Mini-Symposium on Quantum Sciences

Report of Contributions

Contribution ID: **1** Type: **not specified**

Photonics quantum computing: what we know and don't know

Monday, 26 August 2024 13:30 (40 minutes)

Presenter: PAESANI, Stefano

Contribution ID: **2** Type: **not specified**

Quantum censorship—and how to get around it

Monday, 26 August 2024 10:10 (40 minutes)

We may soon see agencies offering public access to quantum communication networks. To prevent the unregulated spreading of quantum resources to malicious parties in their preparation of cryptographic attacks, governmental agencies might try to establish a quantum censorship. In such a protocol, quantum states which are deemed benign cross a network unaltered while hazardous quantum states are rendered classical. A less dystopian—but an information-processing equivalent—scenario might be the censorship of a commercialized network, with a provider offering free transmission of classical information, but demanding premium fees for sharing quantum information.
In this talk, I introduce quantum censorship, a protocol in which an all-powerful agency oversees quantum communication in a public-domain network. Because of the decentralized nature of such networks, collaborating users might try to bypass censorship and I discuss under which conditions the censorship protocol is unbreakable.

Presenter: PINSKE, Julian

Contribution ID: **3** Type: **not specified**

Mathematical methods for tensor networks

Monday, 26 August 2024 11:50 (40 minutes)

Tensor networks provide succinct representations of quantum many-body states and are an important computational tool for strongly correlated quantum systems. In two or more spatial dimensions the mathematical theory of tensor networks is complicated. In this talk I will highlight some methods and mathematical techniques used in the study of tensors and algebraic geometry, which can be applied to tensor networks. I will explain a connection to geometric invariant theory (leading to a better understanding of gauge symmetries in tensor networks) and to algebraic complexity (relating to local multipartite entanglement in tensor networks).

Presenter: WITTEVEEN, Freek

Contribution ID: **4** Type: **not specified**

Quantum Quenches and Matrix Product States in AdS/CFT

Monday, 26 August 2024 11:10 (40 minutes)

I will explain how matrix product states are used to describe defects in the form of e.g. domain walls or monopoles in the AdS/CFT correspondence. Overlaps between the matrix product states and eigenstates of an integrable spin chain constitute correlation functions of the AdS/CFT system and can be computed exactly. The same overlaps contain information about the time development of the chain after a quantum quench. We give examples of integrable as well as non-integrable quantum quenches of relevance in AdS/CFT.

Presenter: KRISTJANSEN, Charlotte

Contribution ID: **5** Type: **not specified**

Voltage-controlled synthesis of higher harmonics and 4e supercurrent in hybrid Josephson junction circuits

Monday, 26 August 2024 09:30 (40 minutes)

Presenter: BANZERUS, Luca

Contribution ID: **6** Type: **not specified**

Unconventional Superconductivity in Quantum Materials

Monday, 26 August 2024 14:10 (40 minutes)

I will review the concepts of conventional and unconventional superconductivity in quantum materials and explain how this is related to the electronic interactions –or correlations –present in the system. While conventional superconductivity typically emerges in weakly correlated systems, unconventional superconductivity appears in moderately and strongly correlated systems, and continues to puzzle theorists and experimentalists alike. Adopting an exact numerical approach, I will demonstrate how unconventional superconductivity can arise in a correlated system.

Presenter: HOLM CHRISTENSEN, Morten

Contribution ID: **7** Type: **not specified**

Combining Spin Qubits and Superconductivity in Quantum Computers

Tuesday, 27 August 2024 09:30 (40 minutes)

In this talk, I argue that utilizing hybrid approaches to quantum computing –that is - combining different qubit implementations into a single platform –could be highly beneficial to building large scale quantum information processors. After a refresher on quantum computation, I review the multitude of hybrid approaches to quantum computing and their place at the Niels Bohr institute, and introduce a novel hybrid material Ge/SiGe spin qubits and PtGeSi superconductors, that offer exciting new avenues into hybrid research.

Presenter: LAWRIE, William

Contribution ID: **8** Type: **not specified**

Multi-scale Modelling of Quantum Devices and Experiments with Spins

Tuesday, 27 August 2024 10:10 (40 minutes)

Semiconductor quantum devices that allow to confine and manipulate single spins as well as control the interactions between them, are a natural system to explore fundamental quantum phenomena or host qubits in tomorrow's quantum computers. Understanding and designing experiments on such chips, requires modelling both at the device and the microscopic scale. Here, I will give an overview of simulations that I have performed on different spin systems from optically active quantum dots in gallium arsenide, to donor atoms in silicon, and germanium super-semi hybrid devices.

Presenter: JOECKER, Benjamin

Contribution ID: **9** Type: **not specified**

Harnessing fundamental interactions between light and atoms

Tuesday, 27 August 2024 11:10 (40 minutes)

There is a growing research community that attempts to create new paradigms for the strong coupling of light and matter by way of individual atoms interacting with photons in nano-scale dielectric lattices.

Combining the exquisite level of control of atomic systems, their non-linearity, and quantum functionality with the guiding and trapping of light in linear nano-dielectric waveguides holds promise for creating novel quantum matter built from atoms and photons one particle at a time.

I will discuss nascent work conducted at the Niels Bohr Institute and present the most recent efforts of our new team towards the integration of neutral atom-based quantum simulators with nano-photonic crystal waveguides.

Our research platform has many advantages for many-body physics studies, such as reconfiguration on-the-fly, scalability with many identical atoms, and operation at room temperature. It offers opportunities to explore and engineer strong and tunable atom-atom interactions mediated by light, with a variety of applications in quantum optics including, for example, quantum simulation, synthetic molecules of light, and atom mirrors.

This is a highly multidisciplinary research field and poses a formidable challenge in the laboratory. I will present some of our tools and methods to overcome many of these challenges.

Presenter: BEGUIN, Jean-Baptiste

Contribution ID: **10** Type: **not specified**

Evading Quantum Noise in Macroscopic Systems

Tuesday, 27 August 2024 11:50 (40 minutes)

Any sensing device will –if it is sufficiently perfected with regard to reducing technical noise – eventually face the obstacle of quantum noise, which can be seen as a ubiquitous consequence of Heisenberg's Uncertainty Principle. Today, a surprising variety of systems have reached this quantum-limited regime, prompting the question of how to improve the sensitivity further. Here, I will describe how quantum noise can and has been evaded in the macroscopic, quantum-limited atomic-spin and mechanical systems investigated in the Quantop lab, with current work pointing towards applications in gravitational wave detection. Turning the focus to magnetic field sensing, I will detail the potential of our atomic vapour magnetometers for biomedical application

Presenter: ZEUTHEN, Emil

Contribution ID: **11** Type: **not specified**

What a Quantum Computer does when it does nothing

Tuesday, 27 August 2024 13:30 (40 minutes)

I will give an overview of the key scientific discoveries leading to the current race towards building a fault-tolerant quantum computer. We will focus on the superconducting qubit platform and I will put our groups research efforts into this context. As an example, I will introduce one of our research interests: the "Lindbladian learning problem", which essentially tries to answer the question "What does a quantum computer do when it does nothing"?

Presenter: KRØJER MØLLER, Svend

Contribution ID: **12** Type: **not specified**

Unveiling order from chaos by approximate 2-localization of random matrices

Tuesday, 27 August 2024 14:10 (40 minutes)

Quantum many-body systems are typically endowed with a tensor product structure.A structure they inherited from probability theory, where the probability of two independent events is the product of the probabilities. The tensor product structure of a Hamiltonian thus gives a natural decomposition of the system into independent smaller subsystems. It is interesting to understand whether a given Hamiltonian is compatible with some particular tensor product structure. In particular, we ask, is there a basis in which an arbitrary Hamiltonian has a 2-local form, i.e., it contains only pairwise interactions? I will show, using analytical and numerical calculations, that a generic Hamiltonian (e.g., a large random matrix) can be approximately written as a linear combination of two-body interaction terms with high precision; that is, the Hamiltonian is 2-local in a carefully chosen basis. Moreover, we find that these Hamiltonians are not fine-tuned, meaning that the spectrum is robust against perturbations of the coupling constants. Finally, by analyzing the adjacency structure of the couplings, we suggest a possible mechanism for the emergence of geometric locality from quantum chaos.

Presenter: LOIZEAU, Nicolas