DODD-WALLS CENTRE
for Photonic and Quantum Technologies

These scholarships are offered by DWC researchers with grants related to DWC themes.

Theme 1a-related scholarship

Rapid bacteria enumeration and identification

Bacteria are everywhere and are involved in many processes relevant to our everyday life yet it is hard to monitor accurately and in real time bacterial concentration. Recently, the physics department in collaboration with the microbiology department has developed an all-fibre spectroscopic system called the optrode that is able to detect and quantify bacteria. It provides an alternative to the conventional plate count techniques with advantages of portability, sensitivity, near real time measurements and ability to detect a high dynamic range of bacteria concentrations in its natural environment. The next challenge is to be able to identify specific type of bacteria. One avenue is to immobilise the microorganism using functionalised fibres or microfluidic devices. This work is funded by a grant in collaboration with a company that is likely to commercialise the device. This research will be carried out in collaboration with microbiologists who will provide samples and knowledge of microorganisms and bacterial processes.

Contact: *Dr Frederique Vanholsbeeck, f.vanholsbeeck@auckland.ac.nz University of Auckland*

Theme 2A-related scholarship

Computational approach to ultra-cold atomic gases with exact diagonalisation quantum Monte Carlo (theory)

Can the computer simulation of walkers who randomly hop, die, or multiply help to solve the hard problems of physics? Many of the difficult problems of condensed matter physics, increasingly being explored with quantum degenerate atomic gases, involve strong quantum correlations between particles. They are consequently not well approximated with mean-field theories of effective quasiparticle pictures. The aim of this project is to develop new approaches and algorithms for computing the ground state and time-evolution of ultra-cold fermions or bosons by combining exact-diagonalisation and quantum Monte-Carlo approaches. These can be formulated as the population dynamics of random walkers. The research will be carried out at Massey University's Auckland-based NZ Institute for Advanced Study with strong collaborative links to the partner universities in the Dodd-Walls Centre and with the Max Planck Institute for Solid State Research in Germany.

Contact: *Prof. Joachim Brand, j.brand@massey.ac.nz, Massey University Auckland*

Theme 2B - Quantum Manipulation and Information

Many-body cavity QED with multilevel atoms

The Theoretical Quantum Optics Group at the University of Auckland is looking for a PhD student to pursue research in the field of many-body cavity quantum electrodynamics; in particular, many-atom systems with interactions mediated by the light fields of optical resonators. Such many-body interacting quantum systems can exhibit a variety of different quantum states, or phases, as well as the concomitant critical phenomena associated with transitions between these phases. We explore schemes for manipulating interactions, via specific atomic level configurations and tailored laser and cavity excitations, in such a way as to generate novel many-body quantum systems.

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