Symposium of The Dodd-Walls Centre for Quantum Science and Technology

9-11 December 2008, Queenstown, New Zealand

Monday, December 8

Welcome reception (6:00pm–7:00pm, Ben Lomond Restaurant)

Cocktail hour and Cash bar

Tuesday, December 9

Conference sign-in (8:00am-8:30am, Foyer)

8:30am–10:30am ■ Ultra-cold atoms (Queenstown room)

Prof. Crispin Gardiner, Presider

8:30am **Opening remarks**

8:45am TuA1 — **From thermal to quasi-condensate to superfluid: Observation of a 2D Bose-gas** **Keynote**

Kristian Helmerson, Pierre Cladé, Changhyun Ryu, Anand Ramanathan, and William D. Phillips. Atomic Physics Division, National Institute of Standards and Technology, Gaithersburg, Maryland 20899-8424, USA.

We present evidence of the crossover to a superfluid state in an optically trapped, 2D, atomic Bose gas. In addition, we observe an intermediate, quasi-condensate state between the thermal and superfluid state.

9:30am TuA2 — **Bragg spectroscopy of a strongly interacting Fermi gas** **Invited**

G. Veeravalli, E. Kuhnle, P. Dyke, and C. J. Vale. ARC Centre of Excellence for Quantum-Atom Optics, Centre for Atom Optics and Ultrafast Spectroscopy, Swinburne University of Technology, Melbourne, 3122, Australia.

The Bose-Einstein condensate to Bardeen-Cooper-Schrieffer (BEC-BCS) crossover in fermionic ^{6}Li is studied using Bragg spectroscopy. A smooth transition from molecular to atomic behaviour is observed and pair correlations are characterised.

10:00am TuA3 — **General atom-optical quantum resonances** **Invited**

Simon A. Gardiner, K. J. Challis, T. P. Billam, P. L. Halkyard, and M. Saunders. Department of Physics, Durham University, South Road, Durham DH1 3LE, United Kingdom.

Quantum resonances are an example of a dramatically quantum effect, and can manifest in a variety of different ways. I will cover recent theoretical progress with a particular view to possible experimental implementations in an atom-optical context.

Morning Tea (10:30am–11:00pm, Foyer)

11:00am–12:40pm ■ Ultra-cold atoms (Queenstown room)

Dr David Hutchinson, Presider

11:00am TuB1 — **Birth of a superfluid: vortices and solitons in the formation of Bose-Einstein condensates** **Invited**

Matthew J. Davis, Ashton S. Bradley, Geoffrey M. Lee, and Brian P. Anderson. ARC Centre of Excellence for Quantum-Atom Optics, School of Physical Sciences, University of Queensland, Brisbane, QLD 4072, Australia.

We find that vortices and solitons can spontaneously appear in Bose-Einstein condensates formed via evaporative cooling in oblate and prolate harmonic traps. We compare our results with recent experiments, and discuss tests of the Kibble-Zurek mechanism.

11:30am TuB2 — **Knots in spinor Bose-Einstein condensates** **Invited**

Yuki Kawaguchi, Muneto Nitta, and Masahito Ueda. Department of Physics, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan.

We show that knots of spin textures can be created in the polar phase of a spin-1 Bose-Einstein condensate, and discuss experimental schemes for their generation and probe, together with their lifetime.

12:00pm TuB3 — **Topological solitons in double-ring Bose-Einstein condensates**

Joachim Brand, Tania Haigh, and Ulrich Zülicke. Centre for Theoretical Chemistry and Physics and Institute of Fundamental Sciences, Massey University Auckland, Private Bag 102904, North Shore City 0745, Auckland, New Zealand.

We consider rotating BECs in two coupled concentric ring traps. The phase diagram for a co-planar configuration shows a rich structure with topological defects analogous to Josephson Vortices appearing in the ground state.

12:20pm TuB4 — **Atom chip interferometry of Bose-Einstein condensates**

R. Scott, T. E. Judd, and T. M. Fromhold. School of Physics and Astronomy, University of Nottingham, Nottingham, NG72RD, United Kingdom.

I interpret recent experiments on atom chip interferometry of Bose-Einstein condensates. I find that the decay of a soliton into vortices provides a mechanism for measuring the initial phase difference between the two merging clouds.

Lunch Break (12:40pm–2:00pm, Ben Lomond Restaurant)

2:00pm–3:30pm ■ Photonics (Queenstown room)

Dr Stuart Murdoch, Presider

2:00pm TuC1 — **Photonic crystal fibre refractive index sensors** **Invited**

Boris Kuhlmey. CUDOS, School of Physics, The University of Sydney, Sydney, Australia.

We review recent developments in the field of photonic crystal fibre based microfluidic refractive index sensors, in particular using long period gratings, bandgap shifts and ultrasensitive directional couplers.

2:30pm TuC2 — **Design considerations for THz lenses**

Rainer Leonhardt and Yat Hei Lo. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We evaluate the performance of different types of lenses designed for THz imaging. By carefully tailoring the intensity distribution after the lens with the symmetric-pass lens, we are able to achieve a spatial resolution of 0.63λ.

2:50pm TuC3 — **Towards a thermodynamic description of supercontinuum generation**

Stéphane Coen, Benoît Barviau, Bertrand Kibler, and Antonio Picozzi. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Based on the kinetic wave theory, we describe continuous-wave supercontinuum generation as a thermalization process, i.e., an irreversible evolution of the optical field towards a state of maximum nonequilibrium entropy.

3:10pm TuC4 — **10 Gb/s visible source based on sum frequency generation in a PPLN crystal**

Élodie Le Cren and John D. Harvey. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We report the generation of a 10 Gb/s source at 639nm obtained via sum frequency generation in a Periodically Poled Lithium Niobate (PPLN) crystal, with applications in characterizing multimode polymer optical fibres (POFs).

Afternoon Tea (3:30pm–4:00pm, Foyer)

4:00pm–5:40pm ■ Ultra-cold atoms/Quantum optics (Queenstown room)

Dr Maarten Hoogerland, Presider

4:00pm TuD1 — **Dynamics with three-body loss in an optical lattice** **Invited**

Andrew J. Daley, J. M. Taylor, S. Diehl, M. Baranov, and P. Zoller. Institute for theoretical Physics and centre for quantum physics, University of Innsbruck, Technikerstr. 25/2. A-6020 Innsbruck, Austria, and Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences, Technikerstr. 21a, A-6020 Innsbruck, Austria.

Three body loss processes for cold atoms in an optical lattice can be used to dynamically create effective three-body interactions. We investigate the many-body dynamics in this system using quantum trajectories methods with t-DMRG.

4:30pm TuD2 — **Generating and measuring spatial entanglement** **Invited**

Hans-A. Bachor, K. Wagner, J. Janousek, J.-F. Morizur, Honxin Zou, N. Treps, P. K. Lam, and C. Harb. ACQAO at the Australian National University, Canberra, Australia.

Optical entanglement has become a key resourse for quantum information processing and communication. We are presenting here new results on spatial multi-mode entanglement that extend our range of options.

5:00pm TuD3 — **Heat capacity of a Bose-Einstein condensate**

Ina B. Kinski and Andrew C.Wilson. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

We report on recent progress towards the measurement of the heat capacity of a Rb Bose-Einstein condensate. Ultimately, a precise amount of added energy is related to an overall temperature increase of the system.

5:20pm TuD4 — **Scale invariant thermodynamics of a toroidally trapped Bose gas**

Ashton S. Bradley. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

We determine the ideal gas thermodynamics of a system of noninteracting bosonic atoms in a harmonic-Gaussian potential, from the harmonic through to the deep toroid regime where system properties become independent of toroid size.

6:00pm–7:30pm ■ Posters (Wakatipu & Queenstown rooms)

Cocktail hour (6:00pm–7:00pm)

TuP1 — **Thermodynamics of trapped interacting bosons in an optical lattice**

Danny Baillie. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

We model trapped interacting bosons in an optical lattice at finite temperature using a Thomas-Fermi condensate and a semiclassical HFBP depletion. We calculate thermodynamic properties such as the change in temperature during adiabatic loading.

TuP2 — **Quasi-condensation and coherence in the quasi-twodimensional trapped Bose gas**

R. N. Bisset and P. B. Blakie. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

A theoretical investigation of quasi-condensation and coherence in the quasi-two-dimensional trapped Bose gas.

TuP3 — **Time-resolved all fiber fluorescence spectroscopy system**

Andy Y. H. Chen, F. Vanholsbeeck, D.C.S. Tai, S. Swift, N. Singhal, J. D. Harvey, D. A. Hooks, and B. H. Smaill. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We describe a simple fluorescence spectrometry system with a wide variety of biomedical applications. We demonstrate the capabilities of the system by presenting experimental measurements of action potentials in the heart and GFP tagged bacteria.

TuP5 — **Trapping a matter-wave soliton in a well**

Thomas Ernst and Joachim Brand. Centre for Theoretical Chemistry and Physics and Institute of Fundamental Sciences, Massey University Auckland, New Zealand.

We investigate the quantum scattering of a BEC soliton on an attractive well. We present numerical calculations and a theoretical framework that describe phenomena like reflection, resonant transmission and trapping of the soliton.

TuP7 — **Towards exploring ultracold hetero-nuclear KRb systems**

S. Hoinka, A. Rakonjac, C. McKenzie, and A. C. Wilson. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

With our novel KRb experiment we intend to study fermi-bose mixtures of ultracold gases. Having created a double species MOT, we are currently implementing the next steps toward further cooling to the quantum degenerate regime.

TuP9 — **All-fiber variable dispersion compensator for a fiber-based optical coherence tomography system**

Sairam Iyer, Stéphane Coen, and Frédérique Vanholsbeeck. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We report on the design and experimental demonstration of an all-fiber optical coherence tomography system in which residual chromatic dispersion is compensated by a pair of fiber stretchers made with different fiber types.

TuP11 — **Characterization of quantum noise on photon echoes**

Patrick M. Ledingham and Jevon J. Longdell. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

We present results of the investigation of quantum noise on standard photon echoes and controlled reversible inhomogeneous broadening echoes.

TuP4 — **Dynamical formation and interaction of bright solitary waves and solitons in the collapse of Bose-Einstein condensates with attractive interactions**

B. J. Dąbrowska-Wüster, S. Wüster, and M. J. Davis. The University of Queensland, School of Physical Sciences, ARC Centre of Excellence for Quantum-Atom Optics, Qld 4072, Australia.

We model the dynamics of formation of multiple, long-lived, bright solitary waves in the collapse of Bose-Einstein condensates with attractive interactions as studied in the experiment of Cornish *et al.* [Phys. Rev. Lett. **96** 170401 (2006)].

TuP6 — **Macroscopic superpositions in small double well condensates**

Tania Haigh, Andrew Ferris, Matthew J. Davis, and Murray K. Olsen. School of Physical Sciences, The University of Queensland, Queensland 4072, Australia.

We consider small condensates in a double well potential, in particular the creation and detection of macroscopic superposition states. We use a two-mode approximation, and a number state analysis.

TuP8 — **Similariton compression in a comb-like dispersion decreasing fibre**

Sung-Hoon Im, David Méchin, Vladimir Kruglov, and John D. Harvey. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Optical pulse compression using similariton propagation in an optical fibre with decreasing dispersion has been demonstrated by theoretical, numerical and experimental means. This compression scheme can provide pedestal free compression down to 200 fs.

TuP10 — **Cavity-assisted two-photon Raman photoassociation of Bose-Einstein-condensed molecules**

Markku Jääskeläinen. Institute of Fundamental Sciences, Massey University, Private Bag 11 222, Palmerston North, New Zealand.

We study the photoassociation of Bose-Einstein condensed atoms into molecules using an optical cavity field. The stationary solutions for the atoms and molecules as well as the intracavity field are found and their stability properties are determined.

TuP12 — **P-wave pairing in two-component system with mismatched Fermi surfaces close to Feshbach resonance**

Renyuan Liao, Florentin Popescu, and Khandker Quader. Center for Theoretical Chemistry and Physics and Institute of Fundamental Sciences, Massey University, Private Bag 102 904, North Shore MSC, Auckland, New Zealand.

We consider p-wave pairing in two component Fermi gases with mismatched Fermi surfaces. After resolving gap structure, we construct phase diagram across BEC-BCS regimes. We find breached pair superfluid with two Fermi surfaces of gapless excitation (BP2) could be stable in certain parameter regimes.

TuP13 — **All-fiber polarization sensitive Fourier domain OCT**

Norman Lippok, Frédérique Vanholsbeeck, and Poul Nielsen. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We present an all-fiber, real-time, non-invasive imaging technique based on low-coherence interferometry, for modeling and instrumentation of deformation stresses and birefringence properties of skin. Signal acquisition is performed in the Fourier domain and dispersion is compensated and characterized.

TuP14 — **Aspheric lenses for Terahertz imaging**

Yat Hei Lo and Rainer Leonhardt. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We demonstrate novel lens designs for terahertz imaging. Simulations and experimental results show that our symmetric-pass lens performs superior than others in terms of spatial resolution and diffraction, with a focal spot size of about 0.63λ.

TuP15 — **Strong coupling using rare-earth doped whispering gallery mode resonators**

David McAuslan and Jevon J. Longdell. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

This poster will present the parameters that are required to access the strong coupling regime in a rare-earth doped whispering gallery mode resonator, and will discuss the initial progress that has been made towards achieving this aim.

TuP16 — **Sub-micron light structures for trapping and manipulating a single neutral atom**

M. McGovern, T. Grunzweig, and M. F. Andersen. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

Our developments towards the construction of sub-micron dipole traps to experimentally study quantum dynamics of a single trapped ^{85}Rb atom.

TuP17 — **All-fiber ring similariton laser with Raman pump**

John D. Harvey, Vladimir Kruglov, and David Méchin. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We report here the theoretical and numerical predictions of the output parabolic pulses in a ring laser with Raman amplification. These similariton pulses tend toward a parabolic shape and accumulate a linear chirp during the propagation.

TuP18 — **Broadband source for multiplex coherent anti-Stokes Raman scattering**

Priyanth Mehta, Stuart Murdoch, and Rainer Leonhardt. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

A broadband source is developed and investigated for use in Multiplex Coherent Anti-Stokes Raman Scattering Spectroscopy (CARS). The red-detuned supercontinuum based source can drive multiple Raman resonances of a polyatomic molecule.

TuP19 — **Dissipation-driven quantum phase transitions in collective spin systems**

S. Morrison and A. S. Parkins. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Strongly dissipative collective-spin systems are studied where both first and second order dissipation driven quantum phase transitions are shown to occur. The bipartite spin-spin entanglement is found to exhibit pronounced maxima at the critical points.

TuP20 — **Investigation of highly efficient photon echoes**

William Naylor. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

We present analytical and numerical solutions to the Maxwell-Bloch equations investigating an optically rephased two-pulse photon echo. Analytic work follows the approximation scheme of Tsang *et al* 03.

TuP21 — **Entangled photon states through quantum control in a linear cavity array**

Changsuk Noh and Howard J. Carmichael. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We investigate the transfer of a photon by way of time-dependent decay rates along a linear cascaded cavity array. With an appropriate choice of decay rates a maximally entangled state of the cavities is produced.

TuP22 — **Bragg Scattering in semiconductor optical amplifiers**

Richard J. Provo, D. A. Reid, David Méchin, and John D. Harvey. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Bragg Scattering for wavelength conversion of telecommunication data channels in semiconductor optical amplifiers is investigated. 10 Gbit/s data streams with 50 GHz and 100 GHz channel spacings were converted across 10 nm in the C-band.

TuP23 — **Surface plasmon resonances in metal-dielectric-metal materials**

Charles Rohde. Department of Chemistry, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Coupled surface plasmon resonances in metal-dielectric-metal materials provide subwavelength manipulation of light at visible frequencies. Periodic modulation of MDM surfaces produces tunable, enhanced absorption, transmission and asymmetric transmission. These phenomenon are examined theoretically and experimentally.

TuP25 — **Multiple independent four-wave mixing processes**

Jochen Schröder, Anne Boucon, Stéphane Coen, and Thibaut Sylvestre. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We observe multiple, simultaneous, independent four-wave mixing processes. We show that these processes are based on both phasematched and non-phasematched four-wave mixing. Furthermore we demonstrate degenerate four-wave mixing with an incoherent pump based on amplified spontaneous emission.

TuP27 — **Characterisation of 40 Gbit/s NRZ & RZ DPSK optical modulation formats**

Reagan T. Watts, M. A. Roelens, Ben J. Eggleton, and John D. Harvey. Southern Photonics Ltd, Auckland, New Zealand.

Using the linear spectrogram technique, a complete characterisation of 40Gbit/s NRZ & RZ DPSK optical modulation formats was performed. Real-time measurement of the intensity and phase profiles of these phase-encoded modulation formats was also realised.

TuP29 — **The dynamics of vortices in dilute Bose-Einstein Condensates at finite temperature**

B. G. Wild, R. J. Ballagh, and D. A. W. Hutchinson. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

We solve the time-independent Hartree-Fock Bogoliubov (HFB) equations in the rotating frame to obtain stationary solutions for a precessing vortex in a quasi-two-dimensional Bose Einstein condensate (BEC), using a conservation law to determine the precessional frequency. Time-dependent solutions confirm these predictions.

TuP31 — **All fiber widely tunable optical parametric oscillator**

Y. Q. Xu, S. G. Murdoch, R. Leonhardt, and J. D. Harvey. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We present a widely-tunable, all-fiber parametric oscillator. The tuning range of the output spectrum stretches from 1262 nm to 1934 nm. The threshold power is measured to be 700 mW for small frequency shift sidebands.

TuP24 — **Bragg scattering from a BEC close to a Feshbach resonance**

Catarina E. Sahlberg, Rob J. Ballagh, and Crispin W. Gardiner. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

We show that a significant difference in the Bragg spectrum arises from a model employing coupled atom and molecule fields, compared to a single field model. This is qualitatively similar to that observed in recent experiments.

TuP26 — **All optical Bose Einstein condensate and Loschmidt cooling**

Arif Ullah and M. D. Hoogerland. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

The influence of an initial momentum on the appearance of "quantum resonances" in the delta kicked rotor system is explored experimentally. We have shown that for certain initial momenta, a resonance can be negated entirely, whereas at others the resonance can be made to appear. We are also presenting an experimental demonstration of the effective time reversal of the atomic matter waves.

TuP28 — **Photon correlation functions and photon blockade in two-mode cavity QED**

Simon J. Whalen and Howard J. Carmichael. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Using numerical solutions of the master equation, we compute steady state second-order photon correlation functions in a system in which two optical cavity modes interact with a Caesium atom via the $6S_{1/2}, F = 4 \longleftrightarrow 6P_{3/2}, F' = 5$ hyperfine transition.

TuP30 — **Vortex nucleation and non-equilibrium dynamics in a Bose-Einstein condensate at finite temperatures**

T. M. Wright, R. J. Ballagh, A. S. Bradley, P. B. Blakie, and C. W. Gardiner. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

We present a beyond-mean-field model of an atomic Bose-Einstein condensate undergoing mechanical stirring, revealing the dynamical thermalization of the atomic field which facilitates the nucleation and motional-damping of superfluid vortices.

Wednesday, December 10

8:30am–10:15am ■ Quantum optics (Queenstown room)

Dr Scott Parkins, Presider

8:30am WeA1 — **Translating Science into Business?** **Keynote**

Thomas W. Mossberg. LightSmyth Technologies, Inc., 1720 Willow Creek Circle, Ste 520, Eugene, Oregon, 97402 USA.

Many academics consider starting a company based on their work. When is it a good idea? One story of "going commercial" is related here as is an overview of the underlying science behind the adventure.

9:15am WeA2 — **Quantum noise in photon echoes**

Jevon J. Longdell, P. M. Ledingham, W. R. Naylor, M. P. Hedges, and M. J. Sellars. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

Photon echoes maybe produced in two different ways: by the use of strong optical rephasing pulses and by controlling the inhomogeneous broadening. We investigate the quantum noise photon echoes made in both ways.

9:45am WeA3 — **Beyond the vacuum Rabi doublet**

Howard J. Carmichael. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Physics in the nonlinear regime of the dissipative Jaynes-Cummings model is reviewed and attempts to realize its predictions are discussed. Recent experiments in circuit cavity QED are featured.

Morning Tea (10:15am–10:45pm, Foyer)

10:45am–12:35pm ■ Industry session (Queenstown room)

Prof. Howard Carmichael, Presider

10:45am WeB1 — **TBA** **Invited**

Hamish Findley. Photonic Innovations.

11:15am WeB2 — **Southern Photonics research and development at Auckland**

John D. Harvey. Southern Photonics Ltd, Auckland, New Zealand.

Southern Photonics was formed in 2001 to manufacture sophisticated optical pulse characterisation equipment in Auckland for use by research workers worldwide. The talk will cover company development and prospects for the future.

11:45am WeB3 — **Positive experiences of commercial exploitation**

Andrew C. Wilson. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

12:15pm WeB4 — **TBA**

TBA.

12:35pm–1:00pm ■ Students session (Queenstown room)

12:35pm WeC — **Student Committee Formation Meeting**

All students of the Dodd Walls Center are cordially invited to the formation meeting of a Student Committee. Come along, have your say, and elect some representatives!

Free afternoon

Symposium Dinner (Ben Lomond Restaurant)

Cash bar from 7:00pm, Dinner at 7:30pm

Thursday, December 11

8:15am–10:00am ■ Biophotonics (Queenstown room)

Dr Cather Simpson, Presider

8:15am ThA1 — **Photons for functional imaging: Microscopy and optical imaging technologies for in-vivo applications** **Keynote**

Elizabeth M. C. Hillman. Laboratory for Functional Optical Imaging, Departments of Biomedical Engineering and Radiology, Columbia University, New York, 10027, USA.

In-vivo optical imaging can allow detailed observation of tissue function. A range of novel in-vivo optical imaging technologies will be described, and applications for brain, cardiac, skin and whole-body small animal imaging will be demonstrated.

9:00am ThA2 — **Holographic aperture synthesis and other spatial frequency-domain approaches to wide-field microscopy** **Invited**

David D. Sampson, Timothy R. Hillman, Thomas Gutzler, and Sergey A. Alexandrov. Optical & Biomedical Engineering Laboratory, School of Electrical, Electronic & Computer Engineering, University of Western Australia, Australia.

The three-dimensional spatial frequency domain representation of transfer functions is applied to proposed novel coherent and incoherent approaches to high-resolution imaging of biological samples. The coherent approaches use Fourier holography. The incoherent approach uses wavelength encoding of spatial frequencies.

9:30am ThA3 — **Functional and structural all fiber in-vivo imaging**

Frédérique Vanholsbeeck, Andy Y. H. Chen, Sairam Iyer, Norman Lippok, Stéphane Coen, John D. Harvey, and Bruce H. Smaill. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

With fluorescence imaging resolving the electrical activity and optical coherence tomography giving a histological overview of the organ under study, we have a complete set of tools to get a better insight of the physiology of electrically active organs.

Morning Tea (10:00am–10:30pm, Foyer)

10:30am–12:10pm ■ Photonics/Biophotonics (Queenstown room)

Dr Stéphane Coen, Presider

10:30am ThB1 — **Advances in nonlinear microscopy** **Invited**

Allister I. Ferguson. Department of Physics, University of Strathclyde, Glasgow G4 0NG, Scotland, UK

Nonlinear optical techniques have revolutionised optical microscopy and has opened a new vista in imaging in the life sciences. I will review some recent progress using examples from work undertaken at the University of Strathclyde. This will include multi-photon microscopy, coherent anti-Stokes Raman scattering microscopy and the use of adaptive optics to improve image quality.

11:00am ThB2 — **Ultrafast nonlinear optics on a photonic chip** **Invited**

Ben J. Eggleton. CUDOS, School of Physics, The University of Sydney, Sydney, Australia.

11:30am ThB3 — **The photon factory in the Dan Walls Centre**

Cather Simpson. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

The Dan Walls Centre for Pure and Applied Optics is establishing a state-of-the-art multi-user laser centre, with a wide variety of pulse widths, energies, wavelengths, and repetition rates. The current capabilities and status will be described, and future plans discussed.

11:50am ThB4 — **Quantum dynamics of coupled triple well condensates**

C. V. Chianca, K. Dechoum, and Murray K. Olsen. ARC Centre of Excellence for Quantum-Atom Optics, School of Physical Sciences, University of Queensland, Brisbane, QLD 4072, Australia.

We investigate a three mode model of a triple well BEC system and calculate population and entanglement dynamics using the truncated Wigner representation.

Lunch Break (12:10pm–1:30pm, Ben Lomond Restaurant)

1:30pm–3:00pm ■ Quantum optics (Queenstown room)

Prof. Howard Carmichael, Presider

1:30pm ThC1 — **Mesoscopic superpositions of quantum phases and quantum states via Rydberg interactions** **Invited**

Peter Zoller. Institute for Quantum Optics and Quantum Information, University of Innsbruck, Austria.

We propose and analyze a scheme to entangle a single atom with a mesoscopic ensemble of cold atoms. The particular protocol is based on a dipole blockade mechanism for Rydberg excited atoms in combination with EIT.

2:00pm ThC2 — **Conditional quantum dynamics in cavity QED with microtoroidal resonators**

A. S. Parkins. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

Recent theoretical and experimental results for cavity QED with microtoroidal resonators are presented, including the demonstration of conditional quantum dynamics with single photons and single atoms.

2:20pm ThC3 — **Uncertainty inequalities as entanglement criteria**

Hyunchul Nha. Department of Physic, Texas A & M University at Qatar, PO Box 23874, Doha, Qatar.

We show that uncertainty relations are both sufficient and necessary to determine legitimate quantum states in general. The explicit construction in this proof can be used to systematically derive entanglement criteria in experimentally accessible forms.

2:40pm ThC4 — **Experiments with an all-optical BEC**

Maarten D. Hoogerland. Department of Physics, The University of Auckland, Private Bag 92019, Auckland, New Zealand.

We show results from the most recent experiments using the alloptical BEC in Auckland. We explore the delta-kicked rotor system over a range of parameters, and discuss new experiments.

Afternoon Tea (3:00pm–3:30pm, Foyer)

3:30pm–5:10pm ■ Ultra-cold atoms (Queenstown room)

Prof. Rob Ballagh, Presider

3:30pm ThD1 — **Ultracold bosons in lattices with binary disorder** **Invited**

K. V. Krutitsky, M. Thorwart, R. Egger, and R. Graham. Fachbereich Physik der Universität Duisburg-Essen, Campus Duisburg, Lotharstr. 1, 47048 Duisburg, Germany.

Quantum phases of ultracold bosons with repulsive interactions in lattices in the presence of quenched disorder are investigated. The disorder is assumed to be caused by the interaction of the bosons with impurity atoms having a large effective mass. The phase diagram as well as experimentally accessible quantities are calculated in various regions of parameter space by using several methods.

4:00pm ThD2 — **Molecules and Feshbach resonances treated by c-field techniques**

Crispin Gardiner, Catarina Sahlberg, and Andrew Haines. The Jack Dodd Centre for Quantum Technologies, University of Otago, 730 Cumberland street, Dunedin, New Zealand.

I will review progress on treating the Bose Nova, and Bragg scattering from condensates in which the scattering length is enhanced by a Feshbach resonance.

4:30pm ThD3 — **Kelvin waves, varicose waves and superfluid turbulence in trapped Bose-Einstein condensates**

Tapio Simula, Takeshi Mizushima, and Kazushige Machida. Mathematical Physics Laboratory, Department of Physics, Okayama University, PO Box 700-8530, Okayama, Japan.

I will discuss the creation, dispersion relations, dynamics, and decay of both Kelvin waves and varicose waves of quantized vortex lines in trapped Bose-Einstein condensates with a reference to a Kelvin-wave cascade and superfluid turbulence.

4:50pm ThD4 — **Force on an impurity moving through a 1D Bose Einstein condensate at subcritical velocities**

Andrew Sykes, Matthew J. Davis, and David Roberts. ARC Centre of Excellence for Quantum-Atom Optics, School of Physical Sciences, University of Queensland, Brisbane, QLD 4072, Australia.

We study the drag force acting on an impurity moving through a 1D Bose-Einstein condensate in the presence of both thermal and quantum fluctuations. We find nonzero force is exerted on the impurity even at subcritical velocities due to the surplus of fluctuations propagating downstream as opposed to upstream.

Author index