katie Gill**, **Ludovico Lami**, **Paul Knott** and the **Quantum Correlations group** at the University of Nottingham.

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MΩΦ

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Programme

Tuesday 10th July Arrivals	
Wednesday 11th July	
08:50-09:00	**Opening**
09:00-10:00	**Prof. Jonathan Oppenheim** Quantum resource theories and quantum thermodynamics [Keighton aud.]
10:00-10:30	**Camille Lombard Latune** The power of non-thermal states in autonomous quantum thermal machines [Keighton aud.]
10:30-11:00	**Coffee Break**
11:00-11:30	**Carlo Maria Scandolo** Microcanonical thermodynamics in general physical theories [Keighton aud.]
11:30-12:00	**Elisa Bäumer** Partial Thermalizations Allow for Optimal Thermodynamic Processes [Keighton aud.]
12:00-12:30	**Mirjam Weilenmann** Smooth entropy in axiomatic thermodynamics [Keighton aud.]
12:30-14:00	**Lunch**
14:00-15:00	**Prof. Jonathan Oppenheim** Quantum resource theories and quantum thermodynamics [Room B1 phys.]
15:00-15:30	**Gian Marcello Andolina** High-power collective charging of a solid-state quantum battery [Room B1 phys.]
15:30-16:00	**Donato Farina** On the energy charging of quantum batteries [Room B1 phys.]
16:00-16:30	**Tea Break**
16:30-17:00	**Simon Milz** General framework for the characterization of complex processes with memory [Room B1 phys.]
17:00-17:30	**Amy Skelt** DFT-style approaches to quantum thermodynamics [Room B1 phys.]
17:30-18:30	**Free time**
18:30-22:00	**Poster Session** [Senate Chamber]
Thursday 12th July	
09:00-10:00	**Dr. Nilanjana Datta** Entropies and Majorization in Quantum Information Theory [Keighton aud.]
10:00-10:30	**Spyros Tserkis** Simulation of Gaussian channels via teleportation and error correction of Gaussian states [Keighton aud.]
10:30-11:00	**Coffee break**
11:00-11:30	**Youngrong Lim** Activation of quantum capacity of Gaussian channels [Keighton aud.]
11:30-12:00	**Yu Xiang** Multipartite Einstein-Podolsky-Rosen steering sharing with separable states [Keighton aud.]
12:00-12:30	**Alberto Riccardi** Multipartite steering inequalities based on entropic uncertainty relations [Keighton aud.]

Thursday 12th July (cont.)	
12:30-14:30	**Lunch**
14:30-15:30	**Dr. Nilanjana Datta** Entropies and Majorization in Quantum Information Theory [Keighton aud.]
15:30-16:00	**James Watson** The Computational Complexity of the Ground State Energy Density Problem [Keighton aud.]
16:00-16:30	**Matteo Rossi** Quantum walks on graphs affected by dynamical noise [Keighton aud.]
16:30-17:00	**Tea Break**
17:00-17:30	**Peter Brown** Constructing quantum-secure device-independent randomness expansion protocols [Keighton aud.]
17:30-22:00	**Social event and Conference dinner**
Friday 13th July	
09:00-10:00	**Prof. Matteo Paris** An invitation to quantum metrology [Keighton aud.]
10:00-10:30	**Thomas Bromley** Quantum Computing – The Emerging Industry [Keighton aud.]
10:30-11:00	**Coffee Break**
11:00-11:30	**Francesco Albarelli** Restoring Heisenberg scaling in noisy quantum metrology by monitoring the environment [Keighton aud.]
11:30-12:00	**Jesús Rubio Jiménez** Extracting maximum information from limited data [Keighton aud.]
12:00-12:30	**Luca Innocenti** Supervised learning of time-independent Hamiltonians for gate design [Keighton aud.]
12:30-14:00	**Lunch**
14:00-15:00	**Prof. Matteo Paris** An invitation to quantum metrology [Keighton aud.]
15:00-15:30	**Michael Vasmer** Reducing the Surface Code Overhead [Keighton aud.]
15:30-16:00	**Emanuele Polino** Experimental Phase Estimation Enhanced By Machine Learning [Keighton aud.]
16:00-16:30	**Tea Break**
16:30-17:00	**Giovanni Chesi** Measuring nonclassicality of well-populated squeezed-vacuum states with Silicon photomultipliers [Keighton aud.]
17:00-17:30	**Dominic Branford** On the fundamental quantum limits of multi-carrier-laser interferometric gravitational-wave detectors [Keighton aud.]
17:30-18:00	**Sofia Qvarfort** Gravimetry through non-linear optomechanics [Keighton aud.]
18:00-18:30	**Closing**
Saturday 14th July Departures	

Invited Talks - Abstracts

Quantum Information theory: Dr. Nilanjana Datta

Dr. Nilanjana Datta is a Reader at the Department of Applied Mathematics and Theoretical Physics at Cambridge University and a fellow of Pembroke College. Since 2002, her research has primarily been in the field of Quantum Information Theory. She has been working on various aspects of this field: perfect transfer of quantum states and entanglement over spin networks, additivity conjectures of the Holevo capacity and the evaluation of the optimal rates of various quantum information protocols using the Quantum Information Spectrum method.

Entropies and Majorization in Quantum Information Theory

Entropies play a key role in Quantum Information Theory. The von Neumann entropy characterizes the optimal rate of quantum data compression. It also arises as the characteristic quantity in the important operational tasks of entanglement distillation and entanglement dilution. The von Neumann entropy belongs to a larger class of entropies, called Renyi entropies, which too have important operational significance, for example, in state discrimination. In these lectures we will study a fundamental property of these entropies, namely, continuity. This concerns the following question: "If two quantum states are close to each other, how close are their entropies?" To address this question, we employ a powerful mathematical toolkit, called Majorization Theory. Then we use our results to study the interesting problem of conversion of bipartite states, shared between two distant parties, via local operations and classical communication (LOCC).

Quantum Thermodynamics: Prof. Jonathan Oppenheim

Prof. Jonathan Oppenheim is a professor of quantum theory in the Department of Physics and Astronomy (Quantum Information Group) at University College London (UCL). He currently holds a Royal Society Wolfson Merit Award and an EPSRC Established Career Fellowship. Together with Michał Horodecki and Andreas Winter, he discovered quantum state-merging and used this primitive to show that quantum information could be negative. More recently he and collaborators have developed a resource theory for thermodynamics on the nano and quantum scale.

Quantum resource theories and quantum thermodynamics

These lectures will provide a tutorial on the general structure of quantum resource theories and their application to quantum thermodynamics. Topics covered may include: the Szilard engine, Maxwell's demon, resource monotones, majorisation theory, and the many second laws of quantum thermodynamics.

Quantum Estimation theory: Prof. Matteo Paris

Prof. Matteo Paris leads the Applied Quantum Mechanics group at the University of Milan, Italy, where theoretical and experimental research is conducted in the fields of Quantum Optics, Quantum Technology, Quantum Mechanics, and Open Quantum Systems. Matteo has given pioneering contributions to the development of quantum tomography for states and operations and to continuous variable quantum information. His current interests concern quantum estimation and the study of correlated systems at the boundary of the quantum and classical worlds.

An invitation to quantum metrology

Quantum detection and estimation theory is a powerful tool for the quantum characterization of states and operations and for the search of new physics in different directions at the forefront of research. In these lectures we provide an introduction to quantum enhanced techniques for state discrimination and precision measurements, i.e. those schemes often referred to as quantum metrology:

1. Generalities about estimation, measurement and discrimination;
2. Ambiguous state discrimination (Bayes and NP strategies);
3. Unambiguous state discrimination (outline);
4. Global quantum estimation theory, estimation of a shift-parameter;
5. Local quantum estimation theory, quantum Cramer-Rao theorem;
6. Examples.

Contributed Talks - Abstracts

(Author alphabetical order)

Francesco Albarelli: Restoring Heisenberg scaling in noisy quantum metrology by monitoring the environment

We study quantum frequency estimation for N qubits subjected to independent Markovian noise, via strategies based on time-continuous monitoring of the environment. Both physical intuition and an extended convexity property of the quantum Fisher information (QFI) suggest that these strategies are more effective than the standard ones based on the measurement of the unconditional state after the noisy evolution. Here we focus on initial GHZ states and on parallel or transverse noise. For parallel noise, i.e. dephasing, we show that perfectly efficient time-continuous photo-detection allows to recover the unitary (noiseless) QFI, and thus to obtain a Heisenberg scaling for every value of the monitoring time. For finite detection efficiency, one falls back to the noisy standard quantum limit scaling, but with a constant enhancement due to an effective reduced dephasing. Also in the transverse noise case we obtain that the Heisenberg scaling is recovered for perfectly efficient detectors, and we find that both homodyne and photo-detection based strategies are optimal. For finite detectors efficiency, our numerical simulations show that, as expected, an enhancement can be observed, but we cannot give any conclusive statement regarding the scaling. We finally describe in detail the stable and compact numerical algorithm that we have developed in order to evaluate the precision of such time-continuous estimation strategies, and that may find application in other quantum metrology schemes.

Gian Marcello Andolina: High-power collective charging of a solid-state quantum battery

Quantum information theorems state that it is possible to exploit collective quantum resources to greatly enhance the charging power of quantum batteries (QBs) made of many identical elementary units. We here present and solve a model of a QB that can be engineered in solid-state architectures. It consists of N two-level systems coupled to a single photonic mode in a cavity. We contrast this collective model ("Dicke QB"), whereby entanglement is genuinely created by the common photonic mode, to the one in which each two-level system is coupled to its own separate cavity mode ("Rabi QB"). By employing exact diagonalization, we demonstrate the emergence of a quantum advantage in the charging power of Dicke QBs, which scales like √ N for N \gg1.

Elisa Bäumer: Partial Thermalizations Allow for Optimal Thermodynamic Processes

Thermalization processes are ubiquitous in macroscopic thermodynamics, being at the core of optimal processes such as a Carnot engine. However, when dealing with small quantum systems, energy exchanges do not always lead to thermalization. A more realistic model to describe these situations are partial thermalizations, where the system becomes closer to a thermal state while not reaching it. In fact, partial thermalizations happen to characterize a large set of interactions between small systems. In our work, we show that optimal thermodynamic processes can still be constructed by means of such partial thermalizations. At the fundamental level, this shows that optimal thermodynamic processes are much more common than previously expected in small quantum systems. Furthermore, this result also has implications at the experimental level, by simplifying the task of constructing optimal thermodynamic processes for small engines.

Dominic Branford: On the fundamental quantum limits of multi-carrier-laser interferometric gravitational-wave detectors

Phase estimation is one of the most fundamental applications of quantum metrology. By measuring the phase of light reflected from test masses in large-scale interferometers it is possible to detect gravitational waves. In order to better resolve this phase shift it is beneficial to use higher intensity light, yet reflected light causes random fluctuations in the mirror's motion which reduce sensitivity to the gravitational wave signal with current detector schemes. We explore whether multi-mode states of light, generated by driving the interferometer with a set of lasers operating at a distinct frequencies, can improve sensitivity and provide an advantage in overcoming radiation-pressure effects. Considering externally squeezed inputs and optical loss we apply quantum metrology techniques to interferometers with multiple carrier-modes to derive fundamental bounds and evaluate the sensitivity attainable with homodyne detection schemes.

Thomas Bromley: Quantum Computing – The Emerging Industry

The race is on to manufacture the first generation of quantum technologies and harness them to solve practically useful problems. A myriad of companies have set up shop hoping to identify the most suitable architectures and applications for quantum computing.

Peter Brown: Constructing quantum-secure device-independent randomness expansion protocols

Randomness expansion protocols exploit a fundamental connection between randomness and nonlocality to enable the production of large quantities of certifiable randomness. Through the unification of two powerful theoretical tools from the device-independent literature, the device-independent guessing probability (DIGP) and the entropy accumulation theorem (EAT), we prove security for a large class of randomness expansion protocols. Overall, this results in a malleable framework for constructing randomness expansion protocols which can be tailored to the requirements of a user. In this talk, we present our framework and analyse the performance of several example protocols.

Giovanni Chesi: Measuring nonclassicality of well-populated squeezed-vacuum states with Silicon photomultipliers

The study of nonclassical properties of quantum states is an important topic in the current research and their exploitation requires effective measurements. Promising results in this respect have been obtained in the last two decades by means of photon-number-resolving (PNR) detectors.
Here we show recent results achieved with the class of Silicon photomultipliers (SiPMs). They are commercial PNR detectors extensively used for particle physics applications. Till now, they have been marginally exploited in the field of Quantum Optics due to the presence of cross-talk effects and low quantum efficiency. We demonstrate that the new generation of SiPMs can be used to observe sub-shot-noise correlations between the two parties of a well-populated squeezed vacuum state. These results are promising for the application of SiPMs to more complex schemes.

Donato Farina: On the energy charging of quantum batteries

In the quantum nano-technology field the study of quantum batteries can become one of the leading frontiers. In particular the understanding of the role of quantum mechanics either in the charging than in the work extraction steps is essential. To describe the charging step I present a theoretical analysis of quantum systems composed of two interacting parties - a charger A and a battery B. After an introduction on the energy transfer from A to B in the closed case and on the benefit coming from global operations, I will describe energy transfer protocols in open frameworks by including a both thermal bath and a coherent field to perform the charging. Under a local Lindblad master equation approach, exact results on the dynamics of the systems under study and optimal configurations for the energy transfer will be discussed.

Luca Innocenti: Supervised learning of time-independent Hamiltonians for gate design

We present a general framework to tackle the problem of finding time-independent dynamics generating target unitary evolutions. We show that this problem is equivalently stated as a set of conditions over the spectrum of the time-independent gate generator, thus transforming the task to an inverse eigenvalue problem. We illustrate our methodology by identifying suitable time-independent generators implementing Toffoli and Fredkin gates without the need for ancillae or effective evolutions. We show how the same conditions can be used to solve the problem numerically, via supervised learning techniques. In turn, this allows us to solve problems that are not amenable, in general, to direct analytical solution, providing at the same time a high degree of flexibility over the types of gate-design problems that can be approached. As a significant example, we find generators for the Toffoli gate using only diagonal pairwise interactions, which are easier to implement in some experimental architectures. To showcase the flexibility of the supervised learning approach, we give an example of a non-trivial four-qubit gate that is implementable using only diagonal, pairwise interactions.

Youngrong Lim: Activation of quantum capacity of Gaussian channels

Quantum channels can be activated by a kind of channels whose quantum capacity is zero. This activation effect might be useful to overcom noise of channels by attaching other channels which can enhance the capacity of a given channel. In this work, we show that such an activation is possible by specific positive-partial-transpose channels for Gaussian lossy channels whose quantum capacities are known. We also test more general case involving Gaussian thermal attenuator whose narrow upper bound on quantum capacity is recently suggested.

Camille Lombard Latune: The power of non-thermal states in autonomous quantum thermal machines

Autonomous thermal machines are capable of extracting energy (from thermal sources) or cooling down systems without need of external control or driving and therefore are promising for local and non-invasive technological and experimental applications. We build a model of autonomous thermal machines where the work reservoir can be any system instead of the usual harmonic oscillator or qubit. It allows us to witness special effects not present in harmonic oscillators or qubits. For the same energetic content, some non-thermal states of the work reservoir yield an efficiency way above the one provided by thermal states. The thermodynamic behaviour of non-thermal states is characterised by the introduction of the concept of apparent temperature which points out the special effects of coherence, correlations, but also non-thermal population distributions. Some example are provided to illustrate their dramatic impact. We also recover seminal results providing an unifying point of view of diverse phenomena.

Simon Milz: General framework for the characterization of complex processes with memory

Traditional descriptions of the dynamics of open quantum systems are plagued by unphysical results as soon as memory effects play a non-negligible role. These effects commonly arise when the system of interest has a complex and structured environment. To make matters worse, the mere definition of a quantum stochastic

process, as well as memory and memory effects in the quantum regime is still subject of active debate and not generally agreed upon. To remedy these shortcomings, a new unified scheme for operationally describing general quantum dynamics, known as the process tensor formalism, has been developed. This new framework allows -- independent of the details of the system-environment interaction -- for a full characterization of the underlying dynamics based on a finite number of local manipulations, and enables one to quantify its complexity in an unambiguous manner.
In my talk, I will outline this general formalism, and illustrate how it naturally generalizes the theory of classical stochastic processes to the quantum regime, thus putting both theories on an equally sound mathematical footing. Furthermore, I will discuss, how this clear-cut understanding of general quantum processes elucidates the role of entanglement and memory effects as a resource for the simulation of processes that display exotic causal structures.

Emanuele Polino: Experimental Phase Estimation Enhanced By Machine Learning

Phase estimation protocols provide a fundamental benchmark for the field of quantum metrology. Most theoretical and experimental studies have focused on determining the fundamental bounds and how to achieve them in the asymptotic regime. However, in most applications it is necessary to achieve optimal precisions by performing only a limited number of measurements. To this end, machine learning techniques can be applied as a powerful optimization tool.
Here we experimentally implement single-photon adaptive phase estimation protocols enhanced by machine learning, showing the capability of reaching optimal precision after a small number of trials. In particular, we introduce a new approach for Bayesian estimation that exhibits best performances for low number of photons. We study the resilience to noise of the tested methods, showing the robustness of the optimized Bayesian approach in the presence of imperfections. Application of this methodology can be envisaged in the more general multiparameter case.

Sofia Qvarfort: Gravimetry through non-linear optomechanics

We investigate whether a generic optomechanical system can be used to perform measurements of the gravitational acceleration g. Through analytic and numerical work, we show that the quantum and classical Fisher information coincide for a homodyne detection scheme and we use the results to estimate a fundamental bound on the sensitivity Δg. We predict a $\Delta g = 10^{-16}$ ms^{-2}

for both levitated nanodiamonds and Fabry-Perot cavities with moving mirrors, which surpasses the sensitivity of every other quantum system to date.

Alberto Riccardi: Multipartite steering inequalities based on entropic uncertainty relations

We investigate quantum steering for multipartite systems by using entropic uncertainty relations. We introduce entropic steering inequalities whose violation certifies the presence of different classes of multipartite steering. These inequalities witness both steerable states and genuine multipartite steerable states. Furthermore, we study their detection power for several classes of states of a three-qubit system.

Matteo Rossi: Quantum walks on graphs affected by dynamical noise

Continuous-time quantum walks (CTQWs) describe the free evolution of quantum particles on N-vertex graphs. They have been subject of intense studies, both theoretical and experimental, as they have proven useful for several applications, ranging from universal quantum computation, to search algorithms (e. g. Grover), quantum transport and state or energy transfer. Given their relevance in applications, a realistic description of the dynamics of quantum walkers should take into account those sources of noise and imperfections that might jeopardize the discrete lattice on which the CTQW occurs.
Here we address the effects of classical random telegraph noise (a typical source of noise in solid state quantum devices) affecting the hopping amplitudes on CTQWs on various kinds of lattices and graphs, showing how the spatial and temporal correlations affect the propagation of the walker. We also discuss the effectiveness of Grover search in the presence of such noise.

Jesús Rubio Jiménez: Extracting maximum information from limited data

Empirical data constitute our primary source of information to construct theories that explain the world around us, and to develop the necessary technologies that help us to accomplish that task. However, the quality of this information is restricted in practice by factors such as the number of experiments that we can perform. This is particularly relevant for the study of fragile systems, or when only a few observations are possible before the system under study is out of reach. In this work we discuss a methodology to develop quantum-enhanced metrology protocols that are suitable for these scenarios, and we provide tight lower bounds on the phase estimation uncertainty of a Mach-Zehnder interferometer that operates in the non-asymptotic regime of limited data and moderate prior information. These ideas are then extended to a multi-parameter scenario where we consider a network of interferometers to model quantum imaging protocols.

Carlo Maria Scandolo: Microcanonical thermodynamics in general physical the-

ories

Microcanonical thermodynamics studies the operations that can be performed on systems with well-defined energy. So far, this approach has been applied to classical and quantum systems. Here we extend it to arbitrary physical theories, proposing two requirements for the development of a general microcanonical framework. We then formulate three resource theories, corresponding to three different choices of basic operations. We focus on a class of physical theories, called sharp theories with purification, where these three sets of operations exhibit remarkable properties. In these theories, a necessary condition for thermodynamic transitions is given by a suitable majorisation criterion. This becomes a sufficient condition in all three resource theories if and only if the dynamics allowed by the theory satisfy a condition that we call "unrestricted reversibility". Under this condition, we derive a duality between the resource theory of microcanonical thermodynamics and the resource theory of pure bipartite entanglement.

Amy Skelt: DFT-style approaches to quantum thermodynamics

Quantum thermodynamics is an emerging topic in quantum physics, with prospects for advancing quantum computing, developing quantum technologies and providing insights in fundamentals of quantum mechanics. Measuring and calculating properties of quantum systems, however, present difficulties, and especially so when many-body interactions are present. Using techniques from Density Functional Theory (DFT), we investigate quantum thermodynamic properties of out-of-equilibrium many-body systems. We extend the approach devised by M. Herrera et al. [M. Herrera, R.M. Serra, I. D'Amico, Scientific Reports 7, 4655 (2017)], improving the DFT-based approximations for the statistics of quantum work and analysing how these approximations behave as the system size is increased.
See arXiv:1603.07508 for more details.

Spyros Tserkis: Simulation of Gaussian channels via teleportation and error correction of Gaussian states

Phase-insensitive Gaussian channels are the typical way to model the decoherence introduced by the environment in continuous-variable quantum states. It is known that those channels can be simulated by a teleportation protocol using as a resource state either a maximally entangled state passing through the same channel, i.e., the Choi-state, or a state that is entangled at least as much as the Choi-state. Since the construction of the Choi-state requires infinite energy, we find the appropriate resource states with the minimum energy needed for the simulation that are equally entangled to the Choi-state, measured by entanglement of formation. We also show that the same amount of entanglement is enough to simulate an equally decohering channel, while even more entanglement can simulate less decohering channels. We, finally, use that fact to generalize a previously known error correc-

tion protocol which was restricted to pure lossy channels.
arXiv.1803.03516

Michael Vasmer: Reducing the Surface Code Overhead

Quantum error correction is necessary for quantum computers to achieve their full potential. 2D surface codes are the leading family of quantum error correcting codes, but they have a large overhead. Millions of qubits would be required to factor a 2000-bit number on a 2D surface code quantum computer. One of the reasons for this overhead is the fact that 2D surface codes don't have any transversal non-Clifford gates. Such a gate is required to achieve universal quantum computation. Here, we show that 3D surface codes possess a transversal (non-Clifford) CCZ gate. We also discuss 3D surface code decoding ie using classical computation to predict a correction given an error syndrome. We show that 3D surface codes can be decoded using a combination of a Minimum-Weight Perfect-Matching decoder and a cellular automaton decoder. Finally, we present a universal quantum computing architecture which uses 2D surface codes and 3D surface codes.

James Watson: The Computational Complexity of the Ground State Energy Density Problem

The field of Hamiltonian Complexity is concerned with the Local Hamiltonian problem, which asks for the ground state energy of a Hamiltonian to some precision. The Local Hamiltonian problem has been shown to be QMA$_{EXP}$-complete for a 1D, translationally invariant, nearest neighbour Hamiltonian (Gottesman & Irani), and a complete classification has been realised for 2-qubit Hamiltonians (Cubitt & Montanaro).
We extend the field of Hamiltonian Complexity to the thermodynamic limit by introducing the `Ground State Energy Density Problem' (GSED Problem). This asks whether the nth digit of the ground state energy density of an infinite lattice is 0 or 1 (thus in effect asking for the ground state energy density to some specified precision). We show that for a translationally invariant, nearest neighbour Hamiltonian on a 2D infinite lattice, the GSED problem is QMA_{EXP}-complete.

Miriam Weilenmann: Smooth entropy in axiomatic thermodynamics

Thermodynamics can be formulated in either of two approaches, the phenomenological approach, which refers to the macroscopic properties of systems, and the statistical approach, which describes systems in terms of their microscopic constituents. We establish a connection between these two approaches by means of a new axiomatic framework that can take errors and imprecisions into account. This link extends to systems of arbitrary sizes including microscopic systems, for which the treatment of imprecisions is pertinent to any realistic situation.
Based on this, we can identify entropy measures known from information theory with the quantities that characterise whether certain thermodynamic processes are

possible. In the error-tolerant case, these entropies are so-called smooth min and max entropies. Our considerations further show that in an appropriate macroscopic limit only one single entropy function is relevant, which turns out to be the von Neumann and the Boltzmann entropy for certain types of states.

Yu Xiang: Multipartite Einstein-Podolsky-Rosen steering sharing with separable states

Distribution of quantum correlations among remote users is a key procedure underlying many quantum information technologies. Einstein-Podolsky-Rosen steering, which is one kind of such correlations stronger than entanglement, has been identified as a resource for secure quantum networks. We show that this resource can be established between two and even more distant parties by transmission of a system being separable from all the parties. First, we design a protocol allowing to distribute one-way Gaussian steering between two parties via a separable carrier; the obtained steering can be used subsequently for 1sDI quantum key distribution. Further, we extend the protocol to three parties, a scenario which exhibits richer steerability properties including one-to-multimode steering and collective steering, and which can be used for 1sDI quantum secret sharing. All the proposed protocols can be implemented with squeezed states, beam splitters and displacements, and thus they can be readily realized experimentally.

Posters - Abstracts

(Author alphabetical order)

Matthieu Arnhem: Optimal estimation of parameters encoded in coherent states quadratures

In the context of multiparameter estimation theory, we suggest an optimal measurement scheme to infer two classical parameters encoded in the quadratures of two coherent states. The optimality is shown as saturation of the quantum Cramér-Rao bound under the global energy condition of the system. We propose and analyse a variety of N-mode scheme where one can encode N classical parameters into N coherent states and estimate all the parameters optimally and simultaneously.

Shrobona Bagchi: A fast algorithm for sampling random quantum states

High-quality random samples of quantum states are needed for a number of tasks in quantum information and quantum computation. These random samples have been generated using the Monte Carlo techniques in the past. However, these methods are mostly very CPU time expensive. To improve the CPU time efficiency, we propose an algorithm to sample random states from the quantum state space. For the case of qubits, our algorithm performs very well in comparison to the existing Monte Carlo algorithm. For qubits, we also implement our algorithm for different settings, showing that this method also has the desired flexibility. We are currently extending this to higher dimensions. We also give new results on the probability distributions of random quantum states. Thus, in this work we present results that are useful in the field of random quantum states in quantum information theory.

Evangelia Bisketzi: Quantum strategies for super-resolution microscopy

In the recent years, the development of super-resolution strategies, which would enhance sub-wavelength imaging, has gained great interest, due to the significant applications from astronomical to biomedical science. The Rayleigh criterion has been the main resolution limit in traditional imaging techniques. Recent work has taken advantage of the techniques of quantum metrology, evading entirely the diffraction limit to the estimation of the separation of two points, beating "Rayleigh's curse". We will present some progress in the generalisation of prior works to the imaging of multiple point sources and the difficulties which arise in this more elaborate.

Thomas Bromley: Using Gaussian Boson Sampling to Find Dense Subgraphs

Boson sampling devices are a prime candidate for exhibiting quantum supremacy, yet their application for solving problems of practical interest is less well understood. We show that Gaussian boson sampling (GBS) can be used for dense subgraph identification. Focusing on the NP-hard densest k-subgraph problem, we find that stochastic algorithms are enhanced through GBS, which selects dense subgraphs with high probability. These findings rely on a link between graph density and the number of perfect matchings — enumerated by the Hafnian — which is the relevant quantity determining sampling probabilities in GBS. We test our findings by constructing GBS-enhanced versions of the random search and simulated annealing algorithms and apply them through numerical simulations of GBS to identify the densest subgraph of a 30 vertex graph.

Alessia Castellini: Multiple entanglement swapping with identical particles

Entanglement swapping entangles two quantum objects that don't share a common past, each being outside the other light cone. In this process, two separated entangled pairs are prepared and a Bell measurement is performed on two particles of the different pairs. To implement quantum repeaters and relays for quantum information processing, multiple swappings are required. Using distinguishable particles, multiple swappings have been theoretically studied while they remain experimentally limited to only two iterations. Here we propose a new scheme of entanglement swapping which utilizes four independently prepared identical particles. In this protocol the indistinguishability of particles permits to use their spatial overlap as an initial entangling gate. This has the advantage of reducing the number of necessary Bell measurements and of increasing the probability of multiple swappings. Finally, this scheme is universal, in that it works for either bosons or fermions.

Dario Cilluffo: Scrambling versus Boson Sampling

It is believed that boson sampling problems cannot be efficiently solved using a classical computer. A boson sampler embodies an experimentally-implementable model of non-universal quantum computation able to test quantum supremacy and identify the boundaries of classical computation.
From this general perspective, it is interesting to investigate how the quantum information locally encoded in a small subpart of a large system, such as a subset of a bunch of photons propagating through a linear network, spreads out over the whole system during the evolution. This concept, which is a central one in chaos theory, is known as "scrambling" and has been widely used to investigate a number of phenomena such as black holes. Here, we propose to use scrambling in linear optical systems to shed light on the connection between quantum computation complexity and the possibility of reconstructing the global information encoded in quantum states via local measurements.

Nikolaos Georgios Eftaxias: Testing the reality of the quantum state under free-choice relaxation

In a previous work R. Colbeck and R. Renner constructed a theorem concluded to the ontic nature of the quantum state within the framework of an underlying physical state (see “A system’s wave function is uniquely determined by its underlying physical state”). A core assumption behind their proof was that the inputs used for a chained Bell inequality test were free-choices. In this work we relax this assumption and we test the robustness of the theorem’s conclusion. We allow the inputs to be correlated with the underlying variables and we show that there exist conditions under which the theorem’s conclusion still holds. Apart from its foundational interest our discussion interacts with ideas related to randomness amplification and to quantum cryptography.

Omid Faizy Namarvar: The ultimate miniaturization of Atomic and Molecular scale Boolean Logic Gates using QHC method

Belonging to the Quantum Hamiltonian Computing (QHC) branch of quantum control [1-2],atomic-scale Boolean logic gates (LGs) with two inputs - one output (OR, NOR, AND, NAND, XOR, NXOR) and - two outputs (half-adder circuit) were designed on a Si(100)-(2×1)–H surface following the experimental realization of a QHC NOR gate [3] and the formal design of an half-adder with 6 quantum states in the calculating block [4]. Recently we have focused also to find an automatization way for designing and miniaturzating of the quantum systems to have for example a functioning Boolean halfadder with minimum number of states.

[1] N. Renaud and C. Joachim, Phys. Rev. A, (2008), 78, 062316.
[2] W. H. Soe et al; Phys. Rev. B: Condens. Matter, (2011), 83, 155443.
[3] M. Kolmer, et al; Nanoscale (2015), 7, 12325–12330.
[4] G. Dridi, R. Julien, M. Hliwa and C. Joachim, Nanotechnology, (2015), 26, 344003.

Marco Fanizza: Optimal programmable machines for quantum state discrimination

A basic machine learning setting is supervised learning, which deals with the task of inferring a labeling rule on a data set, given a certain number of labeled points. We consider a generalisation of this problem in the quantum setting (quantum supervised learning problem): given N copies of an unknown state A, N copies of an unknown state B and a copy of a state C that can be either A or B, determine the best guess for C with a measurement on the resources and the test copy. Restricting to qubit states we determine the optimal measurement in the minimum error setting and the asymptotic average probability of error for various configurations: pure states with fixed overlap but random orientation, random states with fixed purity and totally random states.

Samuele Ferracin: Towards minimising resources for verification of quantum computations

In the future, we will be using quantum computers to solve a wide class of problems that are believed to be intractable for classical computers. At the same time, however, verifying the correctness of the solution to a plethora of such problems will remain a hard task. For instance, this is the case for many problems of interest in physics, such as the simulation of large systems of particles highly entangled. It is therefore necessary to develop methods that will let us decide with high confidence whether the outcome of a quantum computation is correct or not.
In our work, we present a verification technique that can be used when a restricted set of operations work in an ideal way. To verify the correctness of a “target” quantum computation, we propose to run several computations. Only one of those (selected at random) is the target, while the others are chosen so that they always output a fixed outcome and are used as tests. We show that if the test computations yield the correct outcome, then with “high” probability also the outcome of the target is correct.
The complexity of our protocol is similar to that of the least demanding existing verification protocols. However, compared to existing techniques, the set of ideal operations required by our protocol is minimal. Moreover, we argue that the ideas behind our protocol might be furtherly adapted to other interesting scenarios, such as the verification of computations run by multiple users.

Eliana Fiorelli: Open quantum generalization of Hopfield neural networks

Neural networks (NNs) are artificial networks inspired by the interconnected structure of neurons in animal brains. They are now capable of computational tasks where most ordinary algorithms would fail, such as speech and pattern recognition, with a wide range of applicability both within and outside research. Hopfield NNs [1] constitute a simple, but rich example of how an associative memory can work; they have the ability to retrieve, from a set of stored network states, the one which is closest to the input pattern. In the last decades, many models have been proposed in order to combine the properties of NNs with quantum mechanics, aiming at understanding if NNs computing can take advantage from quantum effects. Here we discuss a quantum generalisation of a classical Hopfield model [2] whose dynamics is governed by purely dissipative, yet quantum, processes. We show that this dynamics may indeed yield an advantage over a purely classical one, leading to a shorter retrieval time.

[1] J.J. Hopfield, Proceedings of the National Academy of Sciences, 79, 2554, (1982)
[2] P. Rotondo et al., arXiv:1701.01727 (2017).

Kieran Flatt: Gleason-Busch theorem for sequential measurements

Gleason's theorem is a statement that, if we make some reasonable assumptions, the Born rule is the unique way to calculate quantum probabilities. We have shown that this result contains the mathematical structure of sequential measurements as well as the state transformation. We give a small set of physically motivated axioms and show that the Kraus operator form follows. An axiomatic approach has practical relevance as well as fundamental interest, in making clear those assumptions which underlie the security of quantum communication protocols. Interestingly, the two-time formalism is seen to arise naturally in this approach.

Thomas Hebdige: A Classification of Symmetry Properties of Quantum States and Channels

Resource theories offer a way to incorporate symmetry principles into a QI setting. I will give a brief review of the resource theory of asymmetry. Then I will describe a way to classify the different ways that quantum states and channels break a given symmetry. This classification scheme gives necessary conditions on the resources needed to induce a given channel, while also providing coarse-grained information about irreversibility and dynamics under symmetry constraints.

Anaelle Hertz: Multidimensional entropic uncertainty relation based on a commutator matrix in position and momentum spaces

The seminal continuous-variable entropic uncertainty relation expresses the complementarity between two n-tuples of canonically conjugate variables (x1,x2, . . . ,xn) and (p1,p2, . . . ,pn) in terms of Shannon differential entropy. Here we consider the generalization to variables that are not canonically conjugate and derive an entropic uncertainty relation expressing the balance between any two n-variable Gaussian projective measurements. The bound on entropies is expressed in terms of the determinant of a matrix of commutators between the measured variables. This uncertainty relation also captures the complementarity between any two incompatible linear canonical transforms, the bound being written in terms of the corresponding symplectic matrices in phase space.
We also define a more general form which takes correlations into account and is thus saturated by all pure Gaussian states. Interestingly, we can deduce from it the most general form of the Robertson uncertainty relation based on the covariance matrix of n variables.

Gareth Jones: Remote Quantum Sensing with Sequential Adaptive Spin Measurements

In recent years, there has been growing interest into the use of single spin qubits as quantum sensors. Previous works have shown metrological capabilities beyond the standard measurement limit through the use of spin squeezing or entangled states, and later work has demonstrated similar capability without the need for entanglement. In this poster, we detail a proposal for a novel measurement scheme where the magnetic field applied to a single site in a spin chain can be directly inferred by a distant spin. Such a scenario may be desirable in such applications such as connecting quantum registers, or mediating quantum information between distant sites. Following a semi-classical Bayesian approach, and using sequential, adaptive spin measurements, we show that the distant magnetic field can be estimated with a high degree of accuracy, and with a substantially reduced time overhead. We further demonstrate that replacing the Bayesian approach with a neural network results in an even finer measurement accuracy, with the possibility of inferring a magnetic field which has been applied along any a-priori unknown arbitrary axis.

Tamara Kohler: Translationally invariant universal classical Hamiltonians

Spin models are widely studied in the natural sciences, from investigating magnetic materials to studying neural networks. Previous work has demonstrated that there exist simple classical and quantum spin models that are universal, in the sense that they can replicate the physics of all other classical (respectively, quantum) spin models to arbitrary precision. However, all spin models which were previously known to be universal broke translational invariance. In this paper we demonstrate that there exist translationally invariant universal classical models. We construct a translationally invariant Hamiltonian described by a single parameter that is universal. This means that there exists a single Hamiltonian which can replicate all classical spin physics just by tuning a single parameter in the Hamiltonian and varying the size of the system that the Hamiltonian is acting on. This significantly strengthens previous results. This work may also provide a starting point to constructing translationally invariant quantum models.

Peter McConnell: Non Linear Gates enabling Universal Quantum Computation

Non-Linear Gates Enabling Universal Quantum Computation With Continuous variables. The aim of the present research is to devise scheme to generate non-linear gates enabling universal quantum information processing (computation and simulations) over continuous variables. The motivation behind this work is based upon the continuous variable version of the Gottesman-Knill Theorem that states that we can efficiently simulate arbitrary Gaussian quantum information processing on a classical computer. This implies that to, order to have some quantum speed up, one needs non-Gaussian gates – namely, interactions of order three and above, as all Gaussian gates are at most quadratic. Focusing on a cavity opto-mechanical framework, the successful generation of squeezed and cluster states for systems with different amounts of resonators is a first necessary step, which can be shown to be achievable by driving the cavity with a multi-tone field. The next step is to make use of the intrinsic non-linearities available in this system, such as the radiation pressure coupling.

Chiranjib Mukhopadhyay: Quantifying coherence from the discrepancy between quantum and classical addition

Qudit addition channels have been recently introduced in the context of deriving entropic power inequalities for finite dimensional quantum systems. We show that the relative entropic distance between the output of such a quantum addition channel and the corresponding classical mixture quantitatively captures the amount of coherence present in a quantum system. This new coherence measure admits an upper bound in terms of the relative entropy of coherence and is utilised to formulate a state-dependent uncertainty relation for two observables. We also prove a reverse entropy power equality which may be used to analytically prove an inequality conjectured recently for arbitrary dimension and arbitrary addition weight. Our results provide deep insights to the origin of quantum coherence that truly come from the discrepancy between quantum addition and the classical mixture.

Rosanna Nichols: A genetic algorithm for quantum state engineering

With the interest in quantum technologies growing rapidly it is becoming increasingly important to focus on how useful states may be generated in realistic experiments. We have devised a computational algorithm to search for ways to produce good quantum states by combining experimentally feasible elements. For this we use a genetic algorithm which mimics natural evolution to improve on the experiments it finds. This utilises randomness and often produces experimental set-ups that are unexpected – that you would not find through following human logic alone. The algorithm is very flexible such that you can choose from the elements that are available to you. For us, the “good” states the program finds are judged by having high quantum Fisher information, useful for quantum metrology, but the algorithm may be easily expanded to use other figures of merit.

Varad Pande: Optimal Entropy Compression in Quantum Bits

Global unitary transformations (optswaps) that optimally increase the bias of any mixed computation qubit in a quantum system – represented by a diagonal density matrix – towards a particular state of the computational basis which, in effect, increases its purity are presented. Quantum circuits that achieve this by implementing the above data compression technique – a generalization of the 3B-Comp [Fernandez, Lloyd, Mor, Roychowdhury (2004); arXiv:quant-ph/0401135] used before – are described. These circuits enable purity increment in the computation qubit by maximally transferring part of its von Neumann or Shannon entropy to n-number of surrounding qubits starting with any initial biases. Using the optswaps, a practicable new method that algorithmically achieves hierarchy-dependent cooling of qubits to their respective limits in an engineered quantum register opened to the environment is delineated. In addition to fundamental quantum thermodynamic interests, this work may be important towards satisfying the DiVincenzo criterion for qubit initialization in some quantum computing architectures.

Roberto Pierini: Quantum key distribution in non inertial frames

We investigate how relativistic acceleration of the observers can affect the performance of various quantum key distribution protocols for continuous variable states of localized wavepackets.

Martin Plávala: Conditions for the compatibility and their connection to steering and Bell nonlocality

We formulate steering by channels and Bell nonlocality of channels as generalizations of the well-known concepts of steering by measurements and Bell nonlocality of measurements. The generalization does not follow the standard line of thinking stemming from the EPR paradox, but introduces steering and Bell nonlocality as entanglement-assisted incompatibility tests. The proposed definitions are, in the special case of measurements, the same as the standard definitions, but not all of the known results for measurements generalize to channels. For example we show that for quantum channels steering is not a necessary condition for Bell nonlocality.

Constantino Rodriguez Ramos: Convex structure of double-stochastic qutrit quantum channels

We consider the convex classification of quantum channels. In particular, we consider the extreme points of the set of doubly-stochastic qutrit quantum channels. Examples of known extreme points are presented along with an analysis of the associated Choi matrix and its spectrum, thereby allowing a classification. We also discuss the choice of chosen basis for these extreme points, which we argue in terms of a systematic approach to finding new extreme points for the set of doubly-stochastic channels. Finally, we explore the possibility of extending our results to higher dimensions.

Sheikh Sazim: Coherence makes quantum systems magical

Two primary facets of quantum technological advancement that holds great promise are quantum communication and quantum computation. For quantum communication, the canonical resource is entanglement. For quantum gate implementation, the resource is ‘magic’ in an auxiliary system. It has already been shown that quantum coherence is the fundamental resource for the creation of entanglement. We argue on the similar spirit that quantum coherence is the fundamental resource when it comes to the creation of magic. This unifies the two strands of modern development in quantum technology under the common underpinning of existence of quantum superposition, quantified by the coherence in quantum theory. We also attempt to obtain magic monotones inspired from coherence monotones and vice versa. We further study the interplay between quantum coherence and magic in a qutrit system and that between quantum entanglement and magic in a qutrit-qubit setting.

Hamish Scott: Quantum cryptographic protocols compatible with existing telecommunication hardware

The first protocols in quantum cryptography relied on the sending and measuring of single photons. While this seems a simple and intuitive way to encode information, the challenges in generation and manipulation of single photons and dedicated equipment required for such protocols impose certain restrictions on real-world implementations. Recently attention has turned to exploring potential protocols that would be readily compatible with existing telecommunication hardware, relying on continuous measurements of optical coherent states. We build on recent quantum digital signature protocols with homodyne detection and four signal coherent states, extend this setup to a new quantum secret sharing scheme, and adapt postselection methods from quantum key distribution to improve the security of our protocols and thus to extend the achievable limits for secure transmission distance.

Fengxiao Sun: Entanglement and dynamical phase transition in a spin-orbit-coupled Bose-Einstein condensate

We show that the time-averaged two-mode entanglement in the spin space reaches a maximal value when it undergoes a dynamical phase transition (DPT) induced by external perturbation in a spin-orbit-coupled Bose-Einstein condensate. We employ the von Neumann entropy and a correlation-based entanglement criterion as entanglement measures and find that both of them can infer the existence of DPT. While the von Neumann entropy works only for a pure state at zero temperature and requires state tomography to reconstruct, the experimentally more feasible correlation-based entanglement criterion acts as an excellent proxy for entropic entanglement and can determine the existence of entanglement for a mixed state at finite temperature, making itself an excellent indicator for DPT. Our work provides a deeper understanding about the connection between DPTs and quantum entanglement and may allow the detection of DPT via entanglement become accessible as the examined criterion is suitable for measuring entanglement.

Matthew Thornton: Coherent quantum networks for non-classical state generation

Quantum states of light possess capabilities exceeding those of the classical electromagnetic field.
Highly non-classical states with well-defined photon find important applications in quantum information processing, but methods for their deterministic and efficient generation remain elusive.
In this work we diffusively couple two “signal” bosonic modes via a long “tail” of further modes. All modes are subject to strong Kerr nonlinearity. Simulations

demonstrate the evolution of an input classical state to a sub-Poissonian output in the signal modes. We calculate the negativity of this state and observe entanglement generation as the light propagates. Over short timescales the tail simulates a Markovian reservoir, and our system accurately reproduces the output of a known, but challenging to engineer, case of two nonlinear modes coupled via one highly lossy mode. Our system can be fabricated in photonic waveguides and opens up so-called "coherent diffusive photonics" as an exciting direction towards quantum state generation.

Gökhan Torun: Deterministic Transformation of Coherent States Under Incoherent Operations

It is well known that majorization condition is the necessary and sufficient condition for the deterministic transformations of both bipartite pure entangled states by local operations and coherent states under incoherent operations. In this talk, I present two explicit protocols for the latter. I first present a permutation based protocol which provides a method for the single step transformation of d-level coherent states. I also give a generalization of this protocol for some special cases of d-level systems. Then, I present an alternative protocol where we use d-level (d' < d) subspace solutions of the permutation based protocol to achieve the complete transformation as a sequence of coherent state transformations. I also adapt our step-by-step method to the problem of the distillation of maximally coherent state.

Jinzhao Wang: Confidence Region in Quantum State Tomography

Quantum State Tomography is the task of inferring the quantum state from the measurement data. A reliable Quantum State Tomography scheme should not only report the reconstructed state, but also well-justified error bars. Here we provide a simple and reliable method to generate confidence region in the state space, which is based on a quantum generalisation of the Clopper–Pearson confidence interval in classical statistics. As long as the measurement POVM is informationally complete, our scheme yields a polytope-shaped confidence region in the state space. It is prior independent, easy to compute, and flexible to adapt to any figure of merit of interest. It is the first work in generalizing the classical confidence interval to quantum state tomography. We also demonstrated how our polytope confidence region, via providing information on the error distribution, can be practical and useful in current state tomography experiments.

Xiao Yuan: Confidence Region in Quantum State Tomography

Imaginary time evolution is a powerful tool for studying quantum systems. While it is conceptually simple to simulate with a classical computer, the time and memory requirements scale exponentially with the system size. Conversely, quantum computers can efficiently simulate quantum systems, but non- unitary imaginary time evolution is incompatible with unitary quantum circuits. Here, we propose a hybrid, variational algorithm for simulating imaginary time evolution on a quantum computer. We use this algorithm to find the ground state energy of many-particle Hamiltonians. Our algorithm finds the ground state with high probability, outperforming the variational quantum eigensolver. Our method can also be applied to general optimisation problems, Gibbs state preparation, and quantum machine learning.

Qi Zhao: One-shot coherence dilution

Coherence， as a fundamental property emerging within any quantum system empowers the ability of many quantum information tasks, including cryptography, metrology, and randomness generation. Manipulation and quantification of quantum resources are fundamental problems in quantum physics. Coherence distillation and dilution have been proposed by manipulating infinite identical copies of states in an asymptotic case. In the non-asymptotic setting, finite data-size effects emerge, and the practically relevant problem of coherence manipulation using finite resources has been left open. This work establishes the one-shot theory of coherence dilution, which involves converting maximally coherent states into an arbitrary quantum state using maximally incoherent operations, dephasing-covariant incoherent operations, incoherent operations, or strictly incoherent operations. We introduce several coherence monotones with concrete operational interpretations that estimate the one-shot coherence cost under different incoherent operations.

Social programme

Thursday 12th July

The Round-a-boat

The social event on Thursday 12th July will be a scenic river cruise down the Trent River. The conference dinner will consist of a BBQ meal served during the cruise. Taxis will transport participants from the conference to the marina. We will leave the University of Nottingham from 17:30 and the boat will depart at 18:30.
The cruise will end at 21:30, where taxi’s will be available to take you to town or return you to your accommodation.

Connecting to the Wi-Fi

Eduroam

For those without access, an account has been made for you:

Username: pmaqr1@nottingham.ac.uk

Password: #Itiscominghome18

Connecting to UoN-guest

1. Make sure the wireless network adapter is activated on your device
2. If you are in range, your device should automatically connect to the UoN-guest network. If not, find 'UoN-guest' in the list of wireless connections available and select this network. If it is not listed you are not within range of the hotspot. Please move the device until you are in range
3. Open your web browser, then browse to any unsecure website such as www.bbc.co.uk.
4. The UoN-guest wireless login page will appear
5. Follow the on-screen instructions to register for an account.
6. You will be sent two emails: one asking you to confirm your request and another with your username and password. You have 10 minutes grace time to read and confirm your access. *If you do not validate your account, then it will be deleted and your device will disconnect once its 10 minutes grace period expires.*
7. Once you have confirmed your account, disconnect and reconnect, logging in with your account details. You can log in and use the service for 7 days before you will need to re-register.

Notes:

- 'UoN-guest network' is an open network and does not provide encryption for traffic transmitted or received by connected devices.
- Security for connections made using the UoN-guest network remains the responsibility of the user and the service is used at your own risk. Please do not enter passwords online when using this network.
- If you do not validate your account within the 10 minutes grace period you will be disconnected and need to re-register.

Venue information

The conference will be mostly held at the **Keighton Auditorium**, except on for Wednesday afternoon where it will held at the **Room B1 of School of Physics & Astronomy** and for the **Poster Session** at the **Senate Chamber of Trent Building** in the **University Park Campus**. Participants will be accommodated in **Cripps Hall**, only 300 metres away from the auditorium. A detailed campus map is shown overleaf.

From Nottingham Train Station or City Centre:

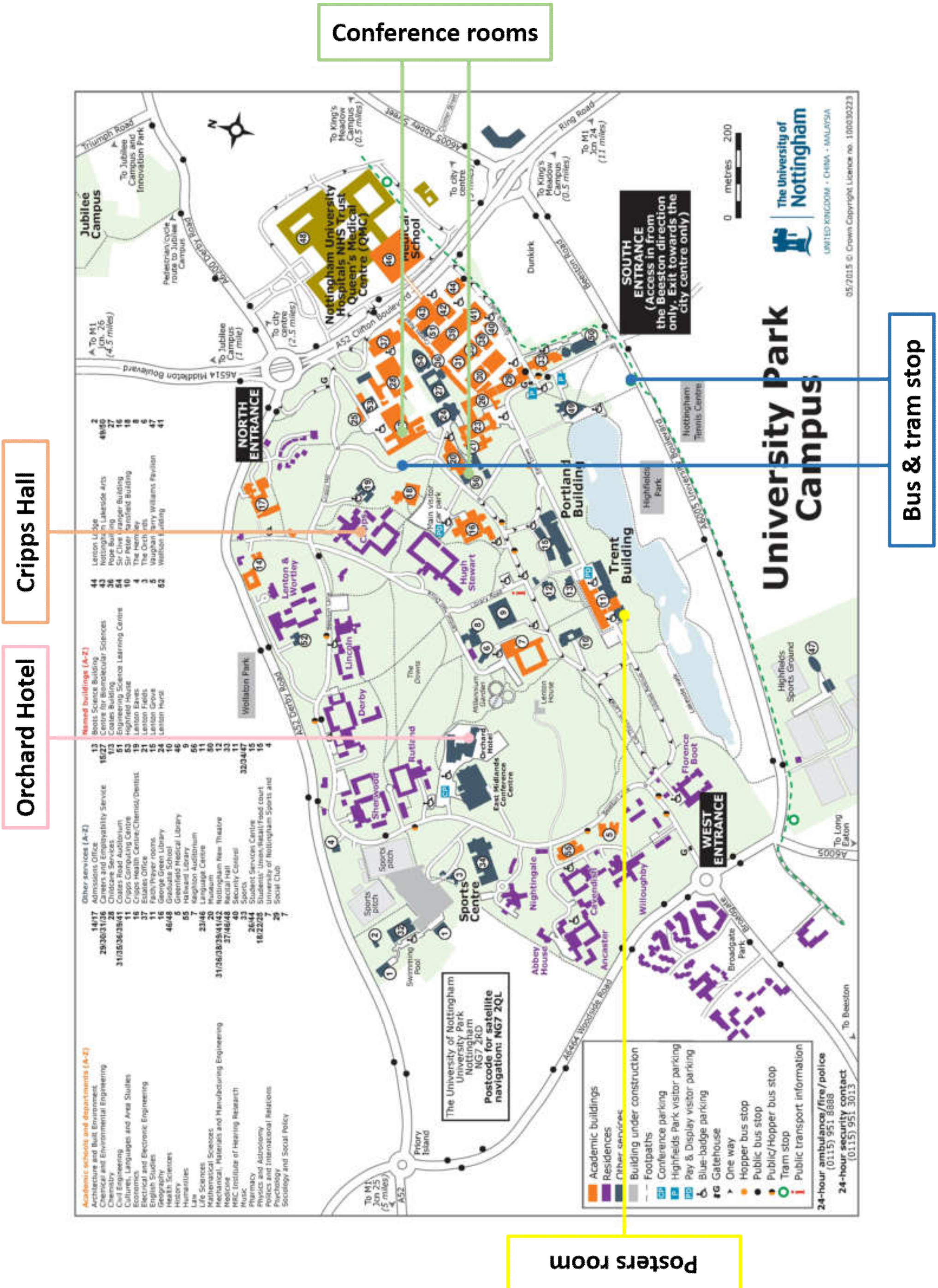
From the **bus stop C7 on Collin St**., take the **NCT 34** (Orange Line) to the Nottingham University Main Campus. The **George Green Library stop (UN31)** is just 60 metres from the conference venue

You can also take **the tram** to Toton Lane directly from the train station.
The **University of Nottingham stop** (South Entrance) is a 10-minute walk from the Keighton Auditorium.

Alternatively, take one of the buses at the **Old Market Square**, a short walk from the train station. You can take the **Indigo** line which stops at **Queen's Medical Centre Main Entrance**, and the **Skylink** bus to East Midlands Airport which stops at **Nottingham University Main Campus South Entrance.** Both stops are a 10-minute walk from the Keighton Auditorium.

From the East Midlands Airport:

The **Skylink** bus runs regularly from East Midlands Airport to Nottingham, stopping at the **Nottingham University Main Campus South Entrance**.



Conference rooms
Cripps Hall
Orchard Hotel
Bus & tram stop
Posters room
University Park Campus
The University of Nottingham
NORTH ENTRANCE
SOUTH ENTRANCE (Access in from the Beeston direction only. Exit towards the city centre only)
WEST ENTRANCE
Jubilee Campus
Portland Building
Trent Building
Sports Centre
Medical School
Nottingham University Hospitals NHS Trust Queen's Medical Centre (QMC)
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