SYQM 1: Symposium: Novel Perspectives in Quantum Technologies

Time: Friday 10:30–12:30 Location: U Audimax

Invited Talk SYQM 1.1 Fri 10:30 U Audimax
Robust symmetry-protected metrology with a topological phase — •Stephen Bartlett[1], Gavin Brennen[2], and Akimasa Miyake[3] — [1]University of Sydney, Sydney, Australia — [2]Macquarie University, Sydney, Australia — [3]University of New Mexico, Albuquerque, USA

Topological materials can protect fragile quantum systems while still allowing for robust metrology. We propose a metrology scheme that is made robust to a wide range of noise processes by using the passive, error-preventing properties of symmetry-protected topological phases. The so-called fractionalized edge mode of an antiferromagnetic Heisenberg spin-1 chain in a rotationally-symmetric Haldane phase can be used to measure the direction of an unknown electric field, by exploiting the way in which the field direction reduces the symmetry of the chain. Specifically, the direction of the field is registered in the holonomy under an adiabatic sensing protocol, and the degenerate fractionalized edge mode is protected through this process by the remaining reduced symmetry. We illustrate the scheme with respect to a potential realization by Rydberg dressed atoms.

Invited Talk SYQM 1.2 Fri 11:00 U Audimax
Diamond quantum sensors for nanoscale magnetic resonance — •Fedor Jelezko — Institute of Quantum Optics, Ulm University, Ulm, Germany

Colour centers in diamond are promising candidates for nanoscale quantum sens-ing and quantum enhanced imaging. In this talk, we will highlight new techniques enabling high spectral resolution in nanoscale NMR. We will also show experiments aiming to develop hyperpolarization enhanced NMR and MRI based on po-larization transfer form optically pumped electron spins in diamond to nuclear spins.

Invited Talk SYQM 1.3 Fri 11:30 U Audimax
Quantum metrology for subdiffraction incoherent optical imaging — •Mankei Tsang — National University of Singapore

Two traumas await starlight at a telescope: the aperture amputates its high spatial frequencies, while the detector measures its energy in rough quanta. The image, as a result, looks blurry and noisy, and the information obtainable from the light must be limited. As these problems arise from the wave-particle duality of light, a quantum treatment is appropriate. The theoretical tools of quantum metrology, in particular, can reveal the ultimate amount of information in the photons regardless of the measurement, thereby establishing a definitive solution to the age-old resolution problem. Using quantum metrology, we recently found that, surprisingly, there is a lot more information in starlight than previously realized. Our results imply that parameters such as the separation between two sub-Rayleigh sources or the moments of a subdiffraction object can be estimated much more accurately than direct imaging can fundamentally do. Furthermore, we have discovered a measurement called spatial-mode demultiplexing (SPADE) that can extract the neglected information and estimate the parameters with accuracies close to the quantum limits. 9 experimental demonstrations have since been reported. Realizable with far-field linear optics and photon counting, SPADE is envisioned to benefit not only observational astronomy but also fluorescence microscopy.

Invited Talk SYQM 1.4 Fri 12:00 U Audimax
Learning Hamiltonians using quantum and classical resources — •Nathan Wiebe — Microsoft Research, Redmond USA

Modeling quantum dynamics can be a challenging task. In recent years, a new approach has come forward that used Bayesian inference to learn an approximate model for a hitherto unknown system. In this talk I will discuss recent advances in this field including our recent work that utilizes this approach to perform NV center magnetometry at room temperature and directly learn Hamiltonian models for poorly characterized NV center Hamiltonians. Finally, I will show how quantum computers can be used to exponentially improve these processes and show how ideas from machine learning can be introduced to allow computers to dream up new models and test them against existing ones and by doing so demonstrate artificial intelligences can already not only help learn Hamiltonians, but autonomously conduct science.